Automotive Technician Training

Tom Denton

Worksheets and Assignments

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If I have used any information, or mentioned a company name that is not listed here, please accept my apologies and let me know so it can be rectified as soon as possible.

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Brakes

Tasklist worksheets

1.Service disc brakes.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Jack up and support the vehicle on stands or use a suitable hoist. Remove the appropriate wheels.

Inspect the brake pads. Recommendations vary slightly but in most cases, the pads should be replaced if the lining is less than 1.5mm.

Methods of pad removal vary so check the manufacturer's data. However, most types are quite simple. The method described here relates to the type where part of the caliper is removed. Turn the steering to a lock position to allow easy access to the caliper and pads.

Wash the caliper and pad assembly using a proprietary brake cleaner or suitable extractor.

If necessary, remove some brake fluid from the reservoir. This is because when the piston is pushed back to allow new pads to be fitted, fluid can overflow.

If a retaining bolt clip if fitted, it should be removed. Undo both caliper piston fixing bolts. Many types require an Allen key.

Rock the assembly side to side. This moves the pads and pushes the piston in, just far enough to allow the caliper piston to be removed. Withdraw the pads. Use a small lever to help, if a spring clip holds one of the pads into the piston. Keep the pads to show to the customer if necessary and then dispose of them in line with current regulations.

Examine the disc rotor for grooves and corrosion.

Use a G/C clamp to push the caliper piston fully home. Fit the new pads in position together with anti-squeal shims if fitted. Some manufacturers recommend that copper grease be applied to the back and sides of each pad. Take care not to contaminate the lining. Repeat the process on the other side of the vehicle. Pads on both sides must always be replaced as a set.

Refit the caliper and tighten both bolts to the recommended torque.

Pump the brake pedal until it feels hard. This is to make sure the pads are moved fully into position. Double check correct fitment and then refit the road wheels and tighten wheel nuts to recommended torque. Lower the vehicle to the ground.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

2.Service drum brakes.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Jack up and support the vehicle on stands or use a suitable hoist. Remove the appropriate wheels. Release the parking brake.

Remove the cap that protects the hub nut. Remove the locking tab or pin if used. Undo the nut and remove the outer bearing. Remove the drum together with the inner bearing.

OR Remove the drum fixing screw and remove the drum.

Wash the backplate, shoes and drum assembly using a proprietary brake cleaner or suitable extractor.

Inspect the brake shoes. Recommendations vary slightly but in most cases, the shoes should be replaced if the lining is less that about 1.5mm. Methods of shoe removal vary so check the manufacturer's data.

Inspect brake drum for grooving. Refinish a grooved drum with a brake drum lathe if allowable. Consult manufacturer's recommendations

Remove the shoe hold-down fixings if fitted. These usually twist or pull free. Note the position of the shoe return springs and remove them with special brake spring tool if necessary. Remove the handbrake cable. On some vehicles, the shoes can be removed together with the handbrake cable, adjuster and return springs, which can then be taken off.

Check the wheel cylinders for leaks by peeling back the dust seals. The cylinders should be overhauled or replaced if leaks are detected. Discard the old shoes in line with current regulations but keep them for the customer to examine if necessary.

Clean off the backplate. Apply special grease to the shoe contact points. Note that ordinary grease will not stand the high temperatures. Fit the return springs and adjuster to the new shoes. Fit the shoes to the backplate, making sure they fit into the lower pivot and wheel cylinder slots. Use a shoe retractor to lever the shoes in to place.

Refit the handbrake cable and shoe hold-down clips. Make sure the shoes are centralized. Pre-adjust brake shoes and parking brake before installing brake drum/hub assembly and wheel bearing. Refit the drum, bearings and nut. Tighten to the correct torque. OR Refit the drum and fixing screw.

Pump the brake pedal until it feels hard. This is to make sure the shoes are adjusted and moved fully into position. Check for correct fitment and that the drum spins freely, then refit the road wheels tightening to the correct torque. Lower the vehicle to the ground.

Road test to ensure correct operation. Remember to check the handbrake operation and adjust the cable if necessary.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

3.Remove, overhaul and refit brake caliper.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove (note that fixing methods vary so refer to manufacturer's procedures)

Raise and support the vehicle. Remove the wheel. Clean away any dust using a proprietary cleaning system.

Undo the securing bolts and inspect them for wear or damage. Remove the brake pads.

Clamp the flexible brake pipe using a proper pipe clamp.

Undo the pipe from the caliper. Note that it may be necessary to remove the caliper assembly and turn it to unscrew the pipe connection. Have plenty of paper or rags handy to catch spilt fluid.

Overhaul

To remove the piston from the caliper it is usually necessary to direct compressed air into the flexible pipe connection on the caliper.

Use lots of paper or rags to catch lost fluid and protect the piston. It may be expelled with quite some force – take care.

Once the piston has been removed, take some time to clean up the spilt fluid. Remove the rubber dust seal if fitted.

Depending on design, the piston seal will be part of the piston or part of the caliper cylinder. Note carefully how it is fitted and remove with a plastic or wooded tool.

Inspect the piston and bore for signs of scratches, corrosion or excessive wear. If any serious damage is noted, the complete unit should be replaced. Light corrosion may be removed using a honing tool or very fine emery paper.

Thoroughly clean all parts using brake fluid or a brake system cleaner. Do NOT use petroleum-based solvents.

Dry all parts using compressed air. Cleanliness is very important.

Lubricate the new piston seal with clean brake fluid and install it. Make sure it is fitted the correct way round. Refit the piston into the cylinder. Refit the dust seal if used.

Refit

Screw the flexible pipe into the caliper and refit the caliper mounting bolts. Make sure the pipe connection is secure.

Refit the pads and secure in position as required. Remove the brake pipe clamp.

The system will now require bleeding to remove air. This may be done using a pressure bleeder or a simple tube and bottle system! Where just one corner of the car has been disturbed, and a pipe clamp used, it is usually possible to just bleed that part.

If the age of the brake fluid is unknown, it is advisable to flush the hydraulic system and bleed the complete system.

NOTE: Brake fluid is hygroscopic, this means that it will absorb moisture from the atmosphere. Use only brake fluid from a new container or one that is known to have been recently opened. Do not store brake fluid for long periods of time.

Connect a small pipe to the bleed nipple and place the other end into a clear bottle that is part full with clean brake fluid. Release the bleed nipple - about half a turn is usually enough.

Get an assistant to pump the brake pedal slowly, whilst making sure the fluid reservoir remains topped off.

Watch the bottle and when no more air is being expelled, get your assistant to hold the brake pedal down – and then tighten the bleed nipple.

Make sure the reservoir is topped off to the correct level and check that the brake pedal feels hard when operated.

Check for leaks, refit the wheel and lower the car to the ground. Road test to ensure correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

4.Remove, overhaul and refit brake wheel cylinder.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove (note that fixing methods vary so refer to manufacturer's procedures)

Raise and support the vehicle. Remove the wheel.

Undo the securing bolt or the hub nut and remove the brake drum. Clean away any dust using a proprietary cleaning system.

Clamp the flexible brake pipe using a proper pipe clamp.

Remove the brake shoe hold down clamps and the brake return springs and inspect for wear. Remove the handbrake cable if appropriate.

Undo the pipe from the cylinder. Have plenty of paper or rags handy to catch any spilt fluid.

Undo the cylinder securing bolts and remove it from the backplate.

Overhaul (description refers to a double-acting cylinder)

Remove the rubber dust seals. To remove the pistons from the cylinder, grip the ends with pliers and remove carefully. Only grip the part that normally contacts the shoes.

Use lots of paper or rags to catch lost fluid and protect the piston(s).

Once the piston has been removed, take some time to clean up the spilt fluid.

Note carefully how the seals are fitted and remove them with a plastic or wooded tool.

Inspect the pistons and bore for signs of scratches, corrosion or excessive wear. If any serious damage is noted, the wheel cylinder should be replaced. Light corrosion may be removed using a honing tool or very fine emery paper.

Thoroughly clean all parts using brake fluid or a brake system cleaner. Do NOT use petroleum-based solvents.

Dry all parts using compressed air. Cleanliness is very important.

Lubricate the new piston seals with clean brake fluid and install them carefully. Make sure they are fitted the correct way round. Refit the pistons into the cylinder. Refit the dust seals.

Refit

Screw the cylinder on to the backplate and fit the flexible pipe. Make sure the pipe connection is secure.

Refit the shoes and secure in position as required. Refit the brake drum and secure in position with the screw or hub nut as appropriate. Remove the brake pipe clamp.

The system will now require bleeding to remove air. This may be done using a pressure bleeder or a simple tube and bottle system! Where just one corner of the car has been disturbed, and a pipe clamp used, it is usually possible to just bleed that part.

If the age of the brake fluid is unknown, it is advisable to flush the hydraulic system and bleed the complete system.

NOTE: Brake fluid is hygroscopic, this means that it will absorb moisture from the atmosphere. Use only brake fluid from a new container or one that is known to have been recently opened. Do not store brake fluid for long periods of time.

Connect a small pipe to the bleed nipple and place the other end into a clear bottle that is part full with clean brake fluid. Release the bleed nipple - about half a turn is usually enough.

Get an assistant to pump the brake pedal slowly, whilst making sure the fluid reservoir remains topped up.

Watch the bottle and when no more air is being expelled, get your assistant to hold the brake pedal down – and then tighten the bleed nipple.

Make sure the reservoir is topped off to the correct level and check that the brake pedal feels hard when operated.

Check for leaks, refit the wheel and lower the car to the ground. Road test to ensure correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

5.Remove and replace brake lines

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Flexible Hose: Free the hose away from any mounting brackets.

Using two close-fitting wrenches, disconnect the hose-to-rigid pipe union. Unscrew the hose from the caliper or wheel cylinder as applicable. When reconnecting pipe or hose fittings, note that the seal is made at the swaged end of the pipe, so do not continue to tighten a union if it is tight, yet still stands proud of the surface into which it is screwed.

A flexible hose must never be twisted, but a slight 'set' is permissible to give clearance from components. Rigid Brake Lines: Rigid pipes may be made to a pattern of the one removed from the vehicle.

Determine the length of tube to be cut. This can be achieved easily by holding a piece of string or cord against the old pipe. Cut to length using a tube cutter. Fit required unions to tube. Check they are the right way round. Clamp tube in flaring tool and flare tube ends.

Note: Male unions require a convex flare, which is produced by a die commonly labeled OP1. Female unions require a concave or double flare. To produce a convex flare, flare the tube using (OP1) followed by a second flaring with a die labeled OP2. Do not attempt to go straight to OP2 as this may split the tube.

Using the original pipe as a pattern, bend the tube to shape using a tube bender. Fit the pipe to the vehicle ensuring the pipe is securely clipped to the vehicle chassis.

When reconnecting pipe or hose fittings, note that the seal is made at the swaged end of the pipe, so do not continue to tighten a union if it is tight, yet still stands proud of the surface into which it is screwed.

Bleeding the System: The system will now require bleeding to remove air. This may be done using a pressure bleeder or a simple tube and bottle system! Where just one corner of the car has been disturbed, and a pipe clamp used, it is usually possible to just bleed that part.

Connect a small pipe to the bleed nipple and place the other end into a clear bottle that is part full with clean brake fluid. Release the bleed nipple - about half a turn is usually enough.

Get an assistant to pump the brake pedal slowly, whilst making sure the fluid reservoir remains topped off.

Watch the bottle and when no more air is being expelled, get your assistant to hold the brake pedal down – and then tighten the bleed nipple. Make sure the reservoir is topped off to the correct level and check that the brake pedal feels hard. Check for leaks, refit the wheel and lower the car to the ground. Road test to ensure correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

6.Remove and refit brake master cylinder

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Removal: Remove fluid from reservoir and place rags to collect spillages.

Remove any ancillary equipment so as to gain access to the master cylinder pipes and connections.

Disconnect any warning light wires.

Undo the brake pipe unions and make sure brake fluid does not contact paintwork.

Most cylinders can now be removed by undoing the two main securing nuts or bolts (check specs. If necessary.

Remove the unit from the vehicle.

Refit:

If required by the manufacturer, bench bleed the replacement master cylinder. Use special pipes to connect the outlets back into the reservoir to do this.

Refitting is now a reversal of the removing process.

The system will now require bleeding to remove air. This may be done using a pressure bleeder or a simple tube and bottle system. If the age of the brake fluid is unknown, it is advisable to flush the hydraulic system and bleed the complete system.

NOTE: Check the manufacturer's specs. Because some systems should be bled in a particular sequence.

NOTE: Brake fluid is hygroscopic, this means that it will absorb moisture from the atmosphere. Use only brake fluid from a new container or one that is known to have been recently opened. Do not store brake fluid for long periods of time.

Connect a small pipe to the bleed nipple and place the other end into a clear bottle that is part full with clean brake fluid. Release the bleed nipple - about half a turn is usually enough.

Get an assistant to pump the brake pedal slowly, whilst making sure the fluid reservoir remains topped off.

Watch the bottle and when no more air is being expelled, get your assistant to hold the brake pedal down – and then tighten the bleed nipple.

Make sure the reservoir is topped off to the correct level and check that the brake pedal feels hard when operated.

Check for leaks and 'road' test to ensure correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

7.Remove and refit wheel bearings

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Front hub assembly: Apply the handbrake, se the front of the vehicle; remove road wheel.

Remove the drive shaft nut split pin, use an assistant to apply firm pressure to the brake pedal and, while the brake is applied, unscrew the drive shaft nut. Remove the brake caliper and support it to prevent straining the hose. Remove the disc.

Using a ball joint breaker tool, disconnect the ball joint from the steering lever. Unscrew the nuts and remove the bolts to release the strut from the hub assembly. Unscrew the nut and remove the clamp bolt securing the lower ball joint to the hub assembly and, using a suitable lever placed between the lower arm and the anti-roll bar, lever downwards to release the ball joint from the hub. Remove the hub assembly from the drive shaft.

Extract the inner oil seal and spacer and the outer oil seal. Drive out one of the bearings, invert the hub and drive out the remaining bearing. Inspect the bearings for signs of wear and damage, renew as necessary. Pack the bearings with suitable grease and press them into the hub. Fit the oil seal spacer and fit the oil seals.

Locate the hub on the drive shaft, fit the flat washer and drive shaft nut and tighten the nut finger tight. Fit the hub assembly to the lower ball joint, fit the clamp bolt and tighten the nut. Fit the hub to the strut, fit the bolts and tighten the nuts to the correct torque.

Connect the ball joint to the steering lever and fit and tighten the nut. Fit the disc to the drive flange and tighten the securing screws. Fit the brake caliper. Use an assistant to apply firm pressure to the brake pedal and, while the brake is applied, tighten the drive shaft nut to the correct torque. Lock the nut with a new split pin. Rear hub assembly: Chock the front wheels and slacken the rear wheel nuts, raise the rear of the vehicle, support it on stands and remove the road wheel. Withdraw the grease retainer cap from the center of the hub and extract the split pin.

Unscrew the hub nut, remove the flat washer and withdraw the hub and brake drum assembly. Extract the hub oil seal, drive the inner bearing out and collect the spacer. Invert the hub and brake drum assembly and drive out the outer bearing. Inspect the bearings for signs of wear and damage, renew as necessary.

Pack the bearings with suitable grease and press the outer bearing into the hub with the side marked 'THRUST' facing outwards. Invert the hub, fit the spacer and press the inner bearing, with the side marked 'THRUST' outwards into the hub. Dip the new oil seal in oil and press it into the hub (sealing lip facing inwards). Fit the hub and brake drum assembly to the stub shaft, fit the flat washer and fit and tighten the hub nut to the correct torque. Lock the nut with a new split pin. Measure drive axle flange run-out and shaft endplay. Fit the grease retainer cap, then fit the road wheel and nuts.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

8.Remove and refit driveshaft.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Apply the handbrake and slacken the road wheel nuts.

Raise the front of the vehicle, support it on stands and remove the road wheel.

Remove the driveshaft nut split pin or lock tab.

Use an assistant to apply the footbrake and then remove the driveshaft nut and washer.

Split the steering track rod end from the steering arm and remove it.

Remove the bolts securing the hub to the suspension strut.

Pivot the hub outwards to the limit of its movement but take care not to strain the brake hose.

Maneuver the drive shaft from the hub.

Carefully lever between the driveshaft inner joint and the differential housing to release the spring ring. Withdraw the driveshaft.

To refit, slide the shaft into the differential housing until the spring ring engages.

Maneuver the outer end of the drive shaft into the hub and fit the nut and washer. A new nut may be required by some manufacturers.

Refit the suspension strut and the steering joint.

Use an assistant to apply the footbrake and then tighten the driveshaft nut to the specified torque. Fit a new split pin or knock in the tab as required.

Refit the road wheel and lower the vehicle. Torque the wheel nuts and road test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

9.Remove and refit antilock braking system (ABS) hydraulic unit.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Removal: Disconnect the battery negative lead. Depressurize the hydraulic system by pumping the brake pedal at least 20 times, or until it becomes hard. Prepare to deal with spilt brake fluid. Have a supply of clean water and plenty of old rags at hand.

Label and disconnect the six multi-plugs from the hydraulic unit. Disconnect the pump plug. Unbolt the earth/ground strap from the unit.

Mark the hydraulic pipes in order for them to be reconnected in their original positions, then disconnect them. Plug the ends to prevent the ingress of dirt and fluid leakage. From inside the vehicle, disconnect the brake pedal. Have an assistant support the unit whilst you remove the mounting nuts from inside the vehicle. Withdraw the unit. Unscrew the accumulator from the unit Drain fluid from the reservoir.

Refit: Fit a new 'O' ring the accumulator, fit to the hydraulic unit and tighten it. Refitting is now a reversal of the removing process.

Note: Do not fill the reservoir until refitting is complete. Use a new gasket between the unit and the bulkhead. Ensure hydraulic pipes are reconnected to the correct unions.

Reconnect the battery. Switch on the ignition and check that the hydraulic unit pump stops within 60 seconds; if not, the accumulator is likely to be faulty.

The system will now require bleeding to remove air. This may be done using a pressure bleeder or a simple tube and bottle system! Where just one corner of the car has been disturbed, and a pipe clamp used, it is usually possible to just bleed that part. Identify and use the correct type of brake fluid.

If the age of the brake fluid is unknown, it is advisable to flush the hydraulic system and bleed the complete system.

Connect a small pipe to the bleed nipple and place the other end into a clear bottle that is part full with clean brake fluid. Release the bleed nipple - about half a turn is usually enough.

Get an assistant to pump the brake pedal slowly, whilst making sure the fluid reservoir remains topped up.

Watch the bottle and when no more air is being expelled, get your assistant to hold the brake pedal down – and then tighten the bleed nipple. Make sure the reservoir is topped off to the correct level and check that the brake pedal feels hard when operated. Check for leaks, refit the wheels and lower the car to the ground. Road test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

10.Check braking system operation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Two methods are used for braking system efficiency tests. These are road testing and brake roller testing. For roller testing follow the manufacturer's instructions.

CAUTION – Before testing brakes, carry out an examination of general brake component condition. This will include: measure and adjust pedal height, check master cylinder for fluid leaks, visual inspection of brake lines and flexible hoses. Do not road test a vehicle in a dangerous condition.

IN THE SHOP: Raise the vehicle on a hoist or a jack and stands. Make sure it is supported securely. Check the brake fluid level and top up as required. Inspect all metal brake pipes for signs of corrosion, leakage and kinks.

Inspect all flexible pipes for leaks, 'ballooning', kinks and wear. Get an assistant to apply pressure to the brake pedal as you examine the flexible pipes. The pipes may move slightly but should not expand.

Inspect the master cylinder for internal and external leaks and proper operation. Inspect the servo assembly for signs of leakage. Check servo operation by applying pressure to the pedal and starting the engine. Your foot should move further down as the engine starts and servo assistance is applied.

Measure brake pedal height and compare to manufacturers specification. Check parking brake cables and components for wear, rusting, binding and corrosion. If fitted, inspect and test hydro-boost system and accumulator for leaks and proper operation.

ROLLER TEST: Carry out roller brake test. Measure braking force at each wheel when applying the foot and hand brake separately. Low efficiency will be caused by either low friction value e.g. worn pads/shoes, worn drums/discs, contamination, etc. or reduced hydraulic pressure e.g. seized caliper/cylinder, faulty pressure control valve. Whatever the cause it must be investigated and rectified.

ROAD TEST: Once you are satisfied with all the above tests then a road test should be carried out. Ideally, this should be on a private road or area in good dry conditions (inaccurate diagnosis can be made in wet conditions – wheels tend to lock at lower speeds) From a slow speed, brake gently and then gradually increase the speed as you become confident in the operation of the brakes. At a slow speed brake harder and note the feel of the steering wheel. If the wheel pulls one way, it indicates uneven braking is being applied to the front wheels. Apply the parking brake when the vehicle is not moving. Engage a gear and try to pull away. The engine will usually 'win' but this test gives a good feel for the parking brake performance! During the above tests, check for general stopping power, pedal pulsation, vibration and any unusual noises. Locking of the rear brakes during braking may indicate a faulty proportioning or load-sensing valve. On return to the shop, strip and inspect the brakes as required.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

11.Check vacuum servo unit operation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Ensure that the engine is in good running order because the vacuum servo is powered by a connection to the intake manifold. Check for air leaks as foot pressure is applied.

Check servo operation by applying pressure to the pedal and starting the engine. Your foot should move further down as the engine starts and servo assistance is applied. It may not be necessary to check further if this test result is satisfactory. However, a thorough test is always advisable.

Shut off the engine and wait five minutes. Apply the brakes and check that servo assistance is available for at least one application. This indicates a good air seal, if vacuum is retained.

Connect a vacuum gauge to the inlet manifold and note the reading with the engine running at idle. A reading of about 0.5 bar is typical.

Connect a vacuum gauge to the servo pipe, after the check valve, and note the reading with the engine running at idle. The reading should be the same as before. If not, check the pipe for kinks, blockages.

Make sure the check valve blocks when you blow from the manifold end. Replace if in any doubt.

Reconnect all parts and check for leaks.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

12.Inspect and measure brake disc thickness and run out.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Jack up and support the vehicle. Remove the appropriate wheels. Select neutral if the wheels are on the driven axle.

Lever the pads back just enough to allow the disc to rotate freely.

Inspect the surface of the disc for signs of cracking and grooves. Small grooves are to be expected after a period of use. Grooves deeper than about 0.4 mm are usually considered excessive.

Using a micrometer, measure the thickness of the disc at several different places around the disc, towards the center and towards the outer edge.

Compare the readings to the manufacturer's specifications. Some manufacturers stamp the minimum thickness just inside the center of the disc.

Mount a dial gauge (dial indicator) on a magnetic, or other appropriate type of stand, with the plunger running about 15 mm in from the outer edge of the disc.

Zero the gauge and rotate the disc. Take note of changes in the dial gauge reading.

Refinish a grooved disc if allowable. Consult manufacturer's recommendations.

Refer to the manufacturer's specifications for maximum allowable run out. As a guide, 0.15 mm is usually considered the limit. Replace discs with excessive run out.

Refit all components and lower the vehicle to the ground.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

13.Inspect antilock brake system and measure wheel sensors.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: There are many types of ABS. Check the latest data before starting work.

Carry out simple 'hand & eye tests' – fluid levels, connection security, leaks, etc.

Check the battery condition, fuses/supplies to ECU and that the operation of the normal brakes is correct.

Check operation of ABS warning light.

Support the vehicle securely on a wheel-free hoist or axle stands.

Inspect the wheel speed sensors and makes sure the reluctor wheel and sensor gap is clean, free from corrosion and in good condition.

Check wheel sensor operation. A clean regular sine wave output proportional to wheel speed should be shown on a scope. If testing with an ohmmeter, disconnect before measuring and note that the resistance of each sensor should be the same.

The results of sensor tests at the ECU connections should be the same as at the sensor. If so, this confirms the wire continuity from the sensors to ECU.

Reset fault memory in ECU by disconnecting the ABS fuse for 10 seconds.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

14.Check antilock braking system (ABS) operation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: There are many types of ABS. Check the latest data before starting work.

Carry out simple 'hand & eye tests' – fluid levels, connection security, leaks, etc.

ABS and Traction Control systems share components, however vehicles fitted with traction control will commonly have a traction control switch fitted. The position and operation of this should be checked.

Check the battery condition, fuses/supplies to ECU and that the operation of the normal brakes is correct.

Check operation of ABS warning light.

Check for fault codes stored by the ECU using scan tool.

Check the vehicle tire size, curb height and final drive ratio are the same as the original manufacturer's specification.

Note: Whilst it is possible to calculate the final drive ratio from the number of input and output turns, it will be easier to consult the vehicle history file if this is available.

Road test and check for poor stopping, wheel lock-up, abnormal pedal feel or pulsation and noise concerns.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

15.Inspect and test hydraulic brake booster system

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Visually check all brake pipe unions and connections for signs of leakage.

Top off the reservoir with the correct fluid.

Check for leaks from accumulator, pump and operating cylinder.

Clean off any areas where leaks may be occurring.

Check and adjust pressure pump drive belt tension.

Check booster operation by applying pressure to the pedal and starting the engine. Your foot should move further down as the engine starts and servo assistance is applied.

Listen for unusual noise from the system, accumulator, pump and operating cylinder.

Check brake pedal height and compare to specifications

Finally check again for signs of fluid leaking.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

16.Inspect, test, replace and adjust brake system valves.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Many vehicles have valves fitted into the braking system. They are commonly fitted to prevent the rear wheels locking before the front wheels, regardless of whether the vehicle is heavily or lightly loaded. They achieve this by reducing pressure to the rear brakes during high decelerations.

NOTE: Vehicle manufacturer service information relevant to the vehicle being worked on should be consulted before carrying out this task.

Inspection and Testing: With the vehicle on the ramp, inspect the valve for security of mountings and fluid leaks. When fitted, lift dust covers on the valve: the area revealed may be slightly moist but should not be wet.

Once you are satisfied with all the above tests then a road test should be carried out. Ideally, this should be on a private road or area in good dry conditions (inaccurate diagnosis can be made in wet conditions – wheels tend to lock at lower speeds).

From a slow speed, brake gently and then gradually increase the speed as you become confident in the operation of the brakes.

At a slow speed brake harder and note if the rear brakes lock before the front. This will give rise to handling problems and must therefore this test must be carried out with caution.

Note: It is common for these valves to be a sealed unit i.e. they should not be dismantled for overhaul. Consult the manufacturer's service manual or bulletins.

Removal and Refitting: Inertia Types: Remove brake pipes from valve, keeping fluid spillage to a minimum. Remove valve mounting bolts and remove valve. Refitting is the reverse of dismantling. Check pipes are fitted to correct valve ports. Bleed the brakes.

Load Sensing Types: Disconnect the valve operating lever from the axle. Remove brake pipes from valve, keeping fluid spillage to a minimum. Remove valve mounting bolts and remove valve. Refitting is the reverse of dismantling. Check pipes are fitted to correct valve ports. Bleed the brakes. Reconnect the operating lever to the axle.

The valve will commonly now need adjusting. The vehicle should be standing on its road wheels, unladen at normal curb weight i.e. no driver or load but full tank of fuel.

A measurement will now be taken between two reference points e.g. position on axle and position on valve lever. Alternatively, a workshop manual may provide a template for the manufacture of a 'gap gauge' to be fitted between axle and body. The operating lever movement may now be adjusted.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

17.Inspect, test and replace brake warning lights.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check stop light operation and adjust switch position.

Remove the two wires from the stoplight switch and bridge them together with a fused jumper wire. The ignition may need to be switched on.

The stoplights should light. If not, trace the circuit for a break starting with the fuse.

If the lights work when the switch is bridged, the switch needs replacing or adjusting.

Most switches are positioned above the brake pedal and have a screwed body with adjusting nuts. These switches make contact as the plunger springs out.

Adjust the switch position so that the lug on the brake pedal allows the plunger to move as soon as the pedal is pushed down.

Check that the switch is not too sensitive, such that the lights flash on due to vibration for example.

Secure all wires and adjusting nuts – check operation again. Check parking brake indicator light/audible warning:

This is a generic test routine; refer to manufacturer's procedures and circuits for specific details.

Apply the handbrake. Switch the ignition on but do not start the engine.

Check that the parking brake warning light is illuminated on the dashboard. If the warning light does not illuminate, check switch adjustment, if OK, simply bridging the switch contact will confirm a sound circuit.

Release the handbrake and check the warning light extinguishes. If not check switch adjustment.

For vehicles fitted with an audible warning device, start the engine and drive vehicle from its position of rest with the handbrake partially applied. The audible warning device should be heard.

Check brake warning light: This is a generic test routine; refer to manufacturer's procedures and circuits for specific details.

Release parking brake and switch ignition.

Check that the general brake warning light is not illuminated on the dashboard. If illuminated check front brake pads for wear, and the master cylinder fluid level. Correct as appropriate.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

Assignments

General Brake System Diagnosis

Task 1:

State **one** cause of each of the following braking system faults:

spongy pedal

excessive pedal travel

excessive force required on pedal to engage brakes

Answer:

Task 2:

State **three** causes, other than driving technique, of premature friction lining wear.

Answer:

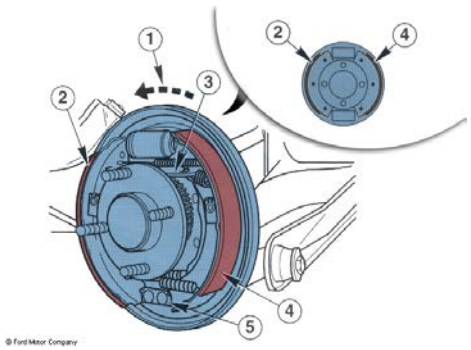
Task 3:

The picture shows a leading and trailing brake shoe assembly.

State which is the leading shoe.

State how the leading shoe is identified.

Explain why a leading and trailing brake shoe arrangement would be fitted to the rear axle when a twin leading brake shoe arrangement is fitted to the front axle.



Answer:

Task 4:

Draw a line diagram to show the piping layout of a hydraulic braking system, to include disc brakes at the front, drum brakes at the rear and a diagonal split piping layout.

Answer:

Task 5:

State **one** symptom of **each** of the following braking system faults:

rear self-adjusters not operating

handbrake compensator seized

front brake caliper insecure on fixings

Answer:

Task 6:

State **four** sources of vehicle service information that may be required during the diagnosis of vehicle braking system faults.

Give **two** examples of braking system faults and the information required to diagnose **each** of them.

Answer:

Instructor Feedback:

Hydraulic System Diagnosis and Repair

Task 1:

State **two** causes of brake fluid contamination.

State **two** possible effects on the braking system of contaminated brake fluid.

Answer:

Task 2:

Describe how to bleed a hydraulic braking system using pressure bleeding equipment.

State **one** precaution that should be taken to avoid damage to the vehicle during bleeding of the brake system.

Answer:

Task 3:

For **each** of the following, state **two** faults which would render the component unserviceable:

rigid brake pipe, flexible hose, wheel cylinder

Answer:

Task 4:

The picture shows a device which forms part of a braking system.

Name the device **and** state its function.

State where in the hydraulic system this is fitted.

State **one** fault that could occur in the device and how it could affect the operation.

Answer:

Task 5:

For **each** of the following symptoms, state **two** hydraulic system faults which would cause the symptom:

poor stopping

pulling

dragging

Answer:

Task 6:

A new brake line is to be fabricated.

Describe with the aid of sketches **two** types of flare that could be formed on the end of a pipe.

Describe a procedure for forming **one** type of flare.

Answer:

Instructor Feedback:

Drum Brake Diagnosis and Repair

Task 1:

For **each** of the following symptoms, state **two** brake system faults that could cause them:

poor stopping

pulling to one side

pedal pulsation

noise

grabbing

Answer:

Task 2:

State in **each** case, **two** routine maintenance tasks on a braking system that require the use of a: dial type indicator and a micrometer. State **one** check which should be made to each of these instruments in above before use

Answer:

Task 3:

The picture shows a drum brake assembly.

State **six** routine maintenance checks/tasks which should be carried out to assess the serviceability of this part of the braking system.

Answer:

Task 4:

The picture shows a drum brake assembly.

Describe in sequence, a procedure for refitting the drum **and** adjusting the lining to drum clearance following replacement of the brake shoes.

Answer:

Task 5:

Describe in sequence, a procedure for removing and refitting a wheel cylinder. Assume the vehicle has been placed on axle stands and the wheel removed.

Answer:

Task 6:

Following the replacement of brake shoes, a vehicle is to be road tested. State:

two safety precautions to be taken when removing the jack and axle stands.

four safety precautions and/or inspections that should be taken/made before road testing.

two precautions that should be taken during road testing.

Answer:

Instructor Feedback:

Disc Brake Diagnosis and Repair

Task 1:

Describe in sequence, a procedure for removing, cleaning and inspecting a brake caliper

Answer:

Task 2:

For **each** of the following symptoms, state **two** brake system faults that could cause them

poor stopping

pulling to one side

pedal pulsation

noise

grabbing

Answer:

Task 3:

The picture shows a measurement being made on a brake disc.

Name the measurement

Name **one** alternative measurement that is made to brake discs

Describe how the measurement given in answer to b) is carried out

Answer:

Task 4:

During the replacement of brake pads, a vehicle has been safely raised from the ground and all its road wheels removed.

Describe in sequence, how to safely lower the vehicle to the ground.

State the actions to be taken before road testing and returning to service.

Answer:

Task 5:

The pads have been removed from a vehicles front brake assembly. Describe **two** checks that should be made on the;

pads

brake assembly

Answer:

Task 6:

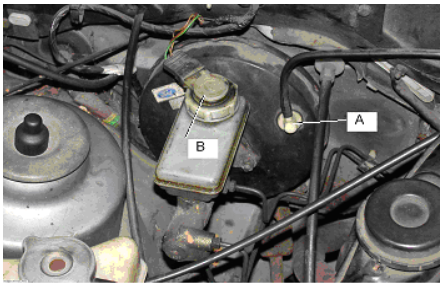
Describe the actions to be taken before refinishing a brake rotor.

Answer:

Instructor Feedback:

Power Assist Unit Diagnosis and Repair

Task 1:



The picture shows a vacuum servo unit / brake booster.

Identify the components labeled A and B

State **three** faults that would cause lack of servo assistance.

Answer:

Task 2:

Describe how to check the operation of a vacuum servo/booster unit without removing it from the vehicle.

Answer:

Task 3:

A vehicle fitted with a vacuum-type power booster is to have its vacuum supply checked.

State **two** sources of vacuum supply.

Describe a procedure for measuring the vacuum supply.

Answer:

Task 4:

The picture shows a check valve fitted to a servo-assisted braking system.

State the function of this valve.

State the effect on the braking system if the valve were to fail in the:

open position

(ii) closed position

Answer:

Task 5:

Explain how to test a hydro-boost system and accumulator for leaks.

Answer:

Task 6:

State **three** safety precautions that should be observed when working on the braking system of a vehicle fitted with a power-assist unit.

Answer:

Instructor Feedback:

Miscellaneous (Wheel Bearings, Parking Brakes, Electrical etc.) Diagnosis and Repair

Task 1:

For **each** of the following, state **two** faults that would cause the symptom:

wheel bearing noise

wheel shimmy

vibration

Answer:

Task 2:

Describe **one** method of adjusting a wheel bearing following its replacement.

Answer:

Task 3:

A parking brake operating system is to be checked for serviceability.

State **six** components in the system that should be checked.

Answer:

Task 4:

The parking brake cable of a vehicle is to be replaced.

State **three** operations/checks that should be made after the cable is fitted and before road testing the vehicle.

Answer:

Task 5:

Describe **two** faults that would require the replacement of a wheel stud.

Describe a procedure for replacing a wheel stud.

Answer:

Task 6:

A vehicle is to have a sealed wheel bearing replaced.

List the tools and equipment required to complete the task.

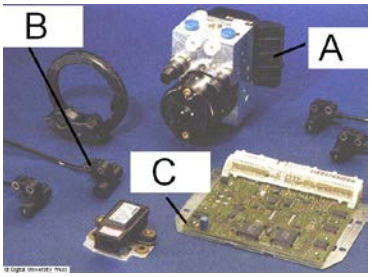
Describe a method of removing the bearing from the hub assembly.

Answer:

Instructor Feedback:

Antilock Brake and Traction Control Systems

Task 1:



The picture shows components from an anti-lock braking system.

Name the components labeled:

A

B

C

Answer:

Task 2:

Foe **each** of the following, give **one** anti-lock brake system fault which could cause the symptom:

poor stopping

wheel lock-up

abnormal pedal pulsation

Answer:

Task 3:

The picture shows an anti-lock braking wheel speed sensor.

State **two** precautions that should be observed during its removal and replacement.

Describe **two** checks that should be made following the sensor replacement.

Answer:

Task 4:

A vehicle with an anti-lock braking system is to have a caliper replaced.

Describe a method of depressurizing the system before dismantling.

State **two** checks that should be made following replacement of the caliper and before road testing.

Answer:

Task 5:

Describe in sequence, a procedure for bleeding the brakes of a vehicle fitted with an anti-lock braking system.

Answer:

Task 6:

The picture shows a scope pattern of a wheel speed sensor output.

Sketch a similar graph showing the pattern for each of the following wheel speeds:

increased

decreased

zero

Answer:

Instructor Feedback:

Suspension and Steering

Tasklist worksheets

18.Check wheels and tires for signs of damage and set tire pressures.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Jack and support the vehicle or raise on a wheel free ramp.

Check wheel for damage (each in turn including the spare).

Check tire for tread depth.

Check tire for damaged sidewalls.

Check for signs of leakage from tire and valve.

Set pressures.

Check tire tread for feathering.

Refit valve caps.

Road test to check for wheel/tire vibration, shimmy and noise.

Rotate tires according to manufacturer's recommendations.

Report findings.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

19.Service manual steering system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Carry out basic checks as described in the 'Check steering components' worksheet.

Check/top off steering gearbox oil (if appropriate).

Check operation of column adjustment if fitted.

Lubricate grease points on swivel joints/kingpins.

Lubricate ball joints/track rod ends if appropriate (most are sealed for life).

Road test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

20.Service power assisted steering (PAS) system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Carry out basic checks as described in the 'Check steering components' worksheet.

Carry out service items as described in the 'Service manual steering system' worksheet.

Check condition of PAS hydraulic pump drive belt.

Renew as required and adjust.

Check fluid for contamination. If contaminated, the fluid will need to be replaced and the system flushed, filled and bled. Hydraulic seals may need to be replaced.

Top off reservoir fluid (check data for correct type).

Run engine and turn steering lock to lock.

Check for correct operation and look for signs of leaks.

Check operation of progressive system during road test.

If electric system is used, check for cable connection security and fault code readouts if appropriate.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

21.Service suspension system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: The service requirements for suspension are very simple. Mostly, these involve quick checks for security and leaks. Dampers/shocks, may however, require replacement. Support the vehicle on a wheel free ramp if possible.

Front damper/shock absorber

Use an open-end wrench, or Allen key, to prevent the upper end from turning. Then remove the upper retaining nut. On some vehicles, it may be necessary to remove a wheel panel for better access. Remove the bolts retaining the lower shock absorber pivot to the control arm.

Prior to installation, place the grommet and washer in position on the upper stem. Insert the stem through the upper mount, push the grommet and washer into place and install the retaining nut. Tighten the nut to the specified torque.

Place the lower end of the shock absorber in position and install the bolts. Tighten the bolts to the specified torque.

Rear damper/shock absorber

Use a backup wrench on the stud on the knuckle and remove the shock absorber nut, then remove the upper through bolt and nut and detach the shock absorber.

To install, place the shock absorber in position and install the retaining nuts and bolts. Using a backup wrench on the stud, tighten the shock absorber-to-knuckle nut to the specified torque.

Raise the knuckle to normal ride height with a jack and tighten the upper shock absorber through bolt and nut to the specified torque.

Lubricate pivots and pins that are provided with grease nipples.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

22.Changing a tire.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove the wheel from the vehicle.

Break the bead using the air breaker.

Removing the tire making sure the opposite bead drops into the wheel well.

Remove the valve by cutting off the rubber seal.

Pull a new valve into place with the correct tool

Apply lubricant/soap and refit the tire.

Inflating the new tire making sure each bead 'pops' into place.

Balance wheel/tire assembly.

Set correct pressure and refit to vehicle.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

23.Repair tire.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: REMOVE TIRE

Remove the wheel from the vehicle.

Identify location of puncture and mark with crayon. Check if tire is repairable by consulting appropriate regulations. If not repairable replace tire.

Break the bead using the air breaker.

Remove the tire making sure the opposite bead drops into the wheel well.

Remove the valve by cutting off the rubber seal.

REPAIR TIRE

Fit patch following manufacturer's instructions and allow to cure.

REFIT TIRE

Pull a new valve into place with the correct tool.

Apply lubricant/soap and refit the tire.

Inflating the new tire making sure each bead 'pops' into place.

Balance wheel/tire assembly.

Set correct pressure and refit to vehicle.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

24.Remove, overhaul and refit steering rack.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove

Disconnect the battery, apply the handbrake and slacken the front road wheel nuts. Raise the front of the vehicle, support it on stands and remove the front wheels. Disconnect the ball joints from the steering levers.

Pull back the carpet and disconnect the intermediate shaft universal joint from the pinion shaft.

Remove the steering rack mounting bolts, clamp plate and plastic seating. Maneuver the rack and pinion clear of the body.

Withdraw the steering rack from the passenger or driver's side of the engine compartment as appropriate. Remove the rack pinion cover seal.

Overhaul

Remove both ball joints from the tie-rods and remove the seals and clips from the ends of the rack housing. Hold the rack in a soft jawed vice and unscrew the ball housing from the rack.

Tighten the ball housing onto the rack, to the correct torque and secure by staking the edge of the ball housing into the groove in the rack.

Replenish any lubricant lost, and fit the rack seals and retaining clips. Screw the ball joint locknuts onto the tie-rods and screw each ball joint on an equal amount.

Refit

Fit the steering rack through the passenger or driver's side of the engine compartment. Position the pinion in the body aperture and loosely fit the bolts on the pinion side of the rack. Fit the plastic seating and clamp; fully tighten the clamp bolts, to the correct torque. Finally, tighten the bolts on the pinion side of the rack to the correct torque.

Centralize the rack. Fit the pinion cover plate, position the steering wheel in the straight-ahead position and connect the universal joint to the pinion shaft. Fit the clamp bolt. Secure the sound deadening material around the pinion shaft and fit the carpet.

Connect the steering ball pins to the steering levers. Fit the road wheels, lower the vehicle to the ground, and tighten the wheel nuts, to the correct torque. Connect the battery. Check, and if necessary, adjust the front wheel alignment.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

25.Remove, inspect and refit PAS pump.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove the cap from the fluid reservoir.

Using suitable wrench, hold the adaptor and remove the high-pressure hose. Disconnect the low-pressure hose and drain the fluid into a container. Blank off the hoses and pump to prevent the ingress of dust and dirt. Replace the reservoir cap.

Slacken and remove the adjustment bolts, situated underneath the pump. Remove the drive belt. Remove the two pivot bolts, withdraw the pump and bracket from the vehicle.

Inspect

Check condition of drive belt, pump pulley, pump mounts, seals & gaskets and hoses & fittings.

Refit

Fit the pump assembly to the engine bracket, feeding the drive belt over the pulley, locate and secure the two pivot bolts but do not fully tighten. Fit the adjustment bolts. Check pulley alignment.

Adjust the drive belt to the correct tension and tighten the pivot nuts and bolts.

Remove the blanking plugs, connect the inlet hose to the adaptor and tighten to the correct torque.

Fill the fluid reservoir to the 'MAX' mark, and fit the filler cap. Do not overfill.

Check system operation and check for leaks.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

26.Remove and refit front suspension strut and spring.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Removal

Apply the handbrake, jack up the front of the car and support on stands. Remove the road wheel.

To prevent the lower arm assembly hanging down whilst the strut is removed, screw a wheel bolt into the hub, then wrap a piece of wire around the bolt and tie it to the car body. This will support the weight of the hub assembly.

Unclip the brake hose and wiring harness from any clips on the base of the strut.

Slacken and remove the lower bolts securing the suspension strut to the steering knuckle.

From within the engine compartment, unscrew the strut upper mounting nuts and then carefully lower the strut assembly out from underneath the wing.

Overhaul

Warning: Before dismantling the front suspension strut, a special tool to hold the coil spring in compression must be obtained. Any attempt to dismantle the strut without such a tool is likely to result in damage and/or injury.

With the strut removed from the car, clean away all external dirt and then mount it upright in a vice. Fit the spring compressor, and compress the coil spring until all tension is relieved from the upper spring seat.

Remove the cap from the top of the strut to gain access to the strut upper mounting retaining nut. Slacken the nut whilst holding the strut piston with an Allen key.

Remove the mounting nut and washer, and lift off the rubber mounting plate. Remove the gasket and dished washer followed by the upper spring plate and upper spring seat. Lift off the coil spring and remove the lower spring seat.

Examine all the components for wear, damage or deformation, and check the upper mounting bearing for smoothness of operation. Renew as necessary.

Examine the strut for signs of fluid leakage. Check the strut piston for signs of pitting along its entire length, and check the strut body for signs of damage. While holding it in an upright position, test the operation of the strut by moving the piston through a full stroke, and then through short strokes (50 to 100 mm). In both cases, the resistance felt should be smooth and continuous. Renew if the resistance is jerky, uneven or if there is any visible sign of wear or damage.

If any doubt exists about the condition of the coil spring, carefully remove the spring compressors, and check the spring for distortion and signs of cracking. Renew the spring if it is damaged or distorted, or if there is any doubt as to its condition. Inspect all other components for damage or deterioration, and renew any that are suspect.

Fit the spring seat and coil spring onto the strut, making sure the spring end is correctly located against the strut stop.

Fit the upper spring plate, aligning its stop with that of the seat, and fit the dished washer and gasket followed by the upper mounting plate. Locate the washer on the strut piston, then fit the mounting plate nut and tighten it to the specified torque.

Ensure the spring ends and seats are correctly located, then carefully release the compressor and remove it from the strut.

Refitting

Maneuver the strut assembly into position, and fit the upper mounting nuts.

Locate the knuckle with the suspension strut, and insert the retaining bolts. Tighten both the lower and upper bolts to the specified torque.

Tighten the strut upper mounting nuts to the specified torque.

Clip the hose/wiring back onto the strut, then refit the road wheel. Lower the car to the ground and tighten the wheel bolts to the correct torque.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

27.Remove and refit rear suspension spring.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: Procedures vary so check the manufacturer's data before starting work.

Removal

Chock the front wheels, jack up the rear of the car and support on stands. Remove the road wheel.

If necessary, remove the bolts and plates securing the driveshaft to the final drive unit flange. Free the driveshaft and support it by tying it to the car under body using a piece of wire.

Position a jack underneath the rear of the trailing arm, and support the weight of the arm.

Slacken and remove the damper/shock absorber lower mounting bolt.

Slowly lower the trailing arm. Keep an eye on the brake pipe/hose to ensure no excess strain is placed on it, until it is possible to withdraw the coil spring. Remove the spring seats.

Inspect the spring closely for signs of damage, such as cracking, and check the spring seats for signs of wear. Renew worn components as necessary.

Refitting

Fit the upper and lower spring seats, making sure they are correctly located.

Engage the spring with its upper seat.

Hold the spring in position and carefully raise the trailing arm whilst aligning the coil spring with its lower seat.

Raise the arm fully and refit the damper/shock absorber lower mounting bolt, tightening it to the correct torque.

If removed, connect the driveshaft to the final drive unit.

Refit the road wheel then lower the car to the ground. Tighten the wheel bolts to the specified torque.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

28.Remove, inspect and replace stabilizer bar, bushings, brackets and links.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove

Disconnect the battery, apply the handbrake and slacken the road wheel nuts. Raise the front of the vehicle, support it on axle stands and remove the front wheels.

Remove stabilizer clamps from frame.

Remove connecting links and bushes.

Remove stabilizer bar from vehicle.

Inspect

Check stabilizer bar for damage such as bending or indentations.

Refit

Ease new split bushes over stabilizer bar in their approximate positions.

Replace stabilizer bar on vehicle.

Replace links to their location on the stabilizer bar and tighten to the correct torque (when fitting bushes a special tool may be required – consult manufacturer's documentation).

Secure stabilizer bar clamps to the vehicle frame ensuring correct positioning of the bushes and tighten to the correct torque.

Replace road wheel, remove axle stands and lower vehicle to the ground. Fully tighten road wheel to the correct torque.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

29.Remove, inspect and replace and adjust suspension torsion bar.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove: Disconnect the battery, apply the handbrake and slacken the road wheel nuts. Raise the front of the vehicle, support it on axle stands and remove the front wheels.

Remove stabilizer and tie bar attachments to the lower arm.

Using ball joint splitter, disconnect track rod end from steering arm.

Place screw jack under hub assembly to slightly place torsion bar under tension.

Remove upper and lower shock absorber mountings and remove shock absorber. Remove screw jack.

Place trolley jack under lower arm and raise to a point where the torsion bar is under tension and the load is removed from the lower ball joint.

Using ball joint splitter, disconnect lower arm ball joint.

Lower the trolley jack slowly to remove tension from torsion bar.

Remove lower arm pivot bolt and torsion bar mounting. Remove lower arm and torsion bar from vehicle.

Inspect: Inspect lower arm, bushing and ball joint – replace as appropriate.

Note: Replacement of bushes and ball joints is only possible on some vehicles. Refer to manufacturer's procedures if possible.

Inspect torsion bar for bend and indentations. It must be replaced if any are found.

Note: Both torsion bars should be replaced as a pair.

Refit: Refitting is a direct reversal of the above procedure. The torsion bar must be adjusted to the manufacturer's specification.

Note: The method of adjusting the torsion bar varies between manufacturers but commonly involves taking a measurement between the floor and the inner end of the lower arm and the floor and the outer end of the lower arm. The torsion bar is adjusted until a specified difference between these measurements is obtained.

Check castor and wheel alignment. Reset if required.

Note: Wheel alignment must be measured and reset after castor has been adjusted.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

30.Remove, inspect and replace leaf spring, bushes and mountings.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove

Disconnect the battery, chock the front wheels to prevent the car moving and slacken the rear road wheel nuts. Raise the rear of the vehicle, support it on axle stands and remove the rear wheels.

Place a trolley jack underneath the differential case to give support to the axle when the springs are removed. Do not raise the jack under the differential so that the springs are flattened, but just enough to take the full weight of the axle when the spring is removed.

Remove shock absorber mounting to axle.

Undo the rear shackle nuts and remove the shackle bolts, plates and bushes.

Undo the nut from the front mounting and take out the bolt running through the mounting.

Undo the nuts on the end of the four 'U' bolts and remove the 'U' bolts together with the attachment plate.

The spring can now be removed from the vehicle.

Inspect

Inspect spring for broken or worn leaves, leaf insulators, shackles, brackets, bushes and mountings. Replace worn or damaged components.

Refit

Refitting is a direct reversal of the above procedure.

Note: The nuts on the 'U' bolts, spring front mounting and rear shackles must be tightened to the correct torque after the vehicle has been lowered onto its wheels.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

31.Remove, inspect and replace upper suspension arm, bushings and ball joint.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove

Disconnect the battery, apply the handbrake and slacken the road wheel nuts. Raise the front of the vehicle, support it on axle stands and remove the front wheels.

Disconnect the flexible brake hose from the caliper.

Support the lower arm with a trolley jack.

Free the upper ball joint from its taper with a ball joint splitter.

Remove the upper arm pivot bolt.

Remove upper arm from vehicle.

Inspect

Inspect upper arm, bushing and ball joint – replace as appropriate.

Note: Replacement of bushes and ball joints is only possible on some vehicles. Refer to manufacturer's procedures if possible.

Refit

Refitting is a direct reversal of the above procedure.

Note: The nuts on the upper pivot bolt tightened to the correct torque when the vehicle has been lowered onto its wheels.

Bleed the brakes.

Check castor and wheel alignment. Reset if required.

Note: Wheel alignment must be measured and reset after castor has been adjusted.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

32.Remove, inspect and replace lower suspension arm, bushings and ball joint.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove: Disconnect the battery, apply the handbrake and slacken the road wheel nuts. Raise the front of the vehicle, support it on axle stands and remove the front wheels.

Remove stabilizer and tie bar attachments to the lower arm.

Using ball joint splitter, disconnect track rod end from steering arm.

Place screw jack under hub assembly and slightly compress spring.

Remove upper and lower shock absorber mountings and remove shock absorber.

Fit spring compressor and compress coil spring.

Using ball joint splitter, disconnect lower arm ball joint whilst supporting lower arm.

Remove coil spring from vehicle and spring compressors from spring.

Remove lower arm pivot bolt and lower arm from vehicle.

Inspect: Inspect lower arm, spring insulator, bushing and ball joint – replace as appropriate.

Note: Replacement of bushes and ball joints is only possible on some vehicles. Refer to manufacturer's procedures if possible.

Inspect coil spring.

Refit: Refitting is a direct reversal of the above procedure.

Note: The spring must be compressed to approximately curb weight position before refitting.

The nuts on the lower pivot bolt must be tightened to the correct torque when the vehicle has been lowered onto its wheels.

Check castor and wheel alignment. Reset if required.

Note: Wheel alignment must be measured and reset after castor has been adjusted.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

33.Remove, inspect and replace rear suspension control arm and bushings.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove: Disconnect the battery, apply the handbrake and slacken the road wheel nuts. Raise the front of the vehicle, support it on axle stands and remove the front wheels.

Remove stabilizer attachments to the lower arm.

Clamp flexible brake pipe and disconnect from connector on shock absorber.

Position jack under lower arm to take weight, remove tie bar to body retention bolt.

Remove lower arm pivot bolt and lower shock absorber/strut connection.

Slowly lower jack and remove lower arm and coil spring.

Inspect: Inspect the lower arm and bushes, spring insulator and spring. Replace as necessary.

Note: Replacement of bushes is only possible on some vehicles. Refer to manufacturer's procedures if possible.

Refit: Reposition lower arm, spring insulator and spring on jack and raise into position.

Refit lower arm pivot bolt and lower shock absorber/strut connection.

Note: The lower pivot bolt must be tightened to the correct torque when the vehicle has been lowered onto its wheels.

Refit tie bar to body retention mounting, tightening to the correct torque.

Connect flexible brake pipe.

Refit stabilizer attachments to the lower arm tightening to the correct torque.

Bleed the brakes.

Lower the vehicle to the ground. Tighten the lower pivot bolt to the correct torque. Tighten the wheel bolts to the correct torque.

Check and adjust rear wheel camber, alignment and thrust angle.

Note: It is not possible to adjust rear wheel alignment on some vehicles. It is essential to fit all washers and spacers in exactly the same order as they were before the commencement of the repair operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

34.Remove, inspect and replace rear McPherson strut and spring.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove

Disconnect the battery, apply the handbrake and slacken the road wheel nuts. Raise the rear of the vehicle, support it on axle stands and remove the wheels.

Unclip the flexible brake hose and wiring harness from any clips on the base of the strut.

Position jack under lower arm. This will support the weight of the hub assembly.

From within the boot, unscrew the strut upper mounting nuts.

Slacken and remove the bolts securing the suspension strut to the hub assembly and then carefully lower the strut assembly out from underneath the wing.

Inspect/Overhaul

Warning: Before dismantling the front suspension strut, a special tool to hold the coil spring in compression must be obtained. Any attempt to dismantle the strut without such a tool is likely to result in damage and/or injury.

With the strut removed from the car, clean away all external dirt and then mount it upright in a vice. Fit the spring compressor, and compress the coil spring until all tension is relieved from the upper spring seat.

Remove the cap from the top of the strut to gain access to the strut upper mounting retaining nut. Slacken the nut whilst holding the strut piston with an Allen key.

Remove the mounting nut and washer, and lift off the rubber mounting plate. Remove the gasket and dished washer followed by the upper spring plate and upper spring seat. Lift off the coil spring and remove the lower spring seat.

Examine all the components for wear, damage or deformation. Renew as necessary.

Examine the strut for signs of fluid leakage. Check the strut piston for signs of pitting along its entire length, and check the strut body for signs of damage. While holding it in an upright position, test the operation of the strut by moving the piston through a full stroke, and then through short strokes (50 to 100 mm). In both cases, the resistance felt should be smooth and continuous. Renew if the resistance is jerky, uneven or if there is any visible sign of wear or damage.

Note: It may be possible to fit a strut insert/shock absorber cartridge into the strut. Check manufacturer's information.

If any doubt exists about the condition of the coil spring, carefully remove the spring compressors, and check the spring for distortion and signs of cracking. Renew the spring if it is damaged or distorted, or if there is any doubt as to its condition. Inspect all other components for damage or deterioration, and renew any that are suspect.

Fit the spring seat and coil spring onto the strut, making sure the spring end is correctly located against the strut stop.

Fit the upper spring plate, aligning its stop with that of the seat, and fit the dished washer and gasket followed by the upper mounting plate. Locate the washer on the strut piston, then fit the mounting plate nut and tighten it to the specified torque.

Ensure the spring ends and seats are correctly located, then carefully release the compressor and remove it from the strut.

Refitting

Maneuver the strut assembly into position, and fit the upper mounting nuts.

Refit the bolts securing the suspension strut to the hub assembly.

Tighten the strut upper and lower mounting nuts to the specified torque.

Clip the hose/wiring back onto the strut, then refit the road wheel. Lower the car to the ground and tighten the wheel bolts to the correct torque.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

35.Remove and refit wheel bearings.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Front hub assembly. Apply the handbrake and slacken the front road wheel nuts, raise the front of the vehicle, support it on stands and remove the road wheel. Remove the drive shaft nut split pin, use an assistant to apply firm pressure to the brake pedal and, while the brake is applied, unscrew the drive shaft nut. Remove the brake caliper and support it to prevent straining the hose. Remove the disc.

Using a ball joint breaker tool, disconnect the ball joint from the steering lever. Unscrew the nuts and remove the bolts to release the strut from the hub assembly. Unscrew the nut and remove the clamp bolt securing the lower ball joint to the hub assembly and, using a suitable lever placed between the lower arm and the anti-roll bar, lever downwards to release the ball joint from the hub. Remove the hub assembly from the drive shaft. Extract the inner oil seal and spacer and the outer oil seal. Drive out one of the bearings, invert the hub and drive out the remaining bearing. Inspect the bearings for signs of wear and damage, renew as necessary. Pack the bearings with suitable grease and press them into the hub. Fit the oil seal spacer against the inner bearing. Fit the oil seals.

Locate the hub on the drive shaft, fit the flat washer and drive shaft nut and tighten the nut finger tight. Fit the hub assembly to the lower ball joint, fit the clamp bolt and tighten the nut. Fit the hub to the strut, fit the bolts and tighten the nuts to the correct torque. Connect the ball joint to the steering lever and fit and tighten the nut. Fit the disc to the drive flange and tighten the securing screws. Fit the brake caliper. Use an assistant to apply firm pressure to the brake pedal and, while the brake is applied, tighten the drive shaft nut to the correct torque. Lock the nut with a new split pin.

Rear hub assembly. Chock the front wheels and slacken the rear wheel nuts, raise the rear of the vehicle, support it on stands and remove the road wheel. Withdraw the grease retainer cap from the center of the hub and extract the split pin from the stub shaft. Unscrew the hub nut, remove the flat washer and withdraw the hub and brake drum assembly. Extract the hub oil seal, drive the inner bearing out and collect the spacer. Invert the hub and brake drum assembly and drive out the outer bearing. Inspect the bearings for signs of wear and damage, renew as necessary.

Pack the bearings with suitable grease and press the outer bearing into the hub with the side marked 'THRUST' facing outwards. Invert the hub, fit the spacer and press the inner bearing, with the side marked 'THRUST' outwards into the hub. Dip the new oil seal in oil and press it into the hub (sealing lip facing inwards). Fit the hub and brake drum assembly to the stub shaft, fit the flat washer and fit and tighten the hub nut to the correct torque. Lock the nut with a new split pin. Measure drive axle flange run-out and shaft endplay. Fit the grease retainer cap, then fit the road wheel and nuts.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

36.Remove, inspect and replace tie rods.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove: Disconnect the battery, apply the handbrake and slacken the road wheel nuts. Raise the front of the vehicle, support it on axle stands and remove the front wheels.

Remove the bolts securing the tie rod to the lower suspension arm.

Disconnect stabilizer bar connecting link (if fitted).

Remove the forward nut, retainer and insulator on the tie rod.

Remove the tie rod complete with spacer, rear insulator and rear lock nut.

Remove spacer, rear insulator and rear lock nut from the tie rod.

Inspect

Inspect the tie bar for bending and condition of threads.

Inspect condition of bushes, replace if needed.

Refit: Assemble rear nut, retainer, spacer and rear insulator to tie rod. Relocate tie rod through frame (ensure spacer tube is located inside rear insulator).

Replace front insulator, retainer and nut to front end of tie rod.

Reconnect stabilizer bar connecting link (if fitted).

Replace the bolts securing the tie rod to the lower suspension arm and tighten to correct torque.

Replace road wheel, remove axle stands and lower vehicle to the ground. Fully tighten road wheel to the correct torque.

Check castor and wheel alignment. Reset if required.

Note: Wheel alignment must be measured and reset after castor has been adjusted.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

37.Remove and replace steering wheel and SRS.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: WARNING: IT IS ESSENTIAL TO REFER TO MANUFACTURERS INFORMATION FOR THE SPECIFIC VEHICLE YOU ARE TO WORK ON BEFORE STARTING WORK ON THIS TASK. For this reason, no information is provided in this worksheet as to the removal of SRS components.

Check the operation of the SRS failure warning light on the instrument panel. If this warning light remains on, the SRS Electronic Control Unit has detected a fault. The fault must be rectified and the ECU memory cleared using the manufacturer's dedicated equipment.

Note: No attempt should be made to diagnose faults using conventional test equipment i.e. test lights, continuity testers, multimeters, etc.

Before the steering wheel is removed ensure the wheels are positioned straight ahead.

Disable and remove the SRS air bag unit following manufacturer's procedures

Remove steering wheel; center/time supplemental restraint system coil following manufacturer's procedures. When refitting, center steering wheel and torque steering wheel nut to manufacturer's specified value.

ALWAYS: Refer to manufacturers' safety precautions that should be adhered to when handling SRS components.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

38.Remove, inspect and replace pitman arm, relay rod, idler arm and steering damper/shock absorber

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Removal

Disconnect the battery, apply the handbrake and slacken the road wheel nuts. Raise the front of the vehicle, support it on axle stands and remove the front wheels.

Disconnect the relay arm ball joints from the pitman arm and idler arm.

Mark the relative position of the pitman arm to the rocker shaft and then remove the pitman arm using a suitable puller.

Remove the idler arm and mountings.

Remove steering linkage damper/shock absorber.

Inspect

Inspect the steering box seals for leakage, the ball joints for play and the idler arm bushes for play.

Adjust pinion worm bearing pre-load and sector lash.

Examine the steering damper for signs of fluid leakage. Check the piston for signs of pitting along its entire length, and check the body for signs of damage. Test the operation of the damper/shock absorber by moving the piston through a full stroke, and then through short strokes. In both cases, the resistance felt should be smooth and continuous. Renew if the resistance is jerky, uneven or if there is any visible sign of wear or damage.

Refit

Refitting is a direct reversal of the removal procedure.

All fixings should be tightened to the manufacturer's recommended torque settings.

Refit the road wheel. Lower the car to the ground and tighten the wheel bolts to the correct torque.

Check wheel alignment. Reset if necessary.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

39.Check wheels, tires, trims and torque.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check carefully all round the tire, inside and out.

Look for tread wear and damage to the sidewalls.

Feel the pattern of the tire from left to right, and right to left, to check for signs of feathering.

Check that the tire shape is uniform and that there are no cuts or bulges.

Check wheels. Alloys with signs of cracking should be replaced immediately.

Make sure trims are fitted correctly and that the valve is positioned so it is not under stress from the trim.

Wheel nuts/bolts should be tightened with a torque wrench.

Check valves for signs of leakage and make sure the dust cap is fitted.

Rock the valve gently from side to side to check for leaks.

Check and adjust tire air pressures.

Measure wheel/tire, axle and hub run out.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

40.Check steering components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Steering wheel alignment - Road test – spokes should be aligned when traveling straight ahead

Column security - Rock up and down/side to side. Check adjustment is secure

Freeplay - Movement of wheel without road wheels moving. Normally should be small (2.5cm/1" max.)

Steering shaft and joints - Side to side movement tests bearings. Rocking movement to test UJs

Rack/box security - Check mounting bolts and rubber components

Rack gaiters/box seals - Look for splits and oil leaks

Ball joints/track rod ends - As steering wheel is rocked, look for excessive 'lift' in the joints

Swivel joints/kingpins - Jack and support vehicle. Rock wheel top and bottom. Look from the inside to check movement. Very little if any should be observed

Wheel bearings - As above

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

41.Check and diagnose steering faults.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Carry out basic checks as described in the 'Check steering components' worksheet.

Rectify any faults found.

Check front tires for unusual wear patterns.

Feathering (feels rough in one direction like feathers) on the outer or inner edges of both tires usually indicates a tracking (toe-in/out) problem. Wear on just one tire would indicate a camber or swivel axis problem (check if a new tire has been recently fitted).

Check for front wheel setback.

Check front sub frame (cradle) alignment.

Check for power steering fluid leakage.

Road test and check for wander, drift, pull, hard steering, bump steer, memory steer, torque steer, self-centering and driver effort.

Wandering or drift may be due to freeplay in any part of the linkages. Self-centering action will reduce if any joints are tight or seized.

Driver effort will be affected by tight joints but also the operation of power assistance (if fitted).

Carry out a full steering geometry test as described in the appropriate worksheets.

Check operation again when work has been carried out.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

42.Check suspension and steering operation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Raise the front end of the vehicle and support it securely on stands placed under the frame rails. Because of the work to be done, make sure the vehicle cannot fall from the stands.

Visually check the suspension and steering components for wear.

Indications of a fault in these systems are excessive play in the steering wheel before the front wheels react, excessive sway around corners, body movement over rough roads or binding at some point as the steering wheel is turned.

Check the wheel bearings. Do this by spinning the front wheels. Listen for any abnormal noises and watch to make sure the wheel spins true (does not wobble). Hold the top and bottom of the tire; pull inward and then outward on the tire. Note any movement, which would indicate a loose wheel bearing assembly. If the bearings are suspect, they should be replaced.

From underneath the vehicle, check for loose bolts, broken or disconnected parts and deteriorated rubber bushings on all suspension and steering components. Look for grease or fluid leaking from the steering assembly. Check the power steering hoses and connections for leaks. Check the ball joints for wear by looking for movement as the steering is rocked.

Have an assistant turn the steering wheel from side-to-side and check the steering components for free movement, chafing and binding. If the steering does not react with the movement of the steering wheel, try to determine where the freeplay is located.

Steering systems use flexible rubber boots, which should be carefully checked for tears, oil contamination or damage.

Lower the vehicle and report any faults found.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

43.Check and diagnose suspension faults.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Damper/shock absorber operation - The vehicle body should move down as you press on it, bounce back just past the start point and then return to the rest position.

Suspension bush condition - Simple levering if appropriate should not show up excessive movement, cracks or separation of rubber bushes.

Trim height - This is available from data books as a measurement usually taken from the wheel center to a point on the car above.

Symptom - Possible causes of faults - Suggested action

Excessive pitch or roll when driving - Dampers/shock absorbers worn - Replace in pairs

Car sits lopsided - Broken spring - Replace in pairs

Car sits lopsided -Leak if hydraulic suspension - Rectify by replacing unit or fitting new pipes

Knocking noises - Excessive free-play in a suspension joint - Renew

Excessive tire wear - Steering/suspension geometry incorrect (may be due to accident damage) - Check and adjust or replace any 'bent' or out of true components

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

44.Measure tire tread and report on condition.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check: **NSF OSF NSR OSR**

Check and report minimum tread depth

Check and report condition

Check suitability for vehicle

Manufacturer's wheel nut torque

Set wheel nut torque

Manufacturer's pressure

Check/adjust pressure

Report to customer

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

45.Measure and adjust tracking (toe-in/out), using optical gauges.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Carry out basic checks as described in the 'Check steering components' worksheet.

Set the arms to the wheel size and then zero the tracking gauges by placing the tips of the arms together.

Roll the vehicle back and forth to make sure the steering is not under stress.

Position the gauges to the wheels and take a reading. Compare to specifications.

If adjustment is required, check the position of the steering wheel. Adjustment is made by changing the overall length of the track rod.

If the spokes are even, make equal adjustments to each end of the track rod.

If the spokes are NOT even, turn the wheel until they are and then make adjustments to each end of the track rod such as to bring the wheels to the correct position.

To adjust track rod length, undo the lock nuts and then turn the rod, which is threaded into the track rod end.

Tighten the lock nuts and check the alignment again (from step 3).

Carry out further adjustment if required – it is quite usual for accurate adjustment to need two or three changes.

Secure all components and remove gauges.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

46.Measure castor, camber and swivel axis/king pin inclination.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Carry out basic checks as described in the 'Check steering components' worksheet.

Position the front wheels of the vehicle on turn plates.

Connect measuring equipment to the vehicle as per the manufacturer's instructions.

Record the correct figures and the measured reading as follows:

Camber

Castor

Swivel axis/king pin inclination (SAI/KPI)

Toe-out-on-turns (turning radius)

Off set

Tracking (Toe-in/out)

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

47.Inspect and measure damper/shock absorber operation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Perform a bounce test by pushing down on one corner of the vehicle.

Check that the corner (or front/rear) rises once and then settles. If it bounces more than once, the damper/shock absorber is worn and should be replaced.

Visually inspect the damper/shock absorber for leakage.

A light oil film near the seal is acceptable but replace if leakage is excessive.

Inspect the damper/shock absorber rod for damage such as bending, scratches and corrosion. Replace if any is found.

Inspect the damper/shock absorber body and replace if damaged. Light corrosion is acceptable.

Check security of all mounting bolts or nuts.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

48.Measure trim height.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Trim height

Position the vehicle on level ground.

Bounce the suspension to ensure it has settled. Also, make sure no heavy loads are being carried.

Refer to the manufacturer's specifications for trim height setting and measurement position. This is usually from the wheel center to a fixed point on the body. Note that trim height measures the suspension setting, not ground clearance.

Take measurement using a suitable measuring tape. Compare with specifications.

Normal suspension system

Incorrect trim height measurements usually mean that suspension components are broken or badly worn.

Carry out a full system inspection as described in the appropriate worksheet.

Hydrolastic suspension

Connect a suspension fluid pump to each valve in turn.

Follow the manufacturer's instructions to 'pump up' the system to the correct trim height.

Remove fluid pump.

Road test the vehicle, recheck trim height and adjust again if required.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

49.Reported symptom - heavy steering.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Ask if the problem has just developed. Road test to confirm.

Check the obvious such as tire pressures. Is the vehicle loaded to excess? Is the tracking correct?

Assuming tire pressure and condition is as it should be, move on to further tests.

Jack up and support the front of the car. Operate the steering lock to lock. Disconnect one of the track rod ends and move the wheel on that side, and so on.

If the fault is in the steering rack then this should be replaced and the racking should be set.

Test the operation with a road test and inspect all other related components for security and safety.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

50.Inspect electronically controlled suspension systems.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: There are many types of electronically controlled suspension systems. Check the latest data before starting work. Some employ an electronic control of a hydraulic or pneumatic suspension systems, others employ electronic control of damping.

Carry out simple 'hand & eye tests' – fluid levels, connection security, leaks, etc.

Check the battery condition, fuses/supplies to ECU and that the operation of the normal suspension is correct.

Check for fault codes stored by the ECU using scan tool.

Some systems have a selectable range for ride comfort and performance – moving a switch positioned on the dashboard or ECU can change the setting. Check the setting corresponds to the assistance provided.

The suspension operating system may use a number of sensors. They may include a steering position sensor, a vehicle speed sensor (they may be shared by other systems), brake on/off switch, etc.

Check vehicle speed sensor operation. A clean regular sine wave output proportional to wheel speed should be shown on a scope. If testing with an ohmmeter, disconnect before measuring and note that the resistance of each sensor should be the same.

Note: Hall type sensors should not be checked with an ohmmeter.

The results of sensor tests at the ECU connections should be the same as at the sensor. If so, this confirms the wire continuity from the sensors to ECU.

Reset fault memory in ECU. This is often achieved by disconnecting a particular fuse for 10 seconds.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

51.Inspect electronically controlled steering systems

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: There are many types of electronically controlled steering systems. Check the latest data before starting work. Some employ an electric motor to drive a hydraulic pump – the assistance is provided by the hydraulic pressure. Others employ a direct acting electric motor positioned on the steering rack or column.

Carry out simple 'hand & eye tests' – fluid levels, connection security, leaks, etc.

Check the battery condition, fuses/supplies to ECU and that the operation of the normal steering is correct.

Check for fault codes stored by the ECU using scan tool.

Some systems have a selectable range for assistance – moving a switch positioned on the ECU can change the setting. Check the setting corresponds to the assistance provided.

Connect an ammeter in series with the motor, turn the steering wheel and measure the current drawn and compare to manufacturer's specification.

The steering operating system may use a number of sensors. They may include a steering position sensor, a vehicle speed sensor (they may be shared by other systems), etc.

Check vehicle speed sensor operation. A clean regular sine wave output proportional to wheel speed should be shown on a scope. If testing with an ohmmeter, disconnect before measuring and note that the resistance of each sensor should be the same.

The results of sensor tests at the ECU connections should be the same as at the sensor. If so, this confirms the wire continuity from the sensors to ECU.

Reset fault memory in ECU. This is often achieved by disconnecting a particular fuse for 10 seconds.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

Assignments

General Suspension and Steering Systems Diagnosis

Task 1:

Draw a line diagram to show what is meant by front wheel toe-in.

State the main purpose of toe-in.

Answer:

Task 2:

The basic Ackerman principle uses angled track arms. Draw a line diagram to show this principle.

Answer:

Task 3:

State, in **each** case, **one** fault that would cause the following symptoms:

steering wander

steering stiff to turn

steering wheel vibration between 40 and 50 miles per hour.

Answer:

Task 4:

One main purpose of a suspension system is to maintain the road wheels in contact with the road. State **three** other purposes of a suspension system.

Answer:

Task 5:

State what is meant by **each** of the following terms in relation to a suspension system.

driving torque

unsprung weight

damping

Answer:

Task 6:

State in **each** case **one** suspension fault that would cause:

excessive ball joint wear

irregular tire wear

reduced trim height

Answer:

Instructor Feedback:

Steering System Diagnosis and Repair

Task 1:

State **one** safety precaution that should be adopted before removal of a steering wheel of a vehicle fitted with a Supplementary Restraint System (SRS).

Explain why this precaution should be adopted.

Describe a procedure for removing and refitting the steering wheel of a vehicle fitted with a Supplementary Restraint System (SRS).

Answer:

Task 2:

Name **six** components on a steering system that should be checked for excessive play.

State **two** symptoms a driver would notice if excessive play was present in the components given in answer to b) above.

Answer:

Task 3:

Describe **one** method of measuring and adjusting the pinion bearing preload of a manual (non-power) steering rack and pinion assembly.

Explain why this preload is necessary.

Answer:

Task 4:

Describe **one** method of filling and bleeding a power steering system.

Explain why the system must be bled after filling.

Answer:

Task 5:

Describe in sequence, a test procedure that will identify an internal leak in the power rack of a vehicle fitted with power steering.

Answer:

Task 6:

The picture shows a tool being used during the removal of a tie rod end from a steering system.

Explain why it is necessary to use the tool during dismantling.

Name the measurement which should be made following the replacement of a tie rod end.

Answer:

Instructor Feedback:

Suspension System Diagnosis and Repair

Task 1:

These pictures show front suspension systems.

Name the type of suspension shown in Picture A

State why the component marked X in Picture B is wishbone shaped

State **two** faults in this system that would result in irregular tire tread wear

Picture A

Picture B

Answer:

Task 2:

Describe in sequence, the operations involved in the removal of a coil spring from the suspension shown in Picture A of Task 1 above. Include safety aspects and tools used in your answer.

Answer:

Task 3:

Describe how **each** of the following should be inspected for wear.

outer ball joint

steering knuckle assembly

upper strut bearing mount

Answer:

Task 4:

The picture shows a rear suspension system.

Describe in sequence, a procedure for the removal of bushes from the upper arm. (assume the suspension is fitted to the vehicle)

Answer:

Task 5:

Explain why it is difficult to remove bushes from a stabilizer bar, when only one wheel is raised from the ground.

Answer:

Task 6:

Describe the symptoms a driver would report to a technician, if a vehicle had defective shock absorbers.

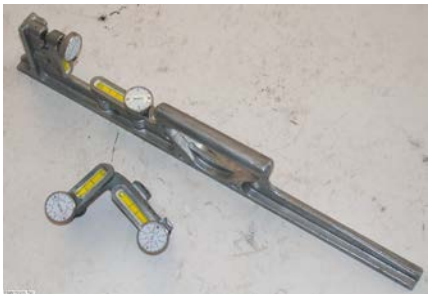
Describe a method of testing the serviceability of shock absorbers.

Answer:

Instructor Feedback:

Suspension System Diagnosis and Repair

Task 1:



The picture shows equipment for measuring steering geometry.

State **three** measurements which can be made with this equipment.

Describe how the equipment is used to perform **one** measurement.

Answer:

Task 2:

For **each** of the following, state **one** suspension **and/or** steering fault which would cause the symptom:

wander drift

pull hard steering

bump steer torque steer

Answer:

Task 3:

Describe how a vehicle should be prepared for steering geometry measurement.

Answer:

Task 4:

Describe the symptoms which would indicate the front wheel toe-in was excessive on a rear wheel drive vehicle.

Answer:

Task 5:

The picture shows a front suspension system.

A technician diagnoses that the system has excessive negative camber. Describe how this could be corrected.

Answer:

Task 6:

In relation to vehicle steering and suspension, explain the meaning of the following terms:

rear wheel thrust angle, front wheel setback

Answer:

Instructor Feedback:

Wheel and Tire Diagnosis and Repair

Task 1:

State the step-by-step procedure for removing an inflated tire from a well based rim.

State **two** checks which should be made to the rim before fitting the tire.

Answer:

Task 2:

Make sketches to show irregular tread wear patterns that result from running a vehicle with:

defective dampers

tire pressure too high

tire pressure too low

Answer:

Task 3:

State the procedure to be used to ensure accuracy when:

checking and adjusting tire air pressures

measuring tire tread depth

Answer:

Task 4:

In relation to tire and wheel assemblies, describe with the aid of sketches, what is meant by static balance.

dynamic balance

Answer:

Task 5:

State what is meant by the term ‘rotating tires’.

Explain why tires are rotated.

Describe the process of rotating tires.

Answer:

Task 6:

State **two** wheel and/or tire faults which would give **each** of the following symptoms:

vibration

shimmy

noise

Answer:

Instructor Feedback:

Electrical/Electronic Systems

Tasklist worksheets

52.Service electrical system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Battery

If the terminals require cleaning, fit a memory keeper and disconnect the earth/ground lead.

Clean the battery posts and terminals. Use a wire brush and hot water as required. If hot water is used, follow this with copious amounts of cold water to wash away any acid from the paintwork.

Dry the terminals and posts. Apply battery grease or petroleum jelly.

If the battery is not sealed, top off with deionized water to a few millimeters above the plates.

Check the battery state of charge using a voltmeter or hydrometer. Recharge if necessary OFF the vehicle.

Refit the battery and terminals, and ensure they are secure.

Restore electronic memory functions if memory keeper not used.

General

Check that spare fuses are fitted.

Carry out a general inspection looking for loose connections and damaged wires.

System operation

Run through ALL electrical systems in turn to check for correct operation.

Make sure that simple items such as the washer fluid bottle are secure and topped off.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

53.Routine maintenance inspections, lubrication and replacement of parts.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: General visual inspection - listen for abnormal noises.

Check operation of ignition/generator warning light.

Listen to operation of starter motor.

Check battery electrolyte level - top off if necessary with specially formulated water.

Check battery casing for leaks and battery security.

Check alternator drive belt for condition and tension.

Check all electrical cables to battery, starter and alternator.

Coat battery terminals with petroleum jelly.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

54.Check battery and charge circuit operation for winter usage of vehicle.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check the alternator drive belt for condition and tension. Look for frays, cracks, glazing of the drive faces caused by slippage and check that the tension or free play is about 12 mm (1/2 in).

Check the security of the battery and the condition of the casing. Look for signs of corrosion or other deterioration on the straps/clamps, on and around the battery and on the battery cables at the battery and at where they connect to the body and to the starter system.

Disconnect both battery leads, earth or ground first, and clean the battery terminals and the cable terminals.

Check the state of charge of the battery with a hydrometer and/or digital voltmeter. Hydrometer readings should be near fully charged (1.28) and the same for all cells……OR

Check the built in hydrometer of maintenance free batteries, which should be green for a fully charged battery and black if partially charged. A yellow dot indicates that the battery is defective

Voltage readings should be 13 volts for conventional lead acid batteries and 12.8 volts for maintenance free batteries.

If hydrometer and voltage readings are low recharge the battery. If the readings are correct carry out a high rate discharge test. Connect the tester and set the discharge rate to the manufacturer's recommended setting. DO NOT exceed 3 x the Ah rate (10 hour rate) and 15 second duration.

Reconnect the battery and coat the terminals with petroleum jelly. Check charge circuit cables for condition and that all terminals are clean and tight. Treat with petroleum jelly or water repellent spray.

Connect a digital voltmeter to the battery terminals and a clamp on ammeter to the alternator output lead.

Start and run the engine at about 2000 rpm and check the voltage and amps readings. Turn on high consumption devices, head lamps, heater blower, heated windscreens, etc. and read volts and amps. Compare readings with manufacturer's data. (Volts 14.7, Amps 20 +)

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

55.Check all vehicle lights for correct operation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note that if the left or right turn signals, or the hazards work, the unit is probably functioning correctly. Remember that a flasher unit is designed to flash at a different rate when a bulb is blown.

Turn signal flasher units are usually located either as part of the fuse box or on the steering column.

Remove covers or shrouds as necessary.

Most types of flasher unit simply pull out of the socket.

Replace by pushing the new unit into the holder.

Make sure the new unit is the correct one for the vehicle. Note that more powerful units may be required if a towing socket is fitted.

After renewal, make sure indicators and hazard lights operate.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

56.Check all vehicle lights for condition and security.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain technical/procedural data from manuals and information from vehicle owner/driver.

Light (lenses, reflectors and general condition)	**Condition**
Headlights	
Sidelights	
Rear/tail lights	
Stoplights	
Fog lights (front and rear)	
Number/license plate light	
Turn signals	
Spot/driving lights	

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

57.Checking operation of the main instruments and warning lights.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: This is a generic test routine; refer to manufacturer's procedures and circuits for specific details.

Switch the ignition on but do not start the engine.

Check that the rev-counter and speedometer both read zero (or less).

Check that the oil pressure warning light (WL) and charge WL are on.

Check that the fuel gauge reads appropriate to fuel in the tank.

Check that the temperature gauge reads appropriate to the engine temperature (best to start from cold if possible).

Check for neutral or park, and start the engine.

Oil light and charge light should go out as engine revs – and stay out at idle speed.

Check rev-counter reads correctly by comparing with a test meter reading.

Check fuel gauge reading remains constant and that temperature gauge rises to 'normal' level.

Road test to check speedometer operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

58.Check driver information systems

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Switch all lights on in turn and check operation of map segments.

Open all doors in turn and check segments.

Switch ignition on and note self-test for ice warning (if fitted).

Refer to handbook as necessary.

Check all functions of trip computer such as time, date and stop watch.

Set a journey distance into the unit.

Road test and note functions such as average speed, estimated time of arrival, fuel consumption and elapsed time.

Reset all when test is complete and make sure that the correct units (miles/kilometers) are set.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

59.Service body electrical system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This is a simple service operation but it is important that the tasks are carried out correctly.

Check washer and wiper operation. Top off the washer fluid as required.

Inspect the wiper blades and recommend renewal as appropriate.

Adjust and clean washer jets as required. A pin is often useful for this.

Check the operation of the audible warning device – the horn should make a noise when the button is pushed!

Carry out a quick check of all body systems. Check windows, door locks and sunroof - for smooth operation (electric or manual).

Disarm SRS air bag for duration of service. Rearm following service. Always follow manufacturer's safety procedures.

Switch on the ignition and make sure all warning lights operate. Check in particular the supplementary restraint system (SRS) light, and that it goes out when the engine starts.

Inspect all air bag positions for security.

Use scan tool to check SRS system. Follow manufacturer's procedures.

Check the ICE system aerial for security.

Test the ICE system for radio static, weak/intermittent/no radio reception, by listening to each speaker in turn. Make sure you reset the unit to the customer's preferences…

Road test the vehicle and check the operation of the cruise control system.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

60.Service/Check seatbelt operation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Caution: Some seatbelts incorporate tensioners that operate in the event of a collision. Do not attempt to dismantle these systems without reference to the manufacturer's data.

Check for twisted webbing due to incorrect alignment. Adjust as required.

Fully extend each belt in turn and inspect the webbing. Look for cuts, damage, broken threads, color fading and bowed webbing. If any damage is noted the belt should be renewed. Follow the manufacturer's procedures for this process.

If the belt will not extend, check for contamination and twisting.

Insert the tongue of each belt into its buckle. Pull hard to make sure it locks in place. Follow manufacturer's procedures to renew if in any doubt.

Push the button to make sure the belt releases from the buckle easily.

Pull each belt in turn fully out and make sure it retracts. It is acceptable to guide the belt home and prevent twisting. However, the spring should pull the belt into its fully retracted position.

Pull sharply on each belt in turn to check that it locks up.

Drive the vehicle in an area away from other traffic, and brake sharply from about 10 mph /16 kph. The driver's belt should lock and hold you in position. Use an assistant to check the other belts if necessary.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

61.Remove and refit electrical components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This worksheet is generic and can be applied to many systems. However, refer to manufacturers' procedures for specific information.

Fit a memory keeper to prevent changing stored settings in electronic control units and in car entertainment systems.

Remove the battery earth/ground lead.

If removing the battery, disconnect the supply connection, remove the casing clamp and remove the battery. Take care to keep it level so that no electrolyte (sulfuric acid) is spilt.

For other components, disconnect their supply wires. Making a note or suitable sketch where necessary of the connections will save time when refitting.

For some components, it may be necessary to remove other parts to allow easy access. For example, an exhaust shield may need to be removed before the alternator can be disconnected.

Disconnect linkages and/or peripherals.

Undo all mountings and remove the unit from the vehicle.

Refitting is a reversal of the removal process.

The last job is always to reconnect the battery earth/ground lead.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

62.Remove and replace battery, battery cables and securing devices.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Open bonnet/hood to access the battery. Check the general condition on and around the battery. Fit memory keeper (if available). Disconnect the earth or ground lead and then the supply lead from the battery.

Undo and remove the battery retaining straps, clamps and brackets and remove. Remove any obstructions that may prevent the battery being lifted out.

Plan the removal so that the lift, route and new position of the battery are known beforehand. Keeping the battery as level as possible lift up from the carrier and lift out from the vehicle. Place the battery on a bench or other suitable place.

If it is necessary to use a lifting tool on the battery ensure that it is correctly located on the battery casing, is secure and will not crush or otherwise damage the battery.

Be very careful not to spill battery acid. If acid is split or has been lost from the battery, treat the area with a solution of baking soda and water or ammonia and water. (An alkaline to neutralize the acid). Treat bare metal and repaint if necessary.

Remove contaminated clothing and rinse as quickly as possible. Rinse acid from skin immediately. If acid burns are experienced seek medical attention.

Remove all cables by undoing securing bolts/nuts or pulling apart at the terminal or terminal block. Clean all terminals and connections to ensure good current flow.

Reconnect and check the tightness of all push fit terminals. Coat with petroleum jelly or water repellent.

Refit the battery and if fitting a replacement ensure that the new battery matches the old battery for casing dimensions, Ah capacity, and the type and position of the terminal posts. Fit retaining straps/clamps and tighten. Do not over tighten as battery damage can occur.

Refit the battery supply lead and the earth or ground lead. Coat the terminals with petroleum jelly.

Start and run the engine and check that the engine starter motor operated correctly and that the generator/ignition warning light came on and went out as the engine speed increased.

Restore electronic memory functions if memory keeper not available.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

63.Remove and replace drive belts and pulleys.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Identify the drive belt for the alternator - V, polyvee (ribbed) or serpentine.

Slacken the alternator securing bolts and drive belt tensioner bolts. Slacken the belt tension. Pull the belt from the alternator and other pulleys and remove. Inspect the belt and pulleys for signs of wear, damage and slipping.

For automatic tensioners fit an appropriate socket and bar to the tensioner, pull anti-clockwise to release the tension. Hold the tensioner in the off position and pull off the belt. Slowly release the tensioner. DO NOT let it fly open under its own spring force as damage can occur.

Fit the new belt and adjust the tension to the manufacturer's specification. For V belts the correct tension is usually about 13 mm or 1/2 inch of free play on the longest side. For polyvee belts use a tension gauge or adjust so that the belt can be twisted through 90° on the long side.

Tighten the tensioner securing bolts. Refit other components in reverse order. Run the engine and check for abnormal noises. A whine would indicate that the belt tension is too tight and a slapping noise of the belt against the cover indicates that the belt is too loose.

To remove pulleys, undo the securing nuts and pull the pulley of its shaft. A special or two legged puller may be required. Remove the key from the shaft if necessary and if replacing it may be necessary to file to size to fit the pulley slot.

To hold a pulley while undoing the securing nut place an old drive belt around the pulley and hold the belt tightly in a vice whilst turning the nut with a wrench.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

64.Remove and replace alternator strip and replace brushes, regulator and diode pack.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery earth or ground lead. Unplug the multi-socket on the rear of the alternator or label and disconnect the cables. Slacken the alternator securing bolts, including the drive belt adjuster strap bolts. Mark the direction of rotation on the belt. Slacken the drive belt tension and remove the belt. Inspect the drive belt and drive pulleys for signs of wear, damage and slipping (glazing on sides).

Hold the alternator secure and remove the securing bolts. Lift out the alternator. Check the spindle bearings by rotating and listening and feeling for uneven and lumpy movement. Check the alternator casing for damage.

To remove the pulley, hold the spindle with a key or wrench and a wrench on the pulley securing nut. If the spindle cannot be held fit an old belt around the pulley and hold the belt in a vice and then turn the pulley securing nut with a wrench. Pull of the pulley. Use a puller if necessary. Lift out the woodruff key if the casing is to be separated.

The brushes are usually integral with the regulator on modern alternators. Undo the securing screws on the rear of the alternator and lift out the regulator and brush assembly. Inspect the brushes for length and condition. Inspect the slip rings on the rotor.

Remove the rear cover. Undo and remove the through bolts holding the casing halves. Carefully separate the casing making sure that the stator remains in the rear casing and attached to the diode pack. Pull out the rotor from inside the stator.

Remove the circlips retaining the bearings in each casing half and gently tap out the bearings. Check that the bearings have not been spinning in the casing. Fit new bearings and pack with grease. Fit new circlips and seals. Pre-packed and integral seal bearings are sometimes used.

Where a diode pack is available as a replacement part undo the retaining screws holding the diode pack to the rear casing and unsolder the old diodes where they attach to the stator. Re-solder the new diodes using a HEAT SINK such as a pair of pliers to prevent heat damage to the diodes.

Reassemble the alternator in the reverse order. Spin before refitting to check for abnormal noises. Carry out a bench test if the equipment is available. Refit in the reverse order and adjust the drive belt tension.

Run the engine and check that the generator/ignition warning light comes on and then goes out as the engine speed increases.

Connect a digital voltmeter and clamp on ammeter and check that the alternator output is correct. Compare with manufacturer's data.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

65.Remove and replace pre-engaged starter motor and replace solenoid.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check the condition of the battery and the operation of the starter motor before removal. Disconnect the battery earth or ground lead. Label and disconnect the cables on the solenoid - solenoid feed from the starter switch and LT ignition feed to bypass the ballast resistor. Disconnect the main supply feed cable to the starter at either end (most convenient).

Remove any components that restrict removal of the starter motor. Undo the starter motor securing bolts. (Socket wrenches and extensions are useful to gain access between the starter motor body and the engine block). Carefully remove the starter motor. Inspect the drive pinion (gear) and the one-way clutch. Check the starter motor casing and fitting flange for damage. Check the starter ring gear on the flywheel through the hole where the starter motor fits. Turn the engine at least one full revolution.

Check all gear teeth for chipped or worn down sections both on individual teeth and around the full circumference of the gear. Uneven wear in one place is a frequent defect. Look at the teeth for wear marks that show that the starter pinion has been fully in mesh.

To strip the motor fit into a bench vice and secure. To remove the solenoid undo the feed cable into the motor and pull back out of the way. Undo the retaining screws in the casing. Carefully pull out the solenoid disconnecting the plunger from the pinion gear engagement lever. To strip the motor, remove the through bolts and the rear cover and brushes. The brushes may be available as replacement parts. Follow the manufacturer's instructions for replacement. Clean and inspect the commutator, armature and spindle bearings. Pull the pinion casing, pinion, engagement lever and armature from the main casing and field coils. Follow the manufacturer's instructions for replacing the drive pinion and one way clutch.

Reassemble in reverse order. Carry out a bench test with the starter securely held in a bench vice. Connect a battery with jump leads to the starter. Negative cable to the battery negative and the starter casing. Positive lead ONLY to the battery positive and then keep the lead clear until testing.

AVOID any connect of the positive lead to the starter casing, vice or bench. Test the solenoid operation by touching the lead to the solenoid terminal, which should click, and the pinion move along the spindle to the engaged position. The spindle may slowly revolve on some motors. Test the motor operation by touching the lead to the motor terminal. The motor should run at full speed. Connect the lead to the solenoid input terminal. The solenoid should not operate and the motor should not run.

Use a jump lead to connect a feed to the solenoid low current terminal. The solenoid should operate and the motor should run. Refit the starter motor to the engine and check the operation. The engine should crank freely without abnormal noises.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

66.Remove and replace power distribution circuit cables and components to main fuse box.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: The main components are the high capacity cables from the battery that feed the vehicle electrical and electronic systems.

These cables run to the main fuse box, auxiliary fuse boxes, fusible links, thermal overload cut outs and other safety devices. Very few systems have a direct electrical supply.

Inspect wiring harness and connections. If damage has occurred to a wire, performing a solder repair may repair it. This involves cutting out the damaged wire and joining a new wire with a solder connection. Similarly, new connectors may be soldered to the wiring harness.

Follow very carefully the manufacturer's instructions and procedures for removing cables, harnesses and looms. Disconnect the battery earth or ground lead before any disconnection. Label and disconnect. Remove grommets to feed cables through vehicle panels.

Where necessary attach a wire or string to a cable before pulling through a hole in a panel or box section. The wire or string is used to guide the new cable back through the hole. Always push cables rather than pull in order that the guide string is not detached.

Identify power fuses and fusible links and replace in accordance with manufacturer's instructions.

On reassembly check carefully for correct connections, routing and security of the cable, harness or loom. AVOID sharp edges and hot components and do not allow cables to be under tension or stretched to fit.

Reconnect the earth or ground lead after first checking for short circuit by lightly touching the earth or ground lead to the battery terminal and looking for arcing. A large arc indicates a short circuit or a high current discharge. A very small arc may be normal.

Check that all electrical systems operate correctly. Run many systems at the same time to check that the cables, terminals and connections are able to carry a full current demand.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

67.Remove and replace starter motor circuit cables/components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery earth or ground lead.

Apart from the starter motor the main circuit components are the supply cables, the ignition and starter switch, the control circuit wiring to the solenoid and the engine earth or ground lead.

Label and disconnect cables. Clean and inspect terminals. Undo and remove the bolts on the engine earth or ground cable and remove the cable. Clean and inspect for fraying, corrosion or other deterioration. Refit and coat with petroleum jelly.

Follow the manufacturer's instructions for replacing the starter switch.

Reassemble in reverse order. Check operation of the starter motor.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

68.Remove and replace alternator circuit cables/components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery earth or ground lead.

Apart from the alternator the main components are the alternator output cable to the battery, the battery feed to the ignition switch, the ignition switch, generator warning light and the feed to the field terminal on the alternator.

Follow the manufacturer's instructions for replacement of the ignition switch and the fascia for access to the warning light bulb and printed circuit board on the rear of the instrument panel. Inspect the printed circuit, bulb holder and instruments multi-socket termination.

Label and remove cables.

Reassemble in reverse order. Run the engine and check the operation of the alternator and charge circuit.

If replacing an old type generator of a dynamo type it is important that the field coils are polarized. Take a live feed with a jump lead from the battery feed terminal directly to the field coil terminal after reconnecting the battery leads but before connecting the field terminal. Hold in contact for 30 seconds.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

69.Remove and replace headlight unit

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, headlight aimer etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Fit memory keeper and disconnect the battery earth/ground lead.

Remove covers as required and disconnect wires to lights.

Remove grill and/or trim as necessary for access to light unit fixings.

Undo bolts and/or clips and remove light unit from the car.

Refitting is a reverse of the removal process.

Note that some manufacturers require special contact grease to be applied to the terminals. This makes for a good electrical contact and keeps water out.

Check and adjust alignment (see other worksheet).

Check all other lights.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

70.Remove and refit multifunction steering column switch.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Fit memory keeper and disconnect the battery earth/ground lead.

Remove steering wheel (if necessary).

Undo the screws and remove the plastic cowling.

Disconnect the multiplug from the switch unit.

Undo the retaining screws and remove the switch from the steering column.

Refitting is a reversal of the removal process.

Torque steering wheel nut to manufacturer's specified value.

Double check that all the cowling and shrouds are refitted correctly and that the self-cancel mechanism switches off the indicators as the steering is turned.

Reconnect the battery and then test ALL lights for correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

71.Remove and refit flasher unit

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note that if the left or right indicators, or the hazards work, the unit is probably functioning correctly. Remember that a flasher unit is designed to flash at a different rate when a bulb is blown.

Flasher units are usually located either as part of the fuse box or on the steering column.

Remove covers or shrouds as necessary.

Most types of flasher unit simply pull out of the socket.

Replace by pushing the new unit into the holder.

Make sure the new unit is the correct one for the vehicle. Note that more powerful units may be required if a towing socket is fitted.

After renewal, make sure indicators and hazard lights operate.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

72.Remove and refit temperature sensor

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Fit covers as required to keep paintwork clean.

Remove cap from coolant header tank (vehicle must be cold) and then replace it. This will ensure that there is no pressure in the system and will minimize coolant loss.

Disconnect wire(s) from sender unit.

Prepare new unit for installation by applying sealant to the threads (if required). Follow manufacturer's guidance.

Remove old sensor from the engine (usually at the front of the head) and replace new one immediately.

Torque to specified value.

Reconnect wire(s).

Top off cooling system.

Start engine and run up to temperature. Check for correct gauge operation and leaks.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

73.Remove and refit speedometer cable.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Fit memory keeper and disconnect the battery earth/ground lead.

Remove instrument panel and disconnect speedometer cable from head unit.

Disconnect cable from gearbox.

Remove clips as required and remove the cable. If the cable runs through a complicated route, attach a string to one end of the cable and pull it through as the cable is removed. This will help when refitting the new one.

Remove driven gear (speedometer drive gear) from the gearbox and check for wear. Renew as required.

Refit cable and make sure it is secured in clips as necessary.

Refit instrument cluster.

Make sure all parts such as the steering wheel are clean.

Check for correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

74.Remove and refit fuel tank sender unit.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Fit memory keeper and disconnect the battery earth/ground lead.

Support vehicle on hoist.

Drain fuel from the tank using special equipment.

If necessary, disconnect fuel lines and filler components.

Remove fuel tank (some senders are accessible without removing the tank, check manufacturer's data).

Remove wires from sender unit.

Undo the ring of bolts and remove sender.

Use a new gasket and sealant when refitting.

Ensure the new sender is positioned correctly.

Refitting is a reversal of the removal process.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

75.Remove and refit windscreen wiper motor.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: This is a generic procedure for a motor that can be accessed from the engine compartment; refer to the specific manufacturer's instructions.

Switch off the ignition.

Mark the position of the wiper blades with masking tape, and remove the wiper arms.

Raise the hood and remove rubber strip and/or covers from the heating/ventilation system area.

Remove wiper motor cover panels.

Remove retaining screws as appropriate and remove the wiring harness plug from the motor.

Unscrew the large nut on the wiper spindles.

Slacken and remove the motor mounting bracket screws.

Maneuver the motor and drive linkage out from its fittings, and remove from the vehicle.

Undo the nut on the wiper spindle after marking the position of the crank arm.

Unscrew the motor fixing bolts and remove the motor.

Refitting is a reversal of the removal process. However, note the following points.

Connect the motor to the harness and run it (without the linkage) until it stops in the 'park' position as normal. Disconnect from the wiring.

Refit the crank and linkage exactly as it was removed.

After refitting the motor and linkage, run the motor and make sure the movement is correct BEFORE refitting the arms and blades.

Finally, fit the arms and blades, wet the screen and check for correct operation at all speeds and settings. Check that the blades park correctly.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

76.Remove and refit central door locking actuator.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: This is a generic procedure; refer to the specific manufacturer's data for detailed instructions.

Fit a memory keeper and disconnect the battery earth/ground.

Remove the interior door handles, lock lever covers, window winder and plastic boxes, etc. as required.

Using a flat forked lever under the plastic clips, remove the interior door trim panel.

If fitted, remove the plastic waterproofing cover. Take care not to tear this or be prepared to renew as required.

Make sure the window is fully closed to allow access into the door cavity. Note: The inside edges of the door structure are often sharp. Wear protective gloves as necessary.

Trace the wires from the lock actuator and disconnect the multiplug. On some cars, this is part of the actuator but on others, it may be inside the sill area or even under the carpets beneath the seats.

Unscrew the actuator fixings and unhook it from the pull rod.

Remove the actuator from the vehicle.

Refitting is a reversal of the removal process.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

77.Check electrical circuits.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: The following procedure is a generic test sequence that is useful for checking any electrical circuit on a vehicle.

Carry out 'hand and eye checks'. Look for loose wires, loose switches and other obvious problems. Make sure all connections are clean and tight.

Check that the battery is at least 70% charged.

Check any motor linkage, bulbs, solenoids, etc. for security and general condition.

Test the fuse continuity. Do not trust your eyes, check for a voltage at both sides with a meter or a test lamp.

If used, check that the relay clicks. If it does, jump to stage 8. Note that this means the relay has operated it is not necessarily making contact.

Check the voltage supply to the switch. It should be battery volts.

Check the supply from the switch, when operated. It should also be battery volts.

The supply from the switch to the relay should be battery volts. Note on some systems, earth/ground switching is used. The readings should therefore be zero volts or alternatively, check from the battery positive terminal to the switch and it should read battery volts.

The feed out of the relay when it has operated should be the same as the feed in to it.

The final voltage supply to the motor, bulb or whatever is being operated should be within about 0.5V of the battery voltage.

The earth or ground connection should have a continuity of 0Ω or a voltage of 0V.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

78.Inspect batteries for condition, security and state of charge.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Open hood to access the battery. Check the general condition on and around the battery. Check the alternator drive belt for condition and tension. Look at the battery for signs of leakage from the casing. A build up of a light colored corrosive substance indicates the presence of battery acid. Look at the securing straps and brackets for security and condition.

Look at the battery cables for condition, security and corrosion. Look at the earth or ground lead connection to the vehicle body for condition, security and corrosion. Make a general check of all cables to the starter and alternator and the engine earth or ground lead. Check the electrolyte level and specific gravity (relative density) with a hydrometer. OR check the built-in hydrometer on maintenance free batteries. Green dot for charged, black for partially charged and yellow for internal faults where the battery should not be recharged.

Carry out battery capacity test and confirm it has a capacity recommended by the vehicle manufacturer. Check the voltage with a digital voltmeter. Compare with the manufacturer's specifications. Conventional lead acid 12 volt batteries should read 13 to 13.2 volts when fully charged. Maintenance free 12 volt batteries should read 12.8 volts when fully charged.

Carry out a high rate discharge test ONLY on a fully charged battery. Connect the tester following the manufacturer's instructions. Observe polarity. Set amperage to 3 x battery Ah rate. Carry out test following the equipment manufacturer's instructions. DO NOT exceed test time. Conventional batteries can be 'fast charged' using a high output (amps) fast charger. Connect and charge at the current (amps) and time specified by the fast charger manufacturer. Disconnect the battery leads before connecting to the fast charger to prevent possible damage to electronic units.

DO NOT allow the battery to overheat. Use the temperature probe if fitted to the charger. DO NOT fast charge maintenance free batteries unless permitted by the manufacturer. Slow (low current - amps) charging of conventional lead acid and maintenance free batteries can be carried out singularly or two or more of a similar type and at a similar state of charge can be connected together.

Connect a single battery to a charger observing the polarity of the charger and the battery. Red (+) to positive, black (-) to negative. Set the charger to 1/10th of the battery Ah (amp hour - 10 hour rating) and charge for 15 hours for a fully discharged battery. For multiple battery charging, connect batteries in parallel for a 12 volt charger. For 24 volt chargers connect 2 x 12 volt batteries in series. 4 batteries are connected in series and parallel. Set the charge rate according to the number and Ah ratings of the batteries.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

79.Check voltage supplies.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: This is a generic test routine, refer to manufacturer's procedures and circuits for specific details.

Hand and eye checks (loose wires, loose switches and other obvious faults) - all connections clean and tight.

Check battery - must be at least 70% charged.

Check bulb(s) - visual check or test with an ohmmeter.

Fuse continuity - do not trust your eyes, check voltage at both sides with a meter or a test lamp.

If fitted, does the relay click - if yes, jump to stage 8 (this means that the relay has operated, but it is not necessarily making contact).

Supply to switch - battery volts.

Supply from the switch - battery volts (switch fault if no supply out).

Supplies to relay - battery volts.

Feed out of the relay - battery volts (relay fault if no supply out and it clicks).

Voltage supply to the light - within 0.5V of the battery.

Earth/ground circuit (continuity or voltage) - 0Ω or 0V.

Check operation of all lights when work is complete.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

80.Check operation of gauges and warning lights.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain technical/procedural data from manuals and information from vehicle owner/driver.

Gauge or warning light	Comments
Fuel gauge	
Temperature gauge	
Speedometer (include odometer)	
Revcounter	
Oil pressure warning light	
Charge warning light	
Check engine warning light	
ABS warning light	
Indicators warning light	
Main beam warning light	
Other…	

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

81.Check electric window operation and reset position memory.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check operation (note that this is a generic procedure, refer to specific information at all times)

Ensure that the battery is charged and then switch on the ignition.

Operate each window from the driver's switch pack. Check, in each case, for one touch operation as well as limited movement.

Operate each window from the appropriate passenger's switch.

Move the driver's safety switch to the 'isolate rear' position and then check that the rear windows are locked.

Check the manual, and if a bounce back or back off facility is included, check this by putting a magazine or similar in position so that the window will 'bounce back' when it is trapped.

If a 'global closing' facility is included, check the operation by opening one or more windows and then locking the car with the remote key. Some vehicles require the key button to be held for a few seconds to make this facility operate.

Switch off the ignition.

Position memory reset (generic procedure for anti-trap systems only; check specific data):

Carry the procedure out on each window in turn.

Press the switch to close the window, hold it until the window is fully closed and then for a further second.

Release the button and then press it to the close position again for a second, three more times.

Open the window fully, press the close switch once and check operation.

The window should close fully in automatic mode but repeat the previous procedure if not.

Note that the anti-trap function is disabled until the position memory has been reset.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

82.Check central door locking and alarm operation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: Different systems operate in different ways so check specific data as necessary.

Use a scan tool where appropriate to check for alarm/central locking stored fault codes.

Close all the doors and operate the central locking from the driver's door lock using the key manually. All doors and the tailgate should lock. If a double locking system is fitted turning the key again, double locks all openings.

Check manually that all doors and openings have locked.

Repeat the above procedure using the remote key if available.

Repeat again from the passenger's door lock.

Open one of the windows and then fully lock the car.

Reach inside the car. If a movement sensor is incorporated, the alarm will sound! If not…

Reach in and open the door from the inside. The alarm should now sound! Press the remote or use the key in the driver's door to reset.

Close all windows and lock the car.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

83.Check voltage supplies.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: This is a generic test routine, refer to manufacturer's procedures and circuits for specific details.

Hand and eye checks (loose wires, loose switches and other obvious faults) - all connections clean and tight.

Check battery - must be at least 70% charged.

Check bulb(s) - visual check or test with an ohmmeter.

Fuse continuity - do not trust your eyes, check voltage at both sides with a meter or a test lamp.

If fitted, does the relay click - if yes, jump to stage 8 (this means that the relay has operated, but it is not necessarily making contact).

Supply to switch - battery volts.

Supply from the switch - battery volts (switch fault if no supply out).

Supplies to relay - battery volts.

Feed out of the relay - battery volts (relay fault if no supply out and it clicks).

Voltage supply to the light - within 0.5V of the battery.

Earth/ground circuit (continuity or voltage) - 0Ω or 0V.

Check operation of all lights when work is complete.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

84.Check fuse and bulb condition. Replace as required.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check data for location of fuse box.

Switch on the circuit under test and the ignition if necessary.

Check for voltage at both sides of the fuse, fusible link or circuit breaker with a meter or a test lamp. Ceramic and glass fuses have metal contacts; blade fuses have small test points at each side on top of the fuse.

Remove the fuse using a clip puller if necessary. Replace with one of the recommended value.

Check bulb replacement methods. Most rear lights are accessible from behind the light cluster inside the vehicle. Headlight bulbs usually have a small cover that should be removed. Side and indicator light units are often removed as a unit after a spring clip is released.

Check bulbs by eye but also with an ohmmeter – a few ohms will indicate that the bulb is in good order. Do not touch the glass of a headlight bulb. This can create a localized hot spot due to grease contamination and cause the bulb to blow. Clean off carefully if touched accidentally.

Replace faulty bulbs with ones of the correct rating (voltage and wattage) as well as the correct fitting. In some cases, the bulbs are colored.

Check all lights for correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

85.Inspect and measure electrical/electronic circuits and components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check out the test methods in detail in the main learning program and then complete the readings in the following table:

Component	Test method	Reading
Resistor (e.g. plug leads)	Measure using an ohmmeter on the correct range	
Capacitor (e.g. as used on old ignition systems)	Charge up to 12V and measure discharge time through digital voltmeter	
Switch (e.g. ignition switch)	Measure voltages at input and output	
Thermistor (e.g. coolant temperature sensor)	Measure using an ohmmeter on the correct range at different temperatures	
Inductive sensor (e.g. ABS wheel sensor)	Check the output waveform on an oscilloscope	
Bulb (e.g. twin filament headlight type)	Connect to a battery or measure resistance	
Electronic control unit (e.g. ignition)	Use 'black box technique' – if all inputs and outputs are ok the box is faulty	
Light emitting diode (e.g. warning light)	Connect to a 1.5V battery or with a series resistor to a 12V battery	
Relay (e.g. fog or driving lights)	Energize coil with 12V (pins 85 and 86) and measure contact resistance	
Diode (e.g. part of an alternator rectifier)	Connect in simple bulb circuit – bulb will light with diode one way but not the other	
Digital components (e.g. most ECUs)	Use a logic probe to check supplies and outputs	
Circuit connections (e.g. wiring harness)	Measure voltage or resistance (if disconnected battery) while wiggling!	

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

86.Check charge circuit operation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check the alternator drive belt for condition and tension. Look for frays, cracks, glazing of the drive faces caused by slippage and check that the tension or free play is about 12 mm (1/2 in).

Turn on the ignition and check that the ignition/generator warning light comes on. Start the engine and increase the speed to check that the warning light goes off. Turn off the engine and open the hood.

Connect a digital voltmeter across the battery terminals. Connect an ammeter (50 amps minimum) between the alternator output lead and the battery (or see 6). DO NOT connect so that starter motor current can flow through the ammeter.

Start and run the engine at about 2000 rpm. Check the voltage and amperage readings. Volts should be 14.2 or 14.7 (check manufacturer's specifications) and the current positive and at about 3 to 5 amps within a short time of starting the engine.

Turn on the headlamps, heater blower, heated screens, air conditioning and other high current devices. The alternator output should rise to meet the demand of the systems switched ….OR

Fit a clamp on ammeter around the battery earth or ground lead or power supply lead. Check the initial current flow without other systems on when the current should be positive. Turn on the high consumption systems - the battery current should remain positive - not discharging.

Some alternators can have the regulator bypassed in order to produce a maximum output. Carefully follow the manufacturer's instructions to carry out this test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

87.Check starter operation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check that the battery is fully charged. Connect a digital voltmeter to the battery terminals.

Disconnect the coil LT lead to the distributor or the coil multi socket and the fuel injectors.

Crank the engine for about 10 seconds and observe the voltage readings. The battery voltage should not fall below 10 volts during cranking. A good reading is above 10 volts.

Connect the voltmeter between a good earth or ground point on the starter and the battery earth or ground terminal. Crank the engine and read the voltage drop. The voltmeter reading should not exceed 0.5 volts. (This test confirms that the engine earth or ground return system is in good condition).

Connect the voltmeter between the starter supply and the battery supply terminal. Crank the engine and read the voltage drop. The voltmeter reading should not exceed 0.5 volts. (This test confirms that the supply system is in good condition).

Check that the cranking speed is normal and that there are no abnormal noises.

Reconnect the coil and fuel injectors and check that the engine starts and runs.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

88.Inspect and measure electric screen heaters.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: Most screen heaters work on a timer relay. This prevents unnecessary load on the battery and charging system. Make sure the relay is switched on when testing the system. The procedure here can be applied to front or rear screen heaters. Some systems require the engine to be running. Check manufacturers' data.

Measure the battery voltage. It should be 12.6V or just over.

Switch on the ignition and the front/rear screen heater switch.

Check that the warning light has illuminated.

Where connections can be accessed, connect a voltmeter across the supply terminals. It should read within about 0.5V of the battery voltage.

Switch off the system and connect an ammeter in series with the heater. This can be done by connecting in place of the fuse using suitable adaptors.

Measure the current draw. Readings will vary, but figures in the region of 20A or more are to be expected. A low reading would indicate a high resistance in the circuit.

Some cars with hatchbacks have contacts that make when the hatch closes. Double check these for operation and cleanliness.

As a final, simple test, switch on the heater and breathe heavily on the screen! The condensation should disappear quickly.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

89.Inspect and measure wiper motor operation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: Wipers should not be operated for long periods on a dry screen. Take extra care when operating wipers with the linkage exposed as it is easy to trap your hands and cause injury.

Run through the washer and wiper operations to check for correct operation. Most wipers have a slow, fast, intermittent and wash/wipe facility.

Check that the blades park when the switch is turned off.

Switch off the ignition.

Connect an ammeter in series with the motor supply. This can be in place of the fuse if necessary, by using suitable adapters.

Run the wipers at each speed after wetting the screen (using the washers is probably easiest).

Measure the current draw. Readings will vary, but figures in the region of 12A or more are to be expected.

A low reading would indicate a high resistance in the circuit.

Inspect the circuit and make sure connections are clean. Connecting a voltmeter across a connection is a good way of testing it. A reading of almost zero volts is to be expected when the motor is operating.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

90.Check temperature and fuel sender resistances.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove wire(s) from temperature sender.

Note that if two wires are used these are the connection points, if one wire, the circuit is from there to the body of the unit.

Connect ohmmeter and measure resistance.

Compare with specifications (many types read about 1.5K at room temperature).

Remove wire(s) from fuel tank sender.

Note that if two wires are used, one is usually for a low fuel switch.

Connect ohmmeter and measure resistance.

Compare with specifications (many types read about 20 ohms full and 200 ohms empty but this varies so check data).

Reconnect all and check operation of all instruments.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

91.Inspect and measure output from road speed sensor.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Inductive sensors

Disconnect the wires (usually two, if a third is used it will be a screen connection to prevent interference entering).

Measure resistance and compare against specifications (often about 800 ohms but double check).

Support the vehicle wheels off the ground and run the car in gear.

Measure ac voltage output and compare against specifications (often about 5 volts ac but this will vary with speed).

Check output signal on a scope. An ac waveform with a frequency that varies with speed is to be expected.

Hall effect and other types requiring a power supply

Do NOT use an ohmmeter as this can damage some types.

Check output signal on a scope. A waveform with a frequency that varies with speed is to be expected.

Reconnect all components.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

92.Check and adjust headlight alignment (beam setting).

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Always follow manufacturer's instructions where available.

If any form of automatic adjuster is fitted, make sure it is moved to the setting position.

Park the car on level ground and place the beam setter in front of each light in turn. The setter should be positioned exactly in line, and square to the front of the car.

The car should not be laden, except for the driver. Bounce the suspension to ensure it is level.

Set the controls on the beam setter to the required value. This is usually 1 to 1.2% dip for asymmetric lights.

With the lights set on dip beam, adjust the cut-off line to the horizontal mark by turning the adjuster.

The break-off point should be adjusted to the center line of the headlight by turning the other adjuster.

Two screws are usually used for making the adjustments. One for vertical movement and one for horizontal movement. On older vehicles, these adjusters are easy to break if they are seized due to corrosion.

Check all lights for correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

93.Check stop light operation and adjust switch position.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove the two wires from the stoplight switch and bridge them together with a fused jumper wire. The ignition may need to be switched on.

The stoplights should light. If not, trace the circuit for a break starting with the fuse.

Note: Part of the circuit is in series and part in parallel. If one light is illuminated the fault must be in the parallel part of the circuit. If neither light is illuminated the fault must be in the series part of the circuit.

If the lights work when the switch is bridged, the switch needs replacing or adjusting.

Most switches are positioned above the brake pedal and have a screwed body with adjusting nuts. These switches make contact as the plunger springs out.

Adjust the switch position so that the lug on the brake pedal allows the plunger to move as soon as the pedal is pushed down.

Check that the switch is not too sensitive, such that the lights flash on due to vibration for example.

Secure all wires and adjusting nuts – check operation again.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

94.Carry out starter motor and circuit tests.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check that the battery is fully charged. To check the starter motor circuit on the vehicle connect a digital voltmeter to the battery terminals and a clamp type ammeter to the starter feed cable.

Disconnect the coil LT lead to the distributor or the coil multi socket and the fuel injectors.

Crank the engine for about 10 seconds and observe the voltage readings. The battery voltage should not fall below 9.5 volts during cranking. A good reading is above 10 volts. The ammeter reading should be compared to the manufacturer's specification.

Connect the voltmeter between a good earth or ground point on the engine and the battery earth or ground terminal. Crank the engine and read the voltage drop. The voltmeter reading should not exceed 0.5 volts. (This test confirms that the engine earth or ground return system is in good condition).

Check that the cranking speed is normal and that there are no abnormal noises.

To test the starter motor before fitting carry out a bench test with the starter securely held in a bench vice. Connect a battery with jump leads to the starter. Negative cable to the battery neg. (-) and the starter casing. Positive lead ONLY to the battery positive and then keep clear until testing.

AVOID any connection of the positive lead to the starter casing, vice or bench. Test the solenoid operation by touching the lead to the solenoid terminal, which should click, and the pinion move along the spindle to the engaged position. The spindle may slowly revolve on some motors.

Test the motor operation by touching the lead to the motor terminal. The motor should run at full speed. Connect the lead to the solenoid input terminal. The solenoid should not operate and the motor should not run.

Use a jump lead to connect a feed to the solenoid low current terminal. The solenoid should operate and the motor should run.

When specialist equipment is available carry out a starter motor torque test. Follow the equipment manufacturer's instructions to carry out this test.

Refit the starter motor to the engine and check the operation. The engine should crank freely without abnormal noises.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

95.Carry out alternator and circuit tests for correct charge rates.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check the alternator drive belt for condition and tension. Look for frays, cracks, glazing of the drive faces caused by slippage and check that the tension or free play is about 12 mm (1/2 in.).

Turn on the ignition and check that the ignition/generator warning light comes on. Start the engine and increase the speed to check that the warning light goes off. Turn off the engine and open the bonnet/hood.

Connect a digital voltmeter across the battery terminals. Connect an ammeter (50 amps minimum) between the alternator output lead and the battery. DO NOT connect so that starter motor current can flow through the ammeter.

Start and run the engine at about 2000 rpm. Check the voltage and amperage readings. Volts should be 14.7 and the current positive and at about 3 to 5 amps within a short time of starting the engine.

Turn on the headlamps, heater blower, heated screens, air conditioning and other high current devices. The alternator output should rise to meet the demand of the systems switched on…..OR

Fit a clamp on ammeter around the battery earth or ground lead or power supply lead. Check the initial current flow without other systems on when the current should be positive. Turn on the high consumption systems - the battery current should remain positive - not discharging.

Some alternators can have the regulator bypassed in order to produce a maximum output. Carefully follow the manufacturer's instructions to carry out this test.

To inspect individual alternator components follow the alternator manufacturer's procedures. Compare the test and inspection results with the manufacturer's specifications.

To carry out inspection off the vehicle use a test rig and follow the rig manufacturer's instructions.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

96.Reported fault – discharged battery.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Open bonnet/hood to access the battery. Check the general condition on and around the battery. Check the alternator drive belt for condition and tension.

Look at the battery cables for condition, security and corrosion. Look at the earth or ground lead connection to the vehicle body for condition, security and corrosion. Make a general check of all cables to the starter and alternator and the engine earth or ground lead.

Check the electrolyte level and specific gravity (relative density) with a hydrometer. OR check the built-in hydrometer on maintenance free batteries. Green dot for charged, black for partially charged and yellow for internal faults where the battery should not be recharged. If vehicle is to be driven immediately, connect jumper cables and a battery or auxiliary power supply.

Start and run the engine at about 2000 rpm and check the voltage and amps readings. Compare readings with manufacturer's data. (Volts 14.2, Amps 20 +). This will ensure the vehicle will charge the battery and allow starting if the engine is stopped or stalled.

Restore electronic memory functions. The reason for the flat battery must be investigated as soon as possible.

Investigating the reason for flat battery

Disconnect the battery from the vehicle and slow charge it. Connect to a charger observing the polarity of the charger and the battery. Red (+) to positive, black (-) to negative. Set the charger to 1/10th of the battery Ah (amp hour - 10 hour rating) and charge for 15 hours for a fully discharged battery.

Reconnect the battery to the vehicle. Connect ammeter in series with battery earth/ground lead. Note reading, which should be very low. High reading will indicate current draw in one of the vehicles many circuits. In order to determine which circuit, remove and replace each fuse in the fuse box in turn. The ammeter reading will fall when the fuse to the circuit drawing current is removed. Remember some circuits will require the ignition to be switched on.

If the cause of the current draw is a short circuit the appropriate fuse will have 'blown'. Replace the fuse with a bulb and suitable connectors. Disconnect parts of the circuit in a systematic way to identify the part of the circuit that is shorted to earth (a wiring diagram will make this process much easier).Restore electronic memory functions.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

Assignments

General Electrical System Diagnosis

Task 1:

This picture shows a Digital Multi Meter connected across the terminals of a switch in a live circuit. The switch is in good serviceable condition.

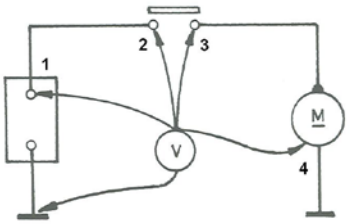
State the setting required on the meter i.e. amps, volts or ohms

State the reading when the switch contacts are

Open, closed

Answer:

Task 2:



The picture shows a basic starter motor circuit being tested with a voltmeter. The battery is fully charged and serviceable. The readings are taken when the engine is being cranked.

State what **each** of the following readings would indicate:

test point 1 – 8V test point 2 – 8V

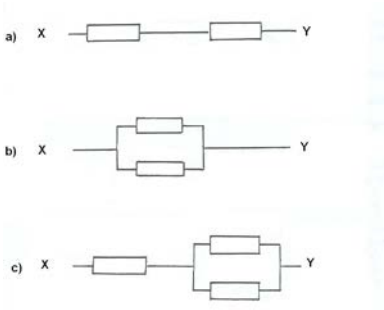
test point 3 – 6V test point 4 – 2V

Answer:

Task 3:

The picture shows 2Ω resistors connected in different ways.

State the reading that would be obtained on an ohmmeter connected between the terminals X and Y on **each** circuit



Answer:

Task 4:

In relation to electrical circuits, state what is meant by the following terms:

short circuit, open circuit, high resistance.

State the most likely result of a short circuit on a vehicle

Describe **one** method of identifying the location of a short circuit in a vehicle electrical system

Answer:

Task 5:

Describe **one** method of testing **each** of the following electrical/electronic devices for serviceability:

wiring connection, relay, wire, transistor, diode

Answer:

Task 6:

A vehicle is suspected of having excessive key-off battery drain (parasitic draw). Describe a method of diagnosing the cause of this fault. Your answer should include the equipment and settings used in the diagnosis.

Answer:

Instructor Feedback:

Battery Diagnosis and Service

Task 1:

The picture shows a test being carried out on a battery in order to determine its state of charge.

Name the test instrument being used.

Explain how the test determines the battery state of charge.

Give the battery 'state of charge' for **each** of the following readings:

1.280, 1.200, 1.100

Answer:

Task 2:

State the meaning of the term 'Battery Capacity'.

Describe a test to determine the capacity of a battery.

Answer:

Task 3:

A Vehicle battery is to be replaced.

Describe a method of maintaining electronic memory functions during the replacement.

State **three** personal safety precautions which must be adopted during the removal and refitting of the battery.

Answer:

Task 4:

Describe **three** maintenance tasks that should be carried out on a vehicle battery.

Answer:

Task 5:

State **three** safety precautions that should be observed when **fast** charging a battery.

Describe a procedure for **slow** charging a 12V 40Ah battery (include voltage and amperage settings used on the charger.

Answer:

Task 6:

Describe in sequence, a procedure for starting a vehicle using jumper cables and a battery (include relevant safety precautions that should be observed).

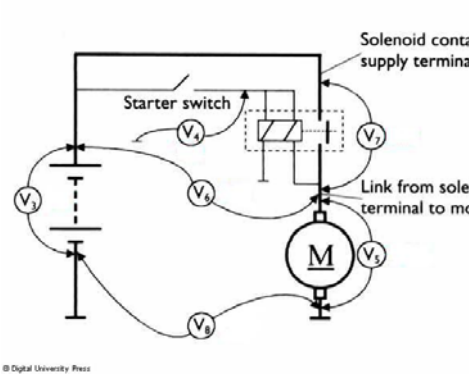
Answer:

Instructor Feedback:

Starting systems diagnosis

Task 1:

The picture shows a 12V starter system being tested using a voltmeter. The battery is serviceable and fully charged. The starter switch is closed.



Name the test being carried out.

State why the starter switch must be closed when the readings are taken.

State what different system faults **each** of the following test readings would indicate:

V_5 = 7V V_7 = 2V

V_8 = 2V V_3 & V_4 = 8V

Answer:

Task 2:

A Pre-engaged starter is to be removed from a vehicle.

State **two** safety precautions that should be adopted during the task.

Describe the sequence of operations required to remove the starter from the vehicle.

Answer:

Task 3:

The picture shows a component being removed from a pre-engaged starter motor.

Name the component.

State **two** faults in the component which would prevent starter operation.

Describe **one** test of the component to determine its serviceability.

Answer:

Task 4:

A technician is to carry out a starter current draw test.

List the equipment required to complete this task.

Describe how the test is carried out.

Answer:

Task 5:

A vehicle is described as having slow cranking problems. The starter motor and battery are new and serviceable components.

State **two** possible faults that would cause this slow cranking.

State **one** diagnostic method used to diagnose **each** fault.

Answer:

Task 6:

When operating the starter switch, an audible click is heard from the starter solenoid, but the motor fails to turn. State **four** possible starter system/component faults that would give this symptom.

Answer:

Instructor Feedback:

Charging systems diagnosis

Task 1:

An alternator charging system is to be checked without removal of components from the vehicle. State **three** checks essential to ensure the charging system is operating satisfactorily.

Answer:

Task 2:

An output test is to be carried out on an alternator charging system.

List the tools and equipment needed to complete the task.

Describe a procedure for carrying out the test.

Answer:

Task 3:

State **two** causes for **each** of the following charging faults:

undercharge

overcharge

no charge

Answer:

Task 4:

The picture shows an alternator drive belt.

State **two** faults, which would require replacement of the belt.

Describe a procedure for the removal and replacement of the belt.

Describe **two** methods of determining the correct belt tension.

Answer:

Task 5:

Describe a procedure for carrying out a volt drop test on an alternator charging circuit.

Answer:

Task 6:

State **six** safety precautions that should be observed when diagnosing faults or working on the charging system of a vehicle.

Answer:

Instructor Feedback:

Lighting Systems Diagnosis and Repair

Task 1:

State in relation to vehicle lighting systems, **two** faults which would give **each** of the following symptoms:

brighter than normal

dimmer than normal

Answer:

Task 2:

A vehicle is reported as having intermittent light operation.

List the tools and equipment required to diagnose the fault.

Describe a procedure that could be used to identify the fault.

Answer:

Task 3:

Describe a procedure for replacing a headlight unit and checking its aim.

Answer:

Task 4:

A driver reports the left and right turn signals of a vehicle operate at different rates. All the bulbs are in working order.

State **one** possible cause of this fault.

Describe a procedure for diagnosing this fault.

Answer:

Task 5:

Turning the lights of a vehicle on causes the fuse to blow.

State **one** possible cause of this fault.

Describe a procedure for locating the source of this fault.

Answer:

Task 6:

The picture shows a fused jumper wire.

State why the wire has an inline fuse fitted.

State **two** hazard light system faults that can be identified with a jumper wire

Explain how the jumper wire is used in the identification of the faults.

Answer:

Instructor Feedback:

Gauges, Warning Devices and Driver Information Systems Diagnosis and Service

Task 1:

State, in relation to instrument gauges, **two** faults which would cause each of the following:

high readings

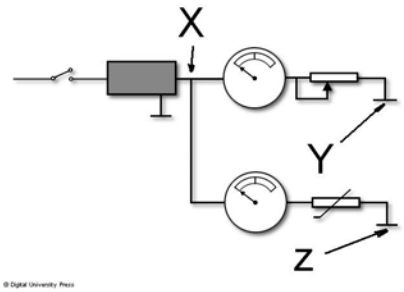
low readings

no reading

Answer:

Task 2:

The picture shows a gauge circuit.



Explain the effect on gauge operation of a high resistance at **each** of the following positions in the circuit.

position X

position Y

position Z

Answer:

Task 3:

The pictures show a fuel tank sender unit.

State the gauge reading if a unit is positioned as in:

Picture A Picture B

b) Describe a procedure for checking the correct operation of the unit.

Picture A

Picture B

Answer:

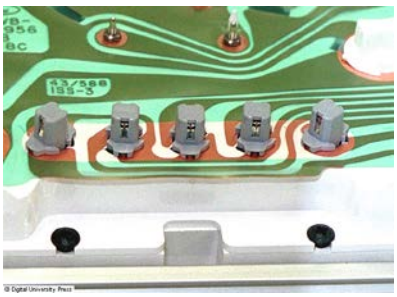
Task 4:

State a procedure for checking a voltage stabilizer with a voltmeter.

Explain why electronic components should not be tested with an analogue type meter.

Answer:

Task 5:



The picture shows a printed circuit board from a driver information system.

State **two** precautions that should be adopted when removing a printed circuit board from a vehicle.

State **three** checks that should be made to a printed circuit boards to determine its serviceability.

Answer:

Task 6:

Describe a procedure for the removal, testing and replacement of a temperature sensor.

Answer:

Instructor Feedback:

Horn and Wiper/Washer Diagnosis and Repair

Task 1:

Describe how to carry out **each** of the following tasks on a horn system:

check the current consumption of the horn

locate a high resistance connection in the circuit

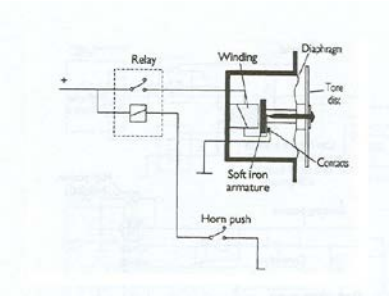
Answer:

Task 2:

The picture shows a horn circuit.

State **two** faults that can cause the circuit fuse to blow when the horn switch is pressed.

Describe how the contacts are adjusted.



Answer:

Task 3:

State **one** fault that could occur in a wiper motor unit that could cause **each** of the following symptoms:

The motor continues to operate when the wipers are switched off.

The motor will not operate at normal speed.

Answer:

Task 4:

Describe, with the aid of a sketch, how a wiper motor could be connected to a battery and ammeter to check the current when operated at:

fast speed

normal speed

Answer:

Task 5:

When the windshield washers are operated, it takes several seconds for water to be emitted from the jets.

State the most likely cause of this fault.

Explain how this fault should be rectified.

Answer:

Task 6:

Describe a method of clearing a blocked water jet.

Describe how the direction of a windshield washer water jet should be adjusted.

Answer:

Instructor Feedback:

Body electrical system diagnosis

Task 1:

The picture shows testing of a heated glass circuit.

Describe **two** electrical tests used to determine the correct operation of a heating circuit.

Answer:

Task 2:

An electrically operated window motor is checked with an ammeter. It is noted that the current draw is abnormally high and the motor speed is slow. State **two** faults that could cause this.

Answer:

Task 3:

Describe a procedure for disarming an airbag system for vehicle service.

Answer:

Task 4:

State **two** faults that could cause each of the following:

radio static

weak radio reception

no radio reception

Answer:

Task 5:

The picture shows the removal of a door panel.

State **two** precautions that should be observed when removing and replacing the panel.

State **two** electrical systems that are accessed by removing the panel.

Answer:

Task 6:

State **six** body electronic systems that could have faults diagnosed using a scan tool.

Answer:

Instructor Feedback:

Engine Performance

Tasklist worksheets

97.Adjust valve clearances

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: OHV:

Run engine and listen for abnormal noises from top of engine. Check for misfire/cylinder balance. Disconnect battery earth/ground cable. Remove rocker cover.

Measure with feeler gauges all valve clearances at the 'back-of-the-cam' (heel) position. Check manufacturer's recommended procedure for positioning the engine e.g. rule of nine or valves rocking method.

Adjust each valve using a special tool or wrench and screwdriver as appropriate. Note that inlet and exhaust settings may vary.

Refit all and run engine to check for noise or misfire.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

98.Inspect and replace timing belt(s).

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Follow manufacturer's instructions exactly to ensure correct valve timing and belt tension. Risk of serious engine damage if the belt is incorrectly fitted.

Run engine and listen for abnormal noises from cam belt and tensioner. (Belt slap or bearing wear). Disconnect battery ground lead. Remove alternator and other drive belts to access cam belt cover. Remove cam belt cover and pulleys if necessary. Check for oil leaks onto the belt.

Turn engine in normal direction of rotation (DOR) until timing marks align. Insert locating pegs or locking devices if specified. If belt is to be reused mark DOR with an arrow in tire crayon for refitting in same direction.

Slacken tensioner and slide belt off toothed wheels. Inspect tensioner bearings and toothed pulleys for condition. Replace any leaking oil seals. (Refer to the engine lubrication-learning program).

Fit new or replace belt with tight side between the camshaft and crankshaft pulleys on DOR side. Slack side should be on tensioner side.

Check timing marks alignment. Adjust belt tension to manufacturer's specification. (General rule is a 90□twist in the long side of the belt).

Remove pegs or locking devices if fitted. Turn engine through 2 or 3 full revolutions and recheck timing marks alignment and belt tension.

Replace cam belt cover, pulleys, belts (adjust) and battery ground lead. Start and run engine, check for abnormal noises from cam belt and tensioner. A whine indicates an over tightened belt or defective tensioner bearings.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

99.Routine Maintenance Inspections, Lubrication and Replacement of Parts.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: General visual inspection - Run engine and listen for abnormal noises (misfire, etc.).

Locate and interpret vehicle and major component identification numbers (VIN, vehicle certification labels and calibration decals).

For electronic distributor systems check pulse generator - lubricate distributor spindle.

Not many left but… for contact breaker systems replace points and set gap. Lubricate cam and distributor spindle.

For all systems, inspect high-tension components. Treat with water repellent.

Remove spark plugs and inspect for ignition, fuel or engine faults.

Clean or replace the plugs. Check and set the gap on the electrodes.

Check basic timing setting and advance curves with stroboscopic timing light.

For ECU systems, check for fault codes or data check readout. OBD1 or OBD2.

Check for module communication errors using a scan tool.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

100.Inspect electronic system primary and secondary circuit components and adjust timing.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain information from driver on engine performance, abnormal noises and fuel efficiency. Run engine/road test to for check for misfire, uneven running, pinking and overheating.

Disconnect live feed to ignition coil; turn on ignition check with voltmeter battery and ignition LT volts at coil terminal. Reconnect and disconnect feed to distributor, check coil output volts. Volts should be similar on both sides of coil. Check coil resistance if wide variation in volts.

Disconnect multiplug on distributor, follow manufacturer's instructions for terminal numbers in order to check pulse generator and amplifier module. Check volts or ohms as instructed and compare with manufacturer's data. Use oscilloscope or test equipment where specified.

Remove distributor cap and check condition of insulator/heat shield below rotor arm. Visually inspect all high-tension components for general condition - signs of electrical tracking or short circuit, perishing or age hardening, security of terminals and corrosion of rotor/cap contacts.

Disconnect LT and HT wiring on the coil and check coil resistances with ohmmeter. Compare with manufacturer's data. Check coil insulation. Tester should indicate open circuit between terminals and coil body or insulations.

Carry out insulation testing on rotor and distributor cap insulation. If satisfactory, visually check condition of rotor and segment contacts inside the cap.

Remove in turn the HT leads and check the condition of the termination in the cap and on the lead. Check the lead resistance with an ohmmeter set on the kilo (1000) ohms scale. Reading should be not less than 10K ohms or as per manufacturer's data.

Reassemble making sure that all terminals are clean and tight. Run engine and check ignition timing using a stroboscopic test lamp and engine tachometer. Set timing observing the conditions specified in the manufacturer's data. Rotate distributor body.

These tests can also be carried out using an engine analyzer or dedicated test equipment.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

101.Inspect, clean or renew and gap spark plugs.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check age/mileage of spark plugs from customer records. Check manufacturer's data for correct plugs for vehicle.

Check security of spark plug leads during disconnection - note and rectify any loose connections. Using an appropriate deep socket to remove the spark plugs. Note any tight threads and rectify before reassembly. Lay out plugs in order for diagnosis of plug or engine condition.

Inspect plugs for condition - erosion of electrodes, carbon fouling, damaged insulation, thread condition and tightness of threaded terminals. Check sealing washer or taper seat condition.

Look also for symptoms of engine or fuel system faults. Black sooty deposits indicate a rich fuel mixture, black oily deposits indicate piston ring or inlet valve stem wear, white/brown sooty deposits indicate a weak mixture and overheating, investigate faults found, replace plugs.

Plugs in good condition can be cleaned and re-gapped with a feeler gauge. All new or replaced plugs should be gapped to the manufacturer's specification before fitting.

Adjust the earth/ground electrode to give a gap between the center and earth/ground electrodes. DO NOT exert a force on the center electrode, either lever out with a suitable tool to increase the gap or tap in on a solid object to reduce the gap. Check with a feeler or gap gauge.

Lubricate the threads of plugs being fitted into aluminum cylinder heads (graphite or high melting point grease as specified by the manufacturer). Fit into cylinder head and tighten hand tight before finally tightening with a torque wrench. Ensure correct torque for washer or taper seat types.

Reconnect leads and check security - leads must be tight and making a good electrical connection.

Run engine/road test and check for correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

102.Replace and or clean fuel filters.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: For gasoline fuel systems, disconnect the battery earth lead. Depressurize fuel system if necessary. Apply vacuum to pressure regulator or cover with rag and undo a fuel supply union.

For gasoline filter elements in fuel pumps and carburetor inlets, remove the cover, catch spilt fuel, clean out sediment chamber and water trap and clean with airline, clean filter with airline. Check seal and replace if necessary. Refit filter and cover, and tighten securing screws.

For inline filters, either disconnect the fuel line above the tank or pinch a flexible hose with a brake pipe clamp before removing the filter in order to prevent fuel draining. Remove the pipes or hoses on each end of the filter, fit new filter observing the direction of flow arrow on the filter.

For canister type filters, undo the canister body with a strap wrench or by hand. Drain canister from drain valve into a suitable small drain tray. Undo valve and unscrew the filter body to provide an air gap. Allow to drain before doing up the drain valve prior to removal.

For replaceable filters in a canister bowl undo the securing screw and lower the bowl, catch the spilt fuel in a drain tray.

Clean out the bowl - check that the spring and plate are in position - replace the sealing rings and filter, fit in position and loosely tighten securing screw. Twist the bowl to seat the sealing rings and then finally tighten the securing screw.

Run engine and check for correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

103.Remove and replace air cleaners, carburetors and inlet manifolds.

R&R early fuel evaporation system components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery earth lead. Undo the air cleaner and ducting securing screws/clips. Lift off air cleaner and ducting.

Label and disconnect the throttle, choke and electrical cables to the carburetor and the early fuel evaporation heater grid. Disconnect and cap or plug the fuel feed and return pipes/hoses.

Undo the carburetor to inlet manifold securing nuts and remove. Lift off the carburetor from the inlet manifold. Inspect all gaskets and the heat insulation block or the early fuel evaporative heater grid plate.

Label and disconnect the vacuum connections on the inlet manifold. For water heated inlet manifolds drain the cooling system and disconnect the coolant pipes/hoses on the inlet manifold.

Undo the inlet manifold to cylinder head nuts/bolts and remove. Lift off the manifold. Inspect the gaskets for signs of leakage. Cleaning all mating faces - cylinder head, manifold, carburetor and heat shield and check for true (flatness). Clean bolt or stud threads if necessary.

Reassemble using new gaskets and either a soft setting sealant, where specified, or apply a smear of grease to the gaskets, particularly the carburetor and heat insulator block. Tighten all nuts/bolts to specified torque and in sequence (center outward).

Refit fuel pipes/hoses, coolant hoses and top up cooling system, refit throttle, choke and electrical cables. Check throttle cable adjustment gives full throttle (throttle plate vertical in carburetor) and choke control is fully off and can be fully applied.

Run engine and check for correct operation. Check coolant level, bleed and top up if necessary. Check in car heater operation. Check and adjust idle and fast idle speeds and mixture strength (CO).

On vehicles with an early fuel evaporation system the heater grid plate replaces the heat insulation block. Lift off from the inlet manifold carefully to avoid damage. The electrical feed is controlled by a temperature switch in the engine coolant and by a relay.

Check with the vehicle manufacturer’s data for the location, testing, removal and reassembly procedures.

When the task has been completed, record here how it went or how it could be improved next time

Instructor’s signature: **Grade:** 1 2 3 4 5

104. Inspect and clean PCV components

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: PLAN obtains technical/procedural data from manuals and information from vehicle owner/driver. Obtain driver information on oil and fuel consumption. Both are likely to be high if the system is blocked. Check for drivability problems resulting from failure of the PCV system.

Run engine and look for blue exhaust smoke and smoke leakage from PCV pipes and hoses. Exhaust smoke and engine smoke can indicate a blocked PCV system. Inspect the air cleaner element for oil contamination. If contaminated check oil separator.

Identify PCV system type (valve or restricted orifice into inlet manifold). Visually inspect all pipes and hoses for condition, blockage, fit onto connectors (leakage), oil contamination - pull off pipes in turn to assess internal and external condition.

Clean or replace pipes/hoses if required. Clean or replace PCV air intake filter (integral with oil filler cap on some engines).

Pull out and open PCV valve, clean and check operation or remove valve and shake to check that the valve is free, listen for a rattle. Check that airflow is toward manifold or air cleaner. Or 6

Check restricted orifice into carburetor or inlet manifold is clean and clear, blow through and listen. Clean out if necessary (Do not increase diameter by drilling clear with oversize drill).

Reconnect all pipes and run engine. Check for vacuum at feed into inlet manifold. Check for symptoms of blocked valve or orifice. Rough or uneven idle; stalling at low speeds, oil leaks, and smoke from engine oil filler cap.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

105.Drain and top off coolant

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain information from the driver on the frequency of topping off the coolant. Check coolant level. Check the water pump drive belt for condition and tension.

Pressure test the cooling system and the radiator cap. Look for leakage, condition of hoses, the pressure cap operating pressure, seals and vacuum valve. Report any defects and recommend rectification before adding new coolant.

Identify the coolant drain points in the radiator and engine block. Undo and drain coolant into a clean drain tray. Dispose of old coolant in accordance with local environmental regulations. Close the radiator and engine block drain taps or plugs.

Mix new coolant to the specified mixture of water and antifreeze with inhibitors or use a premixed coolant. Do not exceed a 50% to 60% ethylene glycol content as this does not improve the frost protection. (Over 70% reduces the protection).

Add coolant to the radiator until the system is full. Open bleed screws to allow air to flow from the system.

Run the engine and bleed air from the heater or high point in the system if required. Follow the engine manufacturer's instructions. Visually check for leaks.

Road test and check the operation of the cooling system and the heater temperature range. Check the operation of the engine coolant temperature gauge.

After road testing, visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

106.Inspect camshaft lobes, journals and bearings.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Strip to access the camshaft. Check the end float before removing.

Remove camshaft and visually inspect for condition of bearing journals and cam lobes. Inspect retaining/thrust plate for wear.

Inspect bearings in the engine block or head. Look for wear, scoring, pitting, or other deterioration.

Lay the camshaft in oiled paper supports in vee blocks on a surface table. Assemble a dial test indicator (dti) to a base and zero on center journal. Rotate shaft and observe variation in needle position to indicate if the shaft is bent.

Measure and record cam lift on all lobes. Compare with manufacturer's data.

Measure cam journals with external micrometer and record results. Measure for ovality. Measure internal dimensions of bearings and record. Compare readings with manufacturer's data for size and wear tolerances.

Reassemble shaft and other components. Run engine and listen for abnormal noises.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

107.Remove and replace electronic distributor - strip and reassemble pulse generator/amplifier module

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery ground lead. Turn engine to align timing/tdc marks. Remove distributor cap.

Note position of the rotor to the distributor body and of the body to the engine. Compare with manufacturer's data. Disconnect multiplug to amplifier unit. Disconnect vacuum hose where fitted.

Undo and remove, if necessary, distributor clamp bolts - pull out distributor. Inspect drive gear.

Undo vacuum unit securing screws and connection to distributor base plate (circlip or hook). Pull out vacuum unit feeding base plate linkage through hole.

Follow manufacturer's instructions for the removal and replacement of the pulse generator. Remove base plate to access centrifugal advance weights and springs. Remove, inspect and replace as necessary. Lubricate all parts and reassemble in reverse order with new springs if required.

Reassemble pulse generator, check, and adjust air gaps with non-ferrous feeler/gap gauge if appropriate. (Depends on type).

Undo and remove amplifier module securing screws and remove module. Before refitting, coat the rear face of the amplifier module with silicon grease. Fit module and then fit and tighten the securing screws. Reconnect internal wiring between pulse generator and amplifier.

Reassemble vacuum unit to distributor base plate and distributor body.

Refit distributor to engine ensuring distributor to engine and rotor to distributor alignments are correct. Refit distributor clamp and securing bolts, leave finger tight, refit distributor cap and spark plug leads. Refit battery ground lead.

Run engine and adjust ignition timing using a stroboscopic timing light and engine tachometer. On some electronic control systems, a timing adjustment connector is disconnected or terminals in the diagnostic socket are bridged in order to set the ignition timing. Reconnect on completion.

Check system with an engine analyzer or test equipment on completion. Road test and check engine performance.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

108.Remove and replace coil, primary and secondary circuit components

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery ground lead. Identify type of ignition system.

Label and disconnect cables to coil, primary and secondary circuit components. Undo and remove coil securing screws and remove coil. Inspect coil insulation and terminals for condition. When replacing a coil always check that the correct type is to be fitted. Check polarity, volts and ohms.

Identify primary circuit cables and components - ballast resistor, starter solenoid leads, cables, switches, etc. Replace as per the manufacturer's instructions.

Identify secondary circuit wires and components, pull out terminal connectors and undo securing screws or clips and remove components, distributor cap, rotor, plug wires and plugs.

Inspect and test components. Replace in reverse order, reconnect battery ground lead, run engine and check for correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

109.Remove and replace electronic sensors and ECUs.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Follow the manufacturer's technical data for the correct procedures to identify remove and replace ignition system and associated systems sensors.

Many sensors are held in place with one or two screws/bolts. Others are threaded and screw directly into the engine, air intake duct, exhaust manifold, etc. Disconnect cable termination blocks, undo and remove sensors.

Locate ECU and disconnect main cable terminal block. Undo and remove securing screws and remove ECU. Inspect terminal sockets and pins.

Refit in reverse order. Use sealant on sensor threads if specified. Check for the correct fitting of spacers, alignments, air gaps and positions as per manufacturer's specifications. Take care when reconnecting to protect terminal sockets and pins from damage.

Check correct operation of sensors using a graphing multimeter (GMM), digital storage oscilloscope (DSO) or scan tool. Compare results to manufacturer's specifications.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

110.Remove and replace electronic monopoint injection components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery ground lead. Ensure a very clean work environment. Clean parts before removal.

The fuel supply components are an electric rotary fuel pump fitted inside the fuel tank, an in-line filter, the fuel pressure regulator and the injector valve in the throttle/injector unit, and the fuel supply and return pipes and hoses.

Identify the location of fuel supply components and disconnect and cap or plug fuel pipes/hoses to prevent loss of fuel and to keep clean. Undo securing devices/clamps/screws and undo union nuts on pipes to remove components. Inspect.

Air supply components are the air box and air cleaner housing and filter element, ducting, the air temperature sensor and control flap, the throttle valve in the throttle/injector unit, the throttle plate control motor and the inlet manifold.

Identify the location of the air supply components and disconnect ducting, securing screws and brackets, electrical terminal blocks, etc. and remove components. Inspect.

The monopoint injector unit (CFI unit or TBI unit) can be removed as a single unit and can be stripped for cleaning and replacement of parts. Follow manufacturer's instructions.

The electronic components are the control relay in the main fuse box, the electronic control unit (ECU/ECM), sensors for air charge temperature, manifold absolute pressure, engine temperature, throttle valve switch for throttle positions, exhaust oxygen/lambda, and others (see manuals).

The actuators are incorporated in and on the injector unit. (Injector and throttle plate control motor). Other actuators controlled by the ECU/ECM are parts of the emission control systems.

Identify the location of the electronic components and remove and replace in accordance with the manufacturer's instructions. Inspect components.

After reassembly run engine, check for fuel leaks and carry out basic idle and mixture (gas analysis) adjustments.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

111.Remove and replace multipoint injection components

Disconnect the battery ground lead. Ensure a very clean work environment. Clean parts before removal.

The fuel supply components are an electric rotary fuel pump fitted inside the fuel tank, an in-line filter, the fuel pressure regulator and the injector valves on the fuel rail over the inlet manifold, and the fuel supply and return pipes and hoses.

Identify the location of fuel supply components and disconnect and cap or plug fuel pipes/hoses to prevent loss of fuel and to keep clean. Undo securing devices/clamps/screws and undo union nuts on pipes to remove components. Inspect.

The fuel rail, pressure regulator and injectors can be removed as a single unit and can be stripped for cleaning and replacement of parts. Follow manufacturer's instructions.

Air supply components are the air box and air cleaner housing and filter element, ducting, the air temperature sensor and control flap, the air flow sensor, the throttle body assembly and the inlet manifold.

Identify the location of the air supply components and disconnect ducting, securing screws and brackets, electrical terminal blocks, etc. and remove components. Inspect.

The electronic components are the control relay in the main fuse box, the electronic control unit (ECU/ECM), sensors for air charge temperature, mass air flow meter, engine temperature, throttle valve switch for throttle positions, exhaust oxygen/lambda, and others (see manuals).

The actuators include the injectors, auxiliary air valve or idle speed control valve, and the control devices for emission control systems.

Identify the location of the electronic components and remove and replace in accordance with the manufacturer's instructions. Inspect components.

After reassembly run engine, check for fuel leaks and carry out basic idle and mixture (gas analysis) adjustments.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

112.Remove and replace fuel tanks, evaporative emission control system, and fuel lines.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery earth/ground lead. Clear area of possible sources of ignition. Put out warning notices. (BEWARE GASOLINE)

Pump out fuel tank contents into special container - follow manufacturer's instructions for use. Connect static electricity safety cable. Working below vehicle, identify feed and return pipes/hoses, filler pipes and vapor pipes.

Undo clamps and disconnect pipes/hoses. Plug or cap to prevent fuel leakage and to keep clean. Disconnect electrical terminals for the fuel pump and fuel gauge sender unit. Remove filler and vent hoses, fuel pipes/hoses and vapor pipes from the fuel tank.

Obtain assistance to support the weight of the fuel tank. Undo and remove securing bolts and lower fuel tank from the vehicle. Undo the securing screws or ring retaining the fuel gauge sender unit (and fuel pump). Remove and inspect sealing 'O' ring.

Disconnect hoses/pipes from retaining clips and connections to the filter, pump, fuel injection equipment, etc. Remove hoses and pipes. Cap or plug as necessary.

Identify location of EVAP canister and purge control valve and vacuum pipes. Disconnect the pipes/hoses/electrical terminals and securing screws, remove canister and purge control valve. Inspect.

Reassemble in reverse order. Check carefully for good sealing and after filling and running the engine for fuel leaks. Check operation of the EVAP purge control system.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

113.Remove and replace fuel injection air supply components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery ground/earth lead. Identify the type of fuel injection system and depressurize in accordance with the manufacturer's instructions. Apply a vacuum to the pressure regulator.

Undo the securing screws/clips on the air intake ducting, air cleaner and resonators. Remove components and inspect for condition, cleanliness and sealing at the joints.

Label and disconnect the vacuum pipes/hoses and the electrical terminal blocks to the air flow meter, throttle body, auxiliary air valve, cold start valve and fuel injectors. Undo and remove the throttle cable and cruise control linkages.

Undo and remove the securing screws for the air flow meter and the throttle body and the ducting in between. Remove components and inspect.

Undo or unclip the securing devices for the fuel rail/pipes and fuel injectors and remove. Inspect sealing 'O' rings. Check, clean and test injectors before replacement.

Undo and remove the plenum chamber and inlet manifold securing bolts and pull off components, inspect for condition and flatness of gasket faces and sealing ring grooves and matching bores.

Reassemble in reverse order using new gaskets and sealing rings - lubricate gaskets and seals with lithium based grease to aid fitting and sealing. Check on reassembly for correct positioning and sealing of components.

Reconnect vacuum pipes/hoses, cables and electrical terminal blocks. Check throttle cable adjustment for specified free play at idle and throttle fully opened at the wide open throttle position.

Run engine and check for correct operation. Listen for uneven running, flat spots and hesitation. Carry out exhaust gas analysis and adjust when necessary.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

114.Remove and replace all parts of catalyst exhaust system including lambda/HEGO sensor.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This task is similar to the replacement of a non-catalyst system but with additional items of the of the sensors, catalytic converter and heat shields.

The converter can usually be removed from the system by undoing the ball joint or flange joint bolts at each end and the mounting bracket bolts and then lowering the catalyst out of the system. Be careful to provide full support for the catalyst. Inspect for condition inside and out.

To remove the lambda/HEGO sensors disconnect the terminal block and use a suitable spanner or special tool (see manufacturer's data) to unscrew the sensor.

Undo the securing screws for heat shields and lower them from their mounting brackets. Check for damage or corrosion to the heat shields and the supporting brackets.

Refit heat shields in reverse order ensuring the correct clearance between the heat shield and the vehicle floor.

Refit sensors with a new sealing washer/gasket if required and tighten to the specified torque. Reconnect the electrical terminal block.

Refit the catalytic converter using new gaskets or sealing compound (see manufacturer's data). Refit the mounting bracket and hangers and check the air gap between the converter and the heat shield and the heat shield and body (VERY IMPORTANT).

Refit and align all exhaust system with new clamps and mountings/hangers and tighten clamp bolts. Check that the exhaust is clear of the body, steering and suspension components and brake pipes and any other components. Check for suspension travel but judging lowest suspension position.

Run the engine and check for leaks. Carry out an exhaust gas analysis to ensure correct operation of the lambda/HEGO sensors and the catalytic converter.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

115.Remove and replace turbocharger (adjust boost pressure) and intercooler.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery ground lead. Raise vehicle and remove exhaust down/front pipe and tie up or support remainder of exhaust.

Work in the engine compartment or under the vehicle to disconnect the air supply and boost supply pipes from the turbocharger.

Drain the coolant if the turbocharger has water cooling and disconnect the coolant pipes to and from the turbocharger. Undo, remove and cap or plug the oil feed and return pipes.

Undo the securing nuts/bolts securing the turbocharger to the exhaust manifold and lift off. Inspect the turbocharger for condition. Check bearings, turbine and impeller blades, the waste gate and gasket faces.

Before refitting follow the manufacturer's instructions for setting the waste gate push rod length. Do not alter the original setting unless the manufacturer specifies that in service adjustment is possible. If adjustment is factory set check only that full waste gate closure and travel is possible.

Refit turbocharger with new gaskets. Do not use sealant unless specified by the manufacturer. Tighten securing bolts/nuts to the specified torque.

Refit and tighten oil and coolant pipes. Top off the coolant.

Refit the exhaust down/front pipe and loosely fit flange and support bracket nuts and bolts. Support the exhaust to prevent any weight or distortion of the turbocharger housing. Progressively tighten the flange and support bracket nuts and bolts to the specified torque.

Refit the down/front pipe to exhaust flange or clamp and tighten. Remove support from the exhaust.

Run the engine and bleed the cooling system if necessary, check for exhaust leaks and that the engine runs correctly.

Road test for correct operation of the turbocharger. The boost pressure can be checked using specialist equipment (pressure gauge and adapters) on a road test or rolling road dynamometer. Follow the manufacturer's instructions for the test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

116.Remove and replace EVAP components

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery earth/ground lead. Identify the location of the EVAP system components from a vehicle workshop manual.

Vapor pipes and vapor traps are held at each end with hoses and hose clips. The pipes are held onto the underside of the vehicle with pipe clips. Remove carefully by prizing open the clip and pulling out the pipe or hose.

Remove atmospheric vent pipe on the canister if fitted. Remove the vapor and vacuum pipes and hoses.

Undo the canister securing screws and clips and remove the canister. The canister cannot be opened and is replaced as a unit.

Locate, label and disconnect the electrical and vacuum connections to the vacuum control solenoid. Undo the securing screws and remove the solenoid.

Reassemble in the reverse order.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

117.Remove and replace AIR (Air injection reactor system) components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery ground lead.

Slacken the drive belt to the air pump and remove. Disconnect the pipe to the air switching/diverter valve.

Undo and remove the pump securing bolts and remove the pump. Check the pump for exhaust gas contamination. (Indicates a defective non return (check) valve).

Label and disconnect the air pipes, vacuum hoses and electrical connections to the air switching/diverter valve, the non-return (check) valve and injection pipe into the exhaust manifold.

Undo the securing nuts/bolts for the air switching/diverter valve and remove the valve.

Undo and remove the non-return (check) valve and injection pipe into the exhaust manifold. Check the operation of the check valve by blowing through into the exhaust and then from the exhaust into the check valve, which should not be possible.

Reassemble using new gaskets and hose clips as appropriate. DO NOT oil the pump. Refit the pump and drive belt and adjust the tension to manufacturer's specifications.

Run the engine and check for leaks and correct operation of the engine and AIR system.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

118.Remove and replace Pulse air system (Air aspiration system) components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery ground lead. Identify the location of pulse air components from a vehicle workshop manual.

Disconnect and remove the air pipe to the air control and check valve assembly.

Undo the air injection pipes into the exhaust ports or exhaust manifold and into the air control and check valve assembly. Remove the pipes and inspect. (Avoid bending the pipes).

Label and disconnect the electrical terminal block and vacuum hoses to the air control and check valve assembly. Undo the mounting bracket bolts and remove the valve assembly.

Locate the vacuum control solenoid and label and disconnect the electrical terminal block and vacuum hoses. Remove the securing screws and remove the solenoid.

Reassemble in reverse order with new seals on the air injection pipes where necessary. Ensure all vacuum and air pipes are in good condition and seal properly at all joints.

Run engine and check for correct operation of the engine and pulse air (air aspiration) system.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

119.Remove and replace EGR (Exhaust gas recirculation) components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery ground lead. Identify the type and location of the EGR components from a vehicle workshop manual.

For vacuum controlled EGR systems label and disconnect the vacuum and electrical connections at the vacuum control solenoid valve. Undo the securing screws and remove the solenoid valve.

Label and remove the vacuum and electrical terminals from the EGR valve and EGR valve position sensor (integral with the EGR valve on closed loop systems).

Undo and remove the exhaust outlet pipe to the EGR valve and the feed pipe to the inlet manifold. Undo the EGR valve and remove.

Reassemble in reverse order using new gaskets and seals as necessary.

For electronic EGR valves, disconnect the electrical terminal block and the exhaust outlet and inlet manifold feed pipes. Remove the securing device and remove the valve. (There are no separate control solenoid or vacuum pipes).

Run engine and check for correct operation of the engine and EGR system.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

120.Remove and replace supercharger.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery ground lead. Disconnect and remove air ducting to the supercharger.

Depending on the type of supercharger identify aligning marks on the pulley and/or gears and the direction of rotation of the drive belt. Align timing marks if necessary, mark direction of rotation on the drive belt, slacken the drive belt tensioner and remove the belt.

Undo and remove oil feed and return pipes.

Undo bolts/nuts securing the supercharger and remove. Lift the supercharger from the adapter or mounting plate on the air intake to the engine.

Replace in reverse order using new gaskets and tighten bolts/nuts to the manufacturer's specified torque settings and in sequence (center outwards). Refit and adjust the tension of the drive belt. (Observe direction of rotation).

Run engine and check for correct operation of the engine and the supercharger.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

121.Remove and replace thermostat.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Drain the coolant into a clean drain tray.

Undo the bolts holding the thermostat housing and remove the bolts and housing. For thermostats fitted in hoses or integrated in housings remove the hose or housing.

Lift out the thermostat and inspect the thermostat housing gasket and the thermostat seal for signs of leakage and other deterioration. Test the thermostat if required.

Clean and inspect the thermostat housing and cover mating faces. Inspect for flatness with a straight edge or surface table. Rectify if necessary.

Fit the thermostat into the housing with new seals, if required. Fit the cover with a new gasket and sealant, if recommended, or grease. Fit the securing bolts with a thread sealant if they pass into the water passages and tighten to the specified torque.

Refill the cooling system. Top off with a correct water and antifreeze mixture to make good any spilt or lost coolant during draining. Run the engine and bleed air from the system if necessary.

Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings.

After road testing, visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

122.Perform visual checks on stationary engine.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check any symptoms with driver if available.

Lift hood - look for general impression - lack of maintenance, oil or coolant leaks.

Check coolant level, leaks, and condition.

Check oil level, leaks, and condition.

Check drives belts and pulleys for condition and tension.

Check camshaft drive belt for condition and tension.

Check engine mountings for condition and security.

Check air supply inlet ducts, air cleaner, inlet manifold for condition and security.

Check exhaust manifold and down pipe for condition and security.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

123.Inspect cooling system, carry out pressure test, check coolant condition and antifreeze.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain a suitable cooling system pressure tester and an ethylene glycol coolant hydrometer.

Remove the radiator or expansion tank cap. Check the coolant for level, color and contamination such as oil or rust and dirt.

Check the ethylene glycol content with the hydrometer - adjust for temperature - and compare with manufacturer's specifications. Usually between 25% and 50% depending on the area of vehicle operation.

Top off the coolant if necessary and attach the pressure tester using a suitable adapter in the filler neck.

Apply a pressure equal to the system operating pressure, which is shown on the radiator filler cap - but should be checked from the manufacturer's data. DO NOT exceed the stated pressure.

Observe the reading on the tester pressure gauge - it should remain stable. If the gauge reading drops look for a good connection to the system and then for leaks in the system.

Look at all hoses, pipes, joints, gaskets, the water pump, the heater and water valve for external leaks. Look inside the vehicle under the heater for leaks from the heater matrix. If no external leaks are visible, check the coolant for oil contamination. (Possible internal leaks.)

Apply a pressure of about half the operating pressure and run the engine. Look for a rapid pressure rise, which would indicate a cylinder head gasket leak or crack between the cylinder or cylinder head and the water jacket.

If the pressure remains stable but internal leakage is suspected, use a combustion gas detector kit with the pressure tester. If the test fluid changes color during the test combustion gases have been detected in the coolant confirming an internal leak.

Fit the radiator/expansion tank pressure cap to the tester using an appropriate adapter and check that the operating pressure is held at the specified value. Remove the cap and check the vacuum valve seal operation and condition.

Compare all findings with manufacturer's data. Report faults found.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

124.Check engine for non-starting, poor starting, pinking, misfire, uneven running, etc.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Identify type of ignition system - contact breaker, electronic distributor, electronic ECM and HT switching distributor or distributorless and if a ballast resistor is fitted (CB and early electronic).

Remove distributor cap and inspect rotor, cap terminals and general condition. Visually check CB or pulse generator. Turn engine and check that the rotor turns. Check that the CB points open and close. Check air gap on inductive signal generator. Check all primary circuit wiring.

Check battery voltage (voltmeter across battery terminals). Turn on the ignition and check voltage at coil negative terminal. Turn engine, voltage readings should alternate from about zero to coil voltage (battery volts or less for ballast resistor types). If correct primary circuit is operating.

For electronic systems without catalytic converter, refit the distributor cap, remove coil to cap wire or a spark plug wire and connect a spark jumper with a 6 mm gap. Crank engine and measure battery cranking volts (9.5 volts minimum) and coil negative terminal volts (6 volts min.).

For electronic systems with catalytic converter and fuel injection remove injector terminal socket to prevent fuelling and carry out procedure at stage 4.

If primary circuit is unsatisfactory trace and rectify faults. If primary circuit is satisfactory - check secondary circuit. Disconnect coil wire and connect a spark jumper, if not already done, crank engine and look for spark quality (should jump 6mm easily)

If no spark - check coil and spark plug leads with ohmmeter. Compare with manufacturer's data. Remove clean and check or replace and gap spark plugs – replace and connect leads. Check terminals are a tight fit onto the spark plugs - check condition of wires into distributor cap.

Check ignition timing and correct alignment of rotor arm to No 1 cylinder when the piston is just before tdc on the compression stroke. Rectify all faults found.

When the engine is running check the dynamic timing and advance with a stroboscopic timing light. Check the dwell angle/period. Listen for uneven running.

If problems still exist connect to an engine analyzer and follow test procedures.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

125.Inspect air supply system for leaks and check intake air temperature control mechanism.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Visually inspect for obvious damage - closely inspect all joints, clips and securing devices for tightness. Check air cleaner for dirt, moisture and oil contamination.

Look closely at all joints after the air cleaner for possible leakage - investigate and rectify if necessary. This is required to prevent unfiltered air entering the engine.

Look closely at all joints after the throttle housing for leakage - listen for abnormal noises (whistles). Check with propane gas or similar spray onto suspect joints - listen for changes in engine speed or for uneven running.

Check air intake temperature control as engine warms up. The control flap should direct warm air from over the exhaust manifold into the air cleaner when the engine is cold and cool air from the main intake spout when the engine is warm. (See also stages 7 to 10)

Check exhaust gas with a gas analyzer. Air leaks causing a weak mixture will be shown by gas readings O2 and NO_X high and CO and HC low. Lambda will be greater than one.

Check exhaust or rich mixture - air cleaner blockage. Typical gas readings would be O2 and NO_X low and CO and HC high. Lambda will be less than one.

Check air intake temperature control - vacuum types. Check that the control flap closes the cold air intake when the engine is cold and opens when the engine is hot.

If the flap does not operate correctly, check the operation of the vacuum unit by disconnecting the vacuum hose to the diaphragm unit. Connect a vacuum pump to the unit and apply a vacuum of about 0.5 bar. The flap should open and close under vacuum and atmospheric pressure.

Check the temperature control valve (bimetallic strip) by removing the air cleaner cover and cooling the valve - check vacuum flow through the valve when cool (none or low vacuum) and when hot (good vacuum).

For waxstat type air intake temperature controls, check that the flap opens and closes at the appropriate temperatures.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

126.Check operation of positive crankcase ventilation system.

Worksheet Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain driver information on oil and fuel consumption. Both are likely to be high if the system is blocked.

Run engine and look for blue exhaust smoke and smoke leakage from PCV pipes and hoses. Exhaust smoke and engine smoke can indicate a blocked PCV system. Inspect the air cleaner element for oil contamination. If contaminated check oil separator.

Identify PCV system type (valve or restricted orifice into inlet manifold). Visually inspect all pipes and hoses for condition, blockage, fit onto connectors (leakage), and oil contamination - pull off pipes in turn to assess internal and external condition.

Clean or replace pipes/hoses if required. Clean or replace PCV air intake filter (integral with oil filler cap on some engines).

Pull out and open PCV valve, clean and check operation or remove valve and shake to check that the valve is free, listen for a rattle. Check that air flow is toward manifold or air cleaner…Or

Check restricted orifice into carburetor or inlet manifold is clean and clear, blow through and listen. Clean out if necessary (Do not increase diameter by drilling clear with oversize drill).

Reconnect all pipes and run engine. Check for vacuum at feed into inlet manifold. Check for symptoms of blocked valve or orifice. Rough or uneven idle, stalling at low speeds, oil leaks, and smoke from engine oil filler cap.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

127.Check exhaust system for condition, leaks, blockage and security.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Open hood – run engine and accelerate engine and listen for abnormal noises – exhaust blow, squeal, screech, excessive noise level and that the engine revs freely (possible blockage).

Allow the engine to idle – cover the tail pipe outlet with a cloth pad – listen for exhaust blow.

Inspect under the hood for exhaust manifold gasket leaks – look for telltale black markings from a loose or broken joint.

Under the vehicle follow the exhaust pipes along – look at the down/front pipe to exhaust manifold joint and all the pipe to pipe or pipe to silencer/muffler/catalyst/resonator/etc. joints. Look for telltale black markings from loose, broken or badly sealed joints.

Look closely at the skin of all pipes, silencers, mufflers, catalysts, resonators, etc. Look for corrosion, holes or other damage or deterioration.

Look closely at the fitting, security, condition and positioning of heat shields. These must be in place to protect flammable materials inside the vehicle (sound deadening, etc.) from ignition from the high temperature of exhausts and catalytic converters.

Look closely at all exhaust mounting brackets and rubber mounting components (hangers) for fitting, corrosion, perishing, separation, tension, etc. On turbocharged engines check the down/front pipe support bracket for condition and security.

Check the position and routing of the exhaust for knocking on the body or chassis and for fouling on other components such as brake pipes, steering, suspension, axle, etc.

If blockage is suspected exhaust gas leaks in front of the blockage are likely. Disconnect a pipe at a suitable position in front of the blockage and check the flow through the remainder of the system with an air line blower – plug the pipe around the blower with a cloth pad.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

128.Carry out exhaust gas analysis using an exhaust gas analyzer.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Set up the exhaust gas analyzer in accordance with the manufacturer's instructions. Observe all setting conditions - clean air, running time, basic checks for contamination and filter changes.

Run the engine up to normal operating temperature and drive to analyzer test area. Insert the exhaust gas probe into the exhaust tail pipe or extraction system probe adapter. Ensure that the probe is inserted to the recommended depth (about 300 mm or 12 inches).

Run the engine at idle and observe and record the readings for gases on the analyzer screen.

Run the engine at about 2500 rpm and observe and record the readings for gases on the analyzer screen. Compare the readings with the idle readings and with statutory requirements or manufacturer's data.

For statutory test certification procedures using an approved gas analyzer, follow the on screen prompt sequence for entering the vehicle data and for connecting the exhaust gas probe and the engine speed tachometer, and in some cases measuring the engine temperature.

Continue to follow the prompt sequence to carry out the test. The result may be given as a pass or fail or as a set of gas percentage (%) values and lambda value for comparison with statutory regulations (different sets of values are used for different years of manufacture).

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

129.Check operation and security of turbochargers/superchargers.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check the air intake ducting to the turbo/supercharger is secure and providing a good seal at the joints. Check air cleaner element is clean. DO NOT run the engine without the air cleaner.

Check pressure side ducts to the intercooler and the inlet manifold for security and sealing. Check the intercooler matrix is clean, not restricted and allows a free flow of air through the cooling fins.

Check electrical connections to the over boost switch - check the bulb on the fascia by touching the terminal to ground with the ignition switched on. Check the operation of the boost pressure gauge when fitted. Check pipes and terminals of the pressure gauge for condition.

Check the security of the turbocharger mounting onto the exhaust manifold and to the down/front pipe and also check the condition and security of the down/front pipe support bracket. There should be no strain applied to the turbocharger body.

Check the fitting of the supercharger to the inlet manifold and air intake ducts. Check for air sealing at all joints and operation of boost pressure release valves. Check the drive belt/gears for condition and tension.

Connect a pressure gauge to the inlet manifold in accordance with manufacturer's instructions so that it can be read inside the vehicle. Road test the vehicle or run a test sequence on a dynamometer and note the pressure readings. Compare with manufacturer's specifications.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

130.Check operation of Early Fuel Evaporative System.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain information from the driver on cold start and warm up performance such as flat spots or hesitation. Carry out the following tests on a cold engine.

Connect a voltmeter negative lead to a good earth. Turn on the ignition and probe, with the positive lead, both terminals on the EFE socket - do not disconnect - both should be live with about 12 volts.

Turn of the ignition and disconnect the terminal socket. Check the resistance of the EFE heater element with an ohmmeter and compare with the manufacturer's specifications (about 3 ohms).

Check the operation of the engine temperature switch when the engine warms up. The feed to EFE heater should be switched off.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

131.Check operation of EVAP (Evaporative canister).

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Inspect the vapor pipes and hoses for condition and security. Check the vacuum pipes for the control and venting of the EVAP canister. Check all components for security.

Disconnect the vapor pipe to the canister (and the atmospheric vent pipe if fitted). Blow through to check for blockage of the carbon (charcoal) element. Refit atmospheric vent pipe.

Check the operation of the purge valve by applying a vacuum with a vacuum pump applied to the diaphragm unit. Disconnect the vapor pipe to the inlet manifold - blow through the inlet and check for an air flow from the outlet when a vacuum is applied.

Where fitted check the thermostatic vacuum switch (TVS) as the engine warms up from cold. Apply a vacuum when the engine is cold and run the engine to heat the TVS - it should hold a vacuum when cold but not when hot. Compare operating temperature with manufacturer's data.

For systems with electronic control of the canister purge solenoid connect a vacuum gauge to the purge valve and check for a vacuum reading as the engine warms up. Reconnect the pipe.

Disconnect the outlet pipe from the canister and connect the vacuum gauge. Run the engine and check for vacuum as the engine warms up. Reconnect the pipe.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

132.Check operation of catalyst and lambda/HEGO sensor.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Carry out this test with a four gas analyzer with a digital multimeter function that can measure the output voltages from the lambda/HEGO sensor.

Set the tester to the manual function and select the lambda sensor test program. Identify the sensor signal wire and connect the meter probe. Connect the earth/ground to a suitable point. Insert the gas probe into the exhaust tail pipe.

Run the engine and follow the procedure for the analyzer being used.

Set the meter to minimum volts reading and record the result. Set the meter to maximum volts reading and record the result.

Compare the results with manufacturer's data. Minimum readings should be about 4 volts (no oxygen in the exhaust gas). Maximum volts should be over 6 volts (oxygen in the exhaust gas).

Follow the test sequence for gas analysis. There should be little or no change in gas values as percentages under all operating conditions.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

133.Check operation of AIR (Air injection reactive system) or pulse air system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check the air pump drive belt for condition and tension.

Check on all systems the air hoses, air pipes to the exhaust, vacuum control hoses and the security and sealing of all components.

Remove the air hose from the air pump and run the engine. Slowly increase the engine speed and check that the output air flow from the pump increases with engine speed. Check the pump for abnormal noises. DO NOT lubricate the pump with engine oil. Reconnect the air hose.

Check the air switching or diverter valve by disconnecting the feed pipe to the air cleaner - check for no air flow when the engine is idling. Apply full throttle and release - check for air flow on deceleration and for up to 5 seconds after idle speed is resumed. Repeat 2 or 3 times to confirm.

If no air flow to the air cleaner is detected check the vacuum and voltage at the air switching or diverter valve. Connect a vacuum gauge to the pipe - run the engine - accelerate and release the throttle and check the vacuum reading - should be more than 35 KPa (10 in Hg) or as per data.

Check voltage at the solenoid feed terminal is present with a test lamp or voltmeter.

Check the operation of the non-return (check) valve in the air feed to the exhaust. Air should blow through into the exhaust but it should not be possible to blow in the opposite direction. If exhaust gas discoloration or carbon build up exists in front of the valve back flow has occurred.

Pulse air systems are controlled by the ECM (engine control module) and actuated by vacuum switching. They operate during engine warm up to supply extra air to the exhaust to assist the catalytic converter to heat up.

Check vacuum to the control valve when the engine is cold and running at idle speed. Check voltage to the control solenoid if no vacuum is present.

Remove the air supply pipe from the air cleaner and check for traces of carbon or exhaust gas contamination. Reconnect the pipe.

For all systems carry our exhaust gas analysis and compare with manufacturer's data.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

134.Check operation of EGR (Exhaust gas recirculation).

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain information from the driver on abnormal noises (pinking), engine temperature and engine performance.

Run engine and listen for air and exhaust leaks, abnormal noises and uneven running. Check all pipes, hoses and components for security and sealing.

Check vacuum operated valves by applying a vacuum to the valve with the engine running at idle speed and listen for uneven running or stalling of the engine.

Run the engine to normal operating temperature and check for vacuum at the EGR valve when the engine speed is increased to about 3000 rpm (light load).

If no vacuum is present check the electrical feed to the vacuum control solenoid for voltage, use a test lamp or voltmeter.

For ECM (engine control module) controlled systems obtain a fault code readout or OBD (on board diagnostic) data in accordance with manufacturer's instructions.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

135.Inspect camshaft and shim adjust tappets

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: OHC with shims:

Run engine and listen for abnormal noises from top of engine. Check for misfire/cylinder balance. Disconnect battery earth/ground cable. Remove cam-housing cover.

Check condition of cams and followers.

Measure with feeler gauges all valve clearances at the 'back-of-the-cam' (heel) position. Record all dimensions and note if inlet or exhaust if they have different clearances specified.

Remove the camshaft - follow the manufacturer's instructions. Lift out the cam followers and keep in exact order.

Working with one follower at a time, remove and measure with a micrometer the thickness of the spacer/shim. Record the dimension and then add or subtract a correction to give the correct clearance.

Select a replacement spacer/shim to the corrected dimension. Measure with a micrometer to check that it is correct and fit to follower.

Repeat with all other followers.

Lubricate all followers before and during assembly with clean engine oil. Refit into bores over valves - keep in strict order.

Refit the camshaft and tighten securing bolts to specified torque/sequence. Check all valve clearances are now correct - if not strip and rectify any errors. Reassemble and recheck.

Rebuild and check that the engine starts and runs. Listen for correct operation. Road test and recheck.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

136.Inspect chain drive mechanisms.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Strip to access chain drive mechanism. Look for general condition, tension, lubrication and damage to covers.

Check chain tension and condition of chain self-tensioner device. Check chain wear or stretch and 'fit' on the sprockets.

Turn engine to align the timing marks and remove the chain and sprockets.

Check chain wear by observing the bend when the chain is held on its side. Check all rollers for tightness or seizure.

Check the condition of the teeth on the sprockets. Check sprocket to hub location and securing holes and devices.

Reassemble chain and sprockets keeping the timing marks aligned. Refit and set tensioner. Turn engine at least 2 full revolutions and recheck timing and chain tension. When engine is running listen for abnormal noises and correct operation of the engine.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

137.Inspect toothed belt drive mechanisms.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Strip to access belt and drive gears. Check the age/mileage of the belt from customer records.

Inspect for oil contamination. All oil leaks on to the belt must be rectified. Check belt tension. Check belt tooth to toothed wheel contact.

Turn engine to align the timing marks. Lock engine in position as per manufacturer's instructions. Mark direction of rotation (DOR) with an arrow on the belt. Slacken tensioner and remove the belt.

Check tensioner bearing by rocking and spinning. Look for free play and listen for bearing whine or seizure. Check toothed wheels for condition.

Check belt for signs of cracking, fraying, twist, tooth separation or other signs of deterioration. Always renew the belt if any doubt about its condition is suspected.

Reassemble keeping timing marks aligned. Turn the engine at least 2 full revolutions and recheck the belt tension and the timing.

Reassemble covers and other components. Run engine and listen for abnormal noises and correct operation of the engine.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

138.Inspect camshaft lobes and bearings.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Strip to access cam followers/tappets. Rock followers/tappets in bores to assess wear.

Inspect running faces of followers/tappets for pitting, wear or other deterioration. Inspect for offset wear that indicates that the follower has not been rotating.

Inspect cam lobe faces for wear.

Follow manufacturer's instructions for stripping and inspecting hydraulic tappets. Check oil flow rate and operation of auto adjustment mechanism, springs and check valves, etc.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

139.Inspect and measure sensors.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Switch off ignition and then remove connections to sensors before testing (except for test 6).

Inductive type crank sensor: Measure resistance.

Temperature sensor: Measure resistance.

Throttle potentiometer: Measure resistance as throttle is moved.

Knock sensor: Gently tap sensor with it connected to a scope and a waveform will be shown (or an AC meter will show some reading).

Hall sensor: Check supply voltage between + and -. Then check output signal from 'o' terminal switches as engine is rotated by hand.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

140.Inspect and measure the ignition coil.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Switch off ignition and disconnect coil wires.

Visual inspection of ignition coil.

Measure resistance between LT terminals.

Measure resistance between one LT terminal and the HT terminal.

Note for multiple outlet DIS coils: Measure between the pairs of HT terminals for secondary resistances and between the inner and each outer LT terminal for primary resistances.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

141.Inspect monopoint fuel injection

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Visually inspect fuel feed and return pipes/hoses. Look for leakage, condition and security.

Visually inspect for damage and deterioration to electrical terminals/cables/sockets to all sensors, the ECU/ECM and actuators.

Check fuel pressure regulator with pressure gauge and adapters (special equipment). Adjust if necessary (only possible on some systems).

Check throttle spindle to housing for wear - rock spindle in housing or check inflow of air when the engine is running. Check that the throttle plate opens fully when the throttle is depressed fully.

Check the sensors, ECU/ECM in accordance with the manufacturer's instructions.

Check the system function with an exhaust gas analyzer and specialist test equipment.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

142.Inspect electronic multipoint injection components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Visually inspect fuel feed and return pipes/hoses. Look for leakage, condition and security.

Visually inspect for damage and deterioration to electrical terminals/cables/sockets to all sensors, the ECU/ECM the injectors and other actuators.

Check throttle spindle to housing for wear - rock spindle in housing or check inflow of air when the engine is running. Check that the throttle plate opens fully when the throttle is depressed fully.

Check fuel pressure regulator with pressure gauge and adapters (special equipment). Check vacuum supply to the regulator and regulator diaphragm with a vacuum gauge/pump.

Check the operation and performance of the fuel injectors using special equipment. Follow manufacturer's instructions carefully. TAKE CARE TO AVOID ANY RISK OF FIRE - FOLLOW ALL SAFETY PRECAUTIONS.

Check the sensors, ECU/ECM in accordance with the manufacturer's instructions.

Check the system function with an exhaust gas analyzer and specialist test equipment.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

143.Check fuel system components using digital multimeter and/or oscilloscope.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Identify fuel system sensors.

Obtain manufacturer's test data and procedures.

Follow manufacturer's instructions to test components. Compare readings with manufacturer's specifications.

Identify fuel system actuators.

Obtain manufacturer's test data and procedures.

Follow manufacturer's instructions to test components. Compare readings with manufacturer's specifications.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

144.Inspect fuel tanks, evaporative emission control system, and fuel lines.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Visually inspect the fuel lines - pipes/hoses for condition - corrosion/perishing, other deterioration and security. Look for signs of leakage - discoloration or staining.

Check security of the fuel tank mountings. Inspect the filler neck, filler cap and vent and vapor pipes. Look for condition - perishing and signs of leakage at seams and fuel gauge sender unit and fuel pump gasket.

Check vapor canister for air flow into canister and return under vacuum to inlet manifold. Disconnect pipes as necessary and apply a vacuum with a vacuum pump to the canister purge valve. Check operation of the canister purge solenoid under appropriate operating conditions.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

145.Inspect fuel cut off/deceleration control circuits and devices.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check individual vehicle manufacturer's data for fuel cut off or deceleration control devices. These are emission control devices and vary according to the vehicle sale area.

Check the fuel cut off solenoid, throttle damping, auxiliary air injection on overrun, (AIR systems) and electronic engine management programs.

Follow engine manufacturer's data for checking procedures and specifications.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

146.Inspect exhaust system including lambda/HEGO sensor/catalytic converter.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain information from the driver on exhaust noise, engine performance, misfire, hesitation and flat spots.

Carry out exhaust gas analysis and lambda/HEGO checks with multimeter function of gas analyzer, if available, and road test before removal to identify symptoms.

Inspect exhaust before removal to identify possible faults. Check for full gas flow through the exhaust and that the engine freely revs. Allow to cool before working on the exhaust, particularly the exhaust manifold and catalytic converter which get very hot.

Remove and separate all exhaust parts as necessary. Check the lambda/HEGO sensor with an ohmmeter for resistance of the heater and sensor circuits. Compare with the manufacturer's data.

Check the pipes internally where possible and externally for corrosion, blockage and the security of mounting brackets.

Check silencers and resonators internally and externally for air flow and blockage, corrosion, holes in the outer and inner skins and security of the mounting brackets. Check for blockage with an air line blower and a rag plug in the pipe.

Look through the converter core to see if any breakage has occurred. Look for blockage or break up of the ceramic or steel core. Check the outer skins for corrosion, damage or other deterioration.

Check the mounting brackets on the vehicle. Closely inspect rubber mountings and hangers for perishing, broken bonding to brackets, splits, age hardening or other deterioration.

Check the position, condition and security of heat shields.

Report defects found.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

147.Inspect turbocharger/supercharger and adjust boost pressure.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove turbo/supercharger. Inspect casing for corrosion, cracking, oil leakage or other deterioration.

Follow the manufacturer's instructions for the stripping, inspection and measurement of components and adjustments.

Check for signs of oil leakage into the exhaust and boost chambers. Check the condition of the turbine and impeller blades, look for fan blade damage, carbon build up, and contact of fan blades with the casing.

Rotate the spindle and turbine and impeller blades and feel for free play in the bearings. Check end float and bearing free play with a dial test indicator (dti). Compare measurements with the manufacturer's data.

If possible strip and inspect spindle bearings, oil seals and inside the casing. (Many turbochargers are factory sealed units and must be replaced as a unit if internal damage has occurred).

Check the operation of the diaphragm unit for the waste gate - apply a pressure and measure the amount of push rod movement for the pressure applied. Compare with manufacturer's data.

Check the waste gate push rod and pivot are free in the casing and that the waste gate valve fully opens and closes. Check the condition of the waste gate valve for burning or other deterioration. Check maximum pressure boost with a pressure gauge on road test and engine under load.

For turbochargers with a pressure release valve (blow off valve) check the release pressure when the engine is running under load on a dynamometer or road test. Connect a pressure gauge and observe maximum boost pressure, which should stabilize under load.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

148.Check emission system components using digital multimeter and/or vacuum pump and gauge.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Follow the manufacturer's instructions to locate emission systems electrical and electronic components. (Sensors and actuators).

Check where possible the voltage signals (AC and DC) and compare with the manufacturer's specifications.

Disconnect components to measure resistances. Sensors, actuators and solenoids. Compare with the manufacturer's specifications.

Check continuity of wiring with a digital multimeter (ohms scale). Wriggle terminals to find loose and poor connections.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

149.Perform cylinder power balance tests; determine necessary action.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check engine manufacturer's data for suitability of this test. Connect engine to test equipment/engine analyzer.

Follow equipment manufacturer's instructions for test procedure. Increase idle speed if necessary. Record results for each cylinder.

Compare rpm drop for each cylinder against other cylinders. A low rpm drop indicates a defective cylinder. Compare range to manufacturer's specifications.

On old engines with contact breaker ignition it is possible to carry out this test with a tachometer and open circuiting the HT leads (remove leads from spark plugs with insulated pliers) or by short-circuiting the HT leads (short to earth with insulated handle screwdriver).

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

150.Perform cylinder compression tests; determine necessary action.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check engine manufacturer's data for suitability of this test and checking conditions (cold or hot). Disconnect LT (low tension) or primary circuit feed at coil to prevent HT current. (LT feed from coil to distributor).

Remove all spark plugs.

Connect compression tester into No. 1 spark plug hole. Fully open throttle.

Crank engine for 3 or 4 revolutions, record initial (first revolution) and final compression reading. (Seek assistance if necessary to hold the throttle and to crank the engine.)

Repeat for all other cylinders and record readings.

If some readings are low put a small drop of clean engine oil into the cylinder and repeat test. Record results.

Repeat for all cylinders.

Compare dry and wet readings with other cylinders and with the engine manufacturer's specifications.

Refit spark plugs, HT leads and coil LT lead - check engine starts and runs.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

151.Perform cylinder leakage tests; determine necessary action.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect vehicle battery ground lead.

Remove spark plugs.

Insert the whistle into No. 1 spark plug hole. Turn engine in normal direction of rotation (DOR) until whistle blows. This will give top dead center (tdc) on the compression stroke.

Remove the whistle and insert a probe or dial test indicator (dti) plunger onto the top of the piston. Rock the engine to find the exact tdc position. Tdc marks should align.

Fit cylinder leakage test adapter into the spark plug hole and attach the airline from the tester.
Keep hands clear of engine - risk of rotation if tdc is not accurately positioned.

Follow equipment manufacturer's instructions to increase the air pressure in the cylinder and hold. Observe the gauge readings and time taken for the pressure to drop.

If air pressure drops quickly maintain a continuous air supply and look and listen for leakage. Air may be lost from the inlet valves or exhaust valves and be heard in manifolds or air may bypass the piston and be found in the crankcase ventilation pipes - remove to see.

Repeat for all other cylinders and record readings.

Compare readings with other cylinders and with manufacturer's specifications.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

152.Perform engine vacuum tests; determine necessary action.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check engine manufacturer's data for suitability of this test. Check ignition timing and carburetor settings where appropriate.

Connect a vacuum gauge to the inlet manifold in accordance with the engine manufacturer's instructions or to a suitable position.

On old engines (distributor ignition) carry out cranking test by disconnecting coil to distributor low tension (LT) primary circuit lead. Crank engine and observe gauge needle. Record vacuum and variations (needle fluctuations).

Start engine and run at idle. Observe gauge readings and if needle is steady or fluctuating.
Record readings and variations.

Blip the throttle and observe readings. Record maximum and minimum readings. Repeat 3 or 4 times to obtain consistent or average results.

Increase engine speed to 2500 rpm. Observe and record readings.

Release throttle and observe readings as engine decelerates. Record readings. Repeat 3 or 4 times to obtain consistent or average readings.

Compare all readings with the engine and equipment manufacturer's specifications.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

153.Check operation of crankcase ventilation (PCV) system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: PLAN obtains technical/procedural data from manuals and information from vehicle owner/driver. Obtain driver information on oil and fuel consumption. Both are likely to be high if the system is blocked. Check for drivability problems resulting from failure of the PCV system.

Run engine and look for blue exhaust smoke and smoke leakage from PCV pipes and hoses. Exhaust smoke and engine smoke can indicate a blocked PCV system. Inspect the air cleaner element for oil contamination. If contaminated check oil separator.

Identify PCV system type (valve or restricted orifice into inlet manifold). Visually inspect all pipes and hoses for condition, blockage, fit onto connectors (leakage), oil contamination - pull off pipes in turn to assess internal and external condition.

Clean or replace pipes/hoses if required. Clean or replace PCV air intake filter (integral with oil filler cap on some engines).

Pull out and open PCV valve, clean and check operation or remove valve and shake to check that the valve is free, listen for a rattle. Check that airflow is toward manifold or air cleaner. Or 6

Check restricted orifice into carburetor or inlet manifold is clean and clear, blow through and listen. Clean out if necessary (Do not increase diameter by drilling clear with oversize drill).

Reconnect all pipes and run engine. Check for vacuum at feed into inlet manifold. Check for symptoms of blocked valve or orifice. Rough or uneven idle; stalling at low speeds, oil leaks, and smoke from engine oil filler cap.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

154.Carry out manifold absolute pressure tests for operation of ignition and emission control systems.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check with the engine manufacturer's data for instructions on connecting a vacuum gauge to a suitable position and the conditions for testing. Some pipes may need to be blanked off.

Follow the test procedures to obtain the vacuum readings. This will generally require the isolation (removal and blanking) of vacuum feeds to some sources such as PCV or brake servo.

Compare test results with manufacturer's specifications.

Connect a voltmeter or oscilloscope to the specified terminals on the MAP sensor. Turn on the ignition and compare the voltage or wave pattern (digital) with the manufacturer's data.

Connect a pressure/vacuum pump to the sensor. Create a vacuum of 0.5 bar and compare the voltage reading or pattern with the manufacture's specifications.

Create a pressure of 0.5 bar and compare the voltage reading or pattern with the manufacture's specifications.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

155.Carry out oscilloscope/engine analyzer diagnostic test procedure.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Connect the oscilloscope/engine analyzer leads as per the manufacturer's instructions.

Follow test instructions for the equipment. Check primary circuit display. Engine speed at about 1500 rpm.

Check coil polarity. Use superimposed or raster patterns for comparisons between cylinders). Check primary voltage pattern. Check dwell angle/period.

Follow test instructions for the equipment. Check secondary circuit display. Engine speed at about 1000 rpm.

Check coil output (Use parade for a general view and check secondary voltage patterns (superimposed or raster patterns for Check voltage to each cylinder (good comparisons between cylinders.

Compare results with the manufacturer's data and specifications.

The faults detected with this test equipment can indicate problems with other systems. Such as mechanical, fuel, PCV, etc.

This equipment can also be used to check alternator output voltage and the condition of the rectifier.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

156.Check ignition system components using scanner

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This task is carried out on vehicles with an electronic engine control module (ECU) and fault code indicator system, diagnostic connector or OBD (on board diagnostic) connector.

Check and follow the manufacturer's data for accessing the fault codes or for connecting the data link/self-test/dedicated tester/scan tool.

Follow the manufacturer's procedures to obtain read outs of fault codes or diagnostic data.

Compare the readings with the manufacturer's data. Report and rectify faults. Reset the ECU memory to erase the fault codes.

Road test the vehicle - long test required - to allow the ECU to detect new or uncorrected faults. Check for NO FAULTS reading on completion of the road test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

157.Check ignition system problems resulting from failures of interdependent systems using scanner

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This procedure is similar to other fault code or OBD (on board diagnostic) tests. Look at emission components, vacuum and sensor outputs, fuel system, A/C, etc.

Check and follow the manufacturer's data for accessing the fault codes or for connecting the data link/self-test/dedicated tester/scan tool.

Follow the manufacturer's procedures to obtain read outs of fault codes or diagnostic data.

Compare the readings with the manufacturer's data. Consider the effect of faulty sensors or actuators on ignition system function. Report and rectify faults. Reset the ECU memory to erase the fault codes.

Road test the vehicle - long test required - to allow the ECU to detect new or uncorrected faults. Check for NO FAULTS reading on completion of the road test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

158.Inspect fuel system for leaks and condition of pipes and hoses, etc.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This is a visual inspection and check for fuel odor under the vehicle and in the engine compartment.

Raise the vehicle onto axle stands or a vehicle hoist. Open the hood. Follow the fuel lines from the tank to the carburetor of fuel injection components. Look carefully at all pipes and hoses. Look from the filler neck to the tank, at the tank, and the feed and return pipes.

Look for washed areas, stains and fuel odor and any other signs of leakage. Check for damage, routing and chaffing. Look for corrosion, perishing, leaks at joints and security of hose clips and pipe securing clips.

Look at the fuel tank security, and for leaks from the fuel gauge sender unit gasket and outlet pipe.

Inspect the vapor lines, vapor trap and the filler cap fit and condition of the sealing ring. Modern tanks hold a small pressure or vacuum under some conditions. There is often a rush of air as the filler cap is removed - this is normal.

Report any defects found.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

159.Carry out vacuum (manifold absolute pressure MAP) tests on fuel and emission systems.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check with the engine manufacturer's data for instructions on connecting a vacuum gauge to a suitable position and the conditions for testing. Some pipes may need to be blanked off.

Follow the test procedures to obtain the vacuum readings. This will generally require the isolation (removal and blanking) of vacuum feeds to some sources such as PCV or brake servo.

Compare test results with manufacturer's specifications.

Connect a voltmeter or oscilloscope to the specified terminals on the MAP sensor. Turn on the ignition and compare the voltage or wave pattern (digital) with the manufacturer's data.

Connect a pressure/vacuum pump to the sensor. Create a vacuum of 0.5 bar and compare the voltage reading or pattern with the manufacturer's specifications.

Create a pressure of 0.5 bar and compare the voltage reading or pattern with the manufacturer's specifications.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

160.Check engine for poor running.

(misfire, uneven running, difficult starting, flat spots/hesitation, running on/dieseling)

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain information from owner/driver on grade of fuel being used. Visually check fuel injection system for leaks and the condition of pipes/hoses. Check for odor.

Check fuel for contaminants and quality

Check the condition of the air cleaner element and the position of the intake ducting. Depending on type, check the operation of the air temperature control flap.

Visually check electrical cables and terminals to all sensors and fuel injectors. Look for loose or broken connections or other deterioration. Wriggle terminal ends when the engine is running to check for poor and/or intermittent connections.

For misfire and uneven running on multi-point injector systems, check the operation of each injector in accordance with the manufacturer's instructions. Check for air leaks. Check mixture control with an exhaust gas analyzer.

For difficult cold starting, check the operation of the cold start injector (if fitted) and the auxiliary air valve. Check sensors and ECM for correct signals and processing.

For flat spots, hesitation and running on check the fuel pressure. Carry out checks on the fuel pressure, the regulator and vacuum controls in accordance with the manufacturer's instructions. Check for air leaks from auxiliary air valve and intake pipes. Check engine temperature sensor.

For electronic control systems, carry out a system check using dedicated test equipment or a self-test fault code readout system.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

161.Check operation of fuel gauge, fuel level indicator and low fuel warning light.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Locate fuel gauge sender unit in the fuel tank. Accessible from under the vehicle or through an inspection panel in the vehicle floor (boot or under seat).

For steel fuel tanks with a single feed to the sender unit, disconnect the feed to the sender unit. Use an assistant to turn on the ignition, the gauge should read empty.

Turn off the ignition and connect the feed wire to a suitable ground point on the vehicle. Turn on the ignition, the fuel gauge should read full. Turn off the ignition and hold the feed wire against the tank, if the tank grounding is good the gauge will read full.

If no change in the gauge reading occurs, check the feed wire for voltage with a voltmeter. If no voltage, check fuse and track through wiring with the voltmeter and the ignition on. Check voltage at the gauge. (Voltage will vary according to value of stabilized volts).

Plastic fuel tanks have a ground wire in the terminal block. Disconnect the block and turn on the ignition. The gauge should read empty. Bridge the two terminals in the terminal block and turn on the ignition, the gauge should read full. If not reading full check voltages in the circuit.

When a fuel low level warning light is fitted there will be three wires to the sender unit. Identify gauge feed, warning light feed and ground from a workshop manual wiring diagram. Check gauge by disconnecting the terminal block, the gauge should read empty with the ignition on.

Bridge the gauge feed to the ground terminal and the gauge should read full. To check the low fuel level warning light bridge the warning light feed to the ground terminal. The warning light bulb should illuminate.

If the above checks do not give gauge readings of full and empty, the gauge is probably faulty.

If the above checks give full and empty readings but the fuel level is not correct in service, the fuel gauge sender unit is probably faulty. Remove sender unit and check that the float is not punctured or fallen off the lever arm. Check condition of the variable resistor and wiper arm.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

162.Check fuel system components using fault code readout or scan tool.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This task is carried out on vehicles with an electronic engine control module (ECM) and fault code indicator system, diagnostic connector or OBD (on board diagnostic) connector.

Check and follow the manufacturer's data for accessing the fault codes or for connecting the data link/self-test/dedicated tester/scan tool.

Follow the manufacturer's procedures to obtain read outs of fault codes or diagnostic data.

Compare the readings with the manufacturer's data. Report and rectify faults. Reset the ECM memory to erase the fault codes.

Road test the vehicle - long test required – to allow the ECM to detect new or uncorrected faults. Check for NO FAULTS reading on completion of the road test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

163.Check fuel system problems resulting from failures of interdependent systems using scan tool.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This procedure is similar to other fault code or OBD (on board diagnostic) tests. Look at emission components, vacuum and sensor outputs, ignition system, A/C, etc.

Check and follow the manufacturer's data for accessing the fault codes or for connecting the data link/self-test/dedicated tester/scan tool.

Follow the manufacturer's procedures to obtain read outs of fault codes or diagnostic data.

Compare the readings with the manufacturer's data. Consider the effect of faulty sensors or actuators on fuel system function. Report and rectify faults. Reset the ECM memory to erase the fault codes.

Road test the vehicle - long test required – to allow the ECM to detect new or uncorrected faults. Check for NO FAULTS reading on completion of the road test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

164.Check emission system components using scanner

This task is common for all electronic systems.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This task is carried out on vehicles with an electronic engine control module (ECM) and fault code indicator system, diagnostic connector or OBD (on board diagnostic) connector.

Check and follow the manufacturer's data for accessing the fault codes or for connecting the data link/self-test/dedicated tester/scan tool.

Follow the manufacturer's procedures to obtain read outs of fault codes or diagnostic data.

Compare the readings with the manufacturer's data. Report and rectify faults. Reset the ECM memory to erase the fault codes.

Road test the vehicle - long test required - to allow the ECM to detect new or uncorrected faults. Check for NO FAULTS reading on completion of the road test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

165.Check emission system problems resulting from failures of interdependent systems using scanner.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This procedure is similar to other fault code or OBD (on board diagnostic) tests. Look at fuel system components, vacuum and sensor outputs, ignition system, A/C, etc.

Check and follow the manufacturer's data for accessing the fault codes or for connecting the data link/self-test/dedicated tester/scan tool.

Follow the manufacturer's procedures to obtain read outs of fault codes or diagnostic data.

Compare the readings with the manufacturer's data. Consider the effect of faulty sensors or actuators on emission systems functions. Report and rectify faults. Reset the ECM memory to erase the fault codes.

Road test the vehicle - long test required - to allow the ECM to detect new or uncorrected faults. Check for NO FAULTS reading on completion of the road test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

166.Inspect drive belt condition and tension.

Inspect water pump bearings and seal for wear and leakage. Check operation of cooling fan and airflow through radiator.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery earth or ground lead. Check the coolant level (cold engine). Identify the drive belt for the water pump - inside the engine compartment or under the vehicle.

Check the condition of the belt, look for frays, cracks, glazing of the drive faces caused by slippage and check that the tension or free play is within manufacturer's tolerances. Free play of about 12 mm (1/2 inch) on the long side of a V belt is usually correct.

Rock the water pump at the pulley and feel for wear/free play in the spindle bearings. Look for signs of leakage at the water pump spindle seal and the housing to engine block gasket. Look under the pump for telltale stains of coolant leakage on and under the pump.

For engine driven and electrically driven cooling fans check for damage and security. Check the fan cowling for damage and security. This is particularly important for electrically driven fans where the cowling is also the support bracket for the motor and fan assembly. Check the radiator matrix air passages for blockage. Blow through with an air line if a build up of dust or dirt is visible. Blow through in the reverse direction.

For engine driven fans with a viscous thermostatic coupling check that the fan is free on the hub when the engine is cold. For all fans check that the fitting is correct. Some old steel fans could be fitted the wrong way round.

For electrically driven fans check the motor spindle bearings by rocking and rotating the fan blades and feeling for free play, lumpiness and grinding in the bearings. (Ensure that the battery earth or ground lead is disconnected whenever handling electrically driven fans).

Reconnect the battery and run the engine. Check for airflow from the fan and a good air draw through the radiator. For electrically driven fans run the engine to the switch temperature so that the fan operates.

Do not allow engine to overheat if the fan switch does not operate or the fan fails to operate. Check the fan motor by disconnecting the switch terminal block and bridging the connections. The motor should run.

If the motor does not run check for an electrical feed at the terminal block. Connect a test lamp or voltmeter between each terminal and a good earth or ground - turn on the ignition if necessary. Check the switch continuity when cold (not continuous) and when hot (continuous).

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

167.Check system operating temperature - check thermostat opening temperature.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check the system from cold. Set the in car heater to the hottest setting. Insert a thermometer into the radiator header tank or attach to the top hose.

Run the engine. The coolant in the top hose should remain cool until the thermostat opens. Compare the top hose temperature to the heater hose temperature. The heater hose should warm up gradually and the top hose rapidly as the thermostat opens.

When the engine is at its normal operating temperature take a reading from the thermometer and compare with the manufacturer's specifications. Check engine temperature gauge reads correctly.

For electrically driven cooling fan types allow the engine to continue to heat up until the cooling fan operates. Check the temperature in the coolant is within the manufacturer's specifications. Check engine temperature gauge reads correctly.

To check a thermostat that has been removed from an engine use a thermostat tester. Put the thermostat into the water in the tester. Check that the water level is correct and that thermometer is correctly positioned. Turn on the tester to heat the water.

Observe the thermometer and the thermostat and look for the temperature when the thermostat begins to open and when it is fully open. Check the temperatures with the manufacturer's data.

When the task has been completed, record here how it went or how it could be improved next time

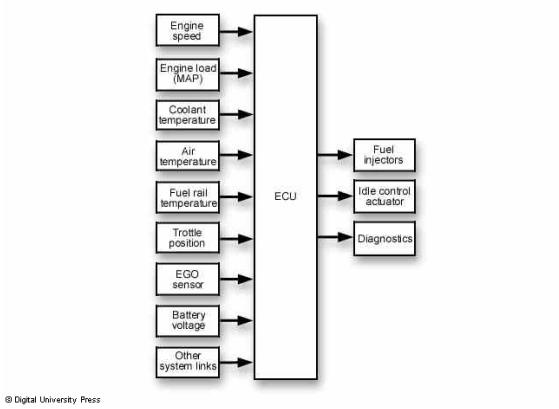
Instructor's signature: **Grade:** 1 2 3 4 5

Assignments

General Engine Diagnosis

Task 1:

This picture shows an engine management ECU inputs and outputs.



Name **three** sensors that produce analogue signals

State one type of sensor used to input engine load

Other than fuel and ignition, name **two** other systems that may be linked to the engine management system

Answer:

Task 2:

State **four** situations where component wear produces abnormal noises in a running engine.

State **two** situations where engine component faults produce abnormal vibrations in a running engine.

Answer:

Task 3:

Describe a procedure for carrying out an engine power balance test by means of:

an engine analyzer, a vacuum gauge

Answer:

Task 4:

An engine is to be tested for cylinder leakage.

State how the engine should be prepared before the test.

State **two** specific faults that this test could identify where a compression test would be inadequate.

Answer:

Task 5:

A four-gas analyzer is used to measure the exhaust emissions of a vehicle. Name the **four** gases measured.

State how the vehicle should be prepared before measurements are taken.

State **one** possible cause of a high reading in each of the gases given in a) above.

Answer:

Task 6:

This picture shows testing equipment fitted to the cooling system of a vehicle.

State the purpose of this test.

Give an approximate value for the reading on the gauge shown.

State **one** other test for which this equipment can be used.

Answer:

Instructor Feedback:

Computerized Engine Control Diagnosis and Repair

Task 1:

Stored diagnostic trouble codes are to be retrieved from a vehicle.

List the equipment required to perform this task

Describe **one** method of retrieving diagnostic trouble codes from a vehicle, which has an OBDII system.

Answer:

Task 2:

The picture shows a scan tool.

State **two** uses of this tool in fault diagnosis.

Explain how this tool can be used to check for module communication errors.

Answer:

Task 3:

A Graphing multi-meter (GMM) is to be used to check the operation of computerized engine control sensors. Sketch the pattern obtained for each of the following during the check:

inductive pulse generator, MAP sensor, TDC sensor, camshaft position sensor

Answer:

Task 4:

Describe a procedure for checking the serviceability of **each** of the following:

coolant temperature sensor

crankshaft position sensor

Answer:

Task 5:

State **four** types of service information/data that may be required before performing systematic diagnosis.

State **two** sources of this information/data.

Answer:

Task 6:

A vehicle is described as having drivability concerns resulting from malfunctions in the computerized engine control system with no stored diagnostic trouble codes.

Give **two** examples of drivability concerns.

State **one** diagnostic procedure to identify **each** concern.

Answer:

Instructor Feedback:

Ignition System Diagnosis and Repair

Task 1:

Dampness on a high-tension lead/wire can cause difficult starting.

State why dampness causes this difficulty.

State **two** features of high-tension leads, which minimize this problem.

Answer:

Task 2:

The minimum resistance between any two distributor cap segments is specified as 50MΩ.

State the action to be taken when the resistance between any two segments is 2KΩ.

Describe how the resistance between two segments is measured.

Answer:

Task 3:

State in **each** case, **one** ignition fault which produces the following symptoms:

Pinking, running-on, an irregular misfire on one cylinder only

Answer:

Task 4:

The pictures show the noses of three spark plugs just removed from their engines. State in **each** case, the fault that is the likely cause for the appearance of each plug.

Plug A

Plug B

Plug C

Answer:

Task 5:

State why ignition timing should be checked with a stroboscopic timing light after first setting the timing with the engine stationary.

The stroboscopic check shows the ignition to be 8º too far retarded at 1200rev/min. State the adjustment that should be made to the distributor.

Answer:

Task 6:

Describe a procedure for checking the correct operation of ignition mechanical **and** vacuum advance.

Answer:

Instructor Feedback:

Fuel system diagnosis and repair

Task 1:

One method of ensuring that an electric fuel pump is cut off in the event of a collision is by the ECU sensing that the engine has stopped and isolating the fuel pump relay. State **one** other method of disabling the electric supply to the pump.

Describe a procedure for testing the correct operation of an electric fuel pump.

Answer:

Task 2:

Fuel delivery partly depends on how long injectors are open (pulse width). State why pressure regulation is also required for precise injection quantity.

Describe how to test that a fuel pressure regulator is operating correctly.

Answer:

Task 3:

A mechanical fuel pump (lift pump) is to be tested without removing it from the engine. Describe **two** tests, which should be carried out to determine its correct operation.

Answer:

Task 4:

A vehicle is fitted with an injection type fuel system. State **one** possible cause of **each** of the following symptoms:

hesitation engine misfire

power loss stalling

poor mileage dieseling

Answer:

Task 5:

Describe a procedure for conducting an exhaust system back-pressure test.

State **two** possible causes of excessive back-pressure

Answer:

Task 6:

Describe how petrol fuel injection systems are safely depressurized before any fuel lines are disconnected.

Describe a procedure for replacing a fuel filter.

Answer:

Instructor Feedback:

Emission control system diagnosis and repair

Task 1:

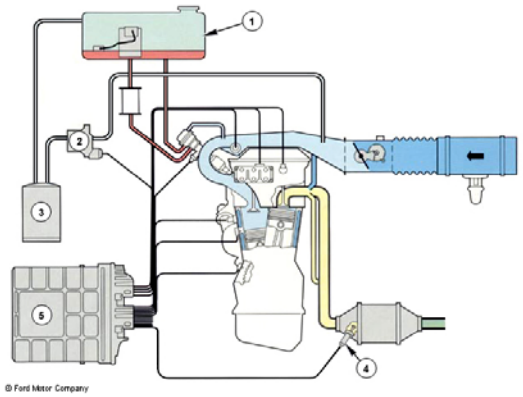
State **four** checks that should be made to a positive crankcase ventilation (PCV) system to ensure its serviceability and correct operation.

Answer:

Task 2:

The picture shows an exhaust gas recirculation (EGR) system.

State **four** checks that should be made to the system to ensure correct operation.



Answer:

Task 3:

The picture shows an automatic intake air temperature control device.

State the symptoms produced if the unit seized in the:

open position

b) closed position

Answer:

Task 4:

Explain how diagnostic trouble codes (DTCs) can be retrieved from a vehicles evaporative emission control system.

Answer:

Task 5:

Describe drivability problems that may arise from malfunctions in the early fuel evaporation control system of a vehicle.

Describe the testing of **one** component from an early fuel evaporation control system, which may cause drivability problems.

Answer:

Task 6:

A catalytic converter performance test is to be carried out.

List the tools and equipment required to carry out this task.

Describe a procedure for carrying out this test.

Answer:

Instructor Feedback:

Engine Related Service

Task 1:

The picture shows valve clearances being measured.

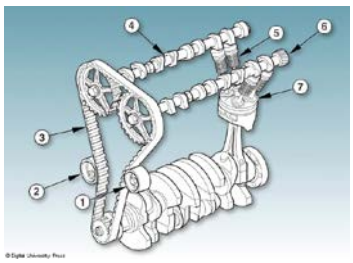
State why the clearance is necessary.

Describe the procedure for correctly positioning a valve so that the clearance is at its maximum for measurement.

Describe the check that should be made after tightening the locknut.

Answer:

Task 2:



The picture shows the layout of a camshaft drive arrangement.

List the tools required to remove and refit the belt.

Describe a procedure for the removal and refitting the belt

Answer:

Task 3:

Describe how correct camshaft timing can be determined following replacement of a camshaft drive belt.

Answer:

Task 4:

Describe a procedure for the removal and replacement of a thermostat.

Answer:

Task 5:

An electrically operated cooling fan is to have its thermostatic switch tested.

State the normal location of the switch in a liquid cooling system.

Name the equipment required to test the switch when it has been removed from the vehicle.

Describe how the test should be carried out.

Answer:

Task 6:

Describe how to inspect and test a viscous type fan when fitted to the engine of a vehicle.

Answer:

Instructor Feedback:

Automatic Transmission and Transaxle

Tasklist worksheets

168. Service automatic transmission system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Fit appropriate car protection kit.

Warm up the transmission, by road test if possible. Raise the vehicle on a suitable hoist.

Loosen and remove the drain plug if fitted and drain the oil into a suitable catch pan. If a drain plug is not fitted, undo the sump/pan bolts and drain carefully. Take care with hot oil; make sure you wear suitable protection such as rubber gloves and overalls. Drain the torque converter if a plug is fitted.

Remove the sump/pan completely.

Remove the transmission fluid filter/screen. This should be cleaned and replaced or renewed.

Inspect the sump/pan for any unusual residues. This is useful to help diagnose faults.

Clean the sump/pan thoroughly inside and out. Make sure all traces of the old gasket are removed. Fit new gaskets and any sealing rings as required, and refit the sump/pan.

Tighten all the bolts evenly to the specified torque setting. Refit drain plug if removed.

Check the manufacturers data for the correct oil and refill with the appropriate quantity. NOTE: only use the recommended oil. Other types may cause serious damage.

Apply parking/handbrake, start the engine and move the lever through all positions. Recheck the fluid level. Note that some manufacturers recommend the level to be checked with the engine running.

Conduct a road test to check for correct operation, noise and vibration. Return to the workshop and double check for leaks. Remove protection kit and report your findings.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

169. Service/Adjust throttle valve/kick down cable and manual shift linkages.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: If a kick down cable is fitted, the correct amount of lost motion (movement that does nothing!) should be set. This is so that it only pulls the valve in the transmission, when the throttle pedal is pushed all the way to the floor.

Make sure the engine is NOT running.

Get an assistant to push the throttle pedal down slowly while you watch the throttle spindle and kick down cable movement. Alternatively, move the throttle by hand from within the engine compartment.

If the pull on the cable is incorrect adjust the position of the outer sleeve until the movement is as specified. This is often a figure of 10 to 15 mm or about half an inch.

Many systems include an automatic adjuster. If this is the case, depress the re-adjust tab and move the slider away from the linkage. Manually turn the throttle to the wide-open position, which will automatically make the adjustment.

Do not use excessive force in case there is a problem with the cable.

Check operation and adjustment of manual shift linkages or cables.

Check the adjustment of the manual lever position sensor. Don’t forget to check the reverse lights illuminate when R is selected, and starting the engine is only possible when P or N are selected.

After adjustment, check for correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor’s signature: **Grade: 1 2 3 4 5**

170. Remove and refit automatic transmission.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove: Fit car protection kit as required. Disconnect the battery earth/ground cable. Drain the fluid from the transmission. Disconnect the throttle valve/kick down cable if fitted.

Remove the transmission fluid dipstick and any other components, which may impede movement or be damaged, as the box is removed. Raise the vehicle on a hoist and remove, if required, the exhaust system.

Disconnect and label all electrical connections on the transmission (inhibitor switch, reverse switch and sensors/actuators for example). Disconnect the shift control/gear selector mechanism.

Remove the lower cover to access the torque converter. Scribe a line on the driveplate and converter so that they can be reassembled in their original positions. Remove the converter to driveplate nuts and/or bolts. Turn the engine over by hand to do this.

Remove the propshaft/driveshaft and associated support bearings as required. Position a suitable transmission jack underneath and secure it to the transmission. Raise the jack slightly and then remove the transmission support beam.

Lower the transmission slightly to allow access to any other components. In particular, the transmission fluid cooler pipes and the throttle valve/kick down cable if fitted. Support the engine, if necessary, using an axle stand underneath or a support bar from above. Remove the engine to transmission bolts.

Double check that all cables and wires are disconnected. Separate the transmission from the engine and lower it. Make sure the torque converter stays in the transmission housing. Secure this with a support bar if necessary.

Remove the transmission from the vehicle. Inspect, replace and align powertrain mounts.

Refit: Refitting is a reversal of the removal process. However, a few pointers may be necessary.

Make sure the converter rotates freely before securing it to the driveplate. Ensure all nuts/bolts are tightened to the recommended torques. Adjust the shift mechanism and the throttle valve/kick down cable.

Fill the transmission with the recommended quantity and type of fluid. Follow the ‘fill’ procedure outlined on the ‘servicing’ worksheet to do this. Finally, road test the vehicle and then return to the workshop for a final inspection for security and leaks.

When the task has been completed, record here how it went or how it could be improved next time

Instructor’s signature: **Grade: 1 2 3 4 5**

171. Transmission assembly (RWD) – dismantle, inspect and reassemble.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: There are many types of automatic transmission, therefore the vehicle manufacturers service information relevant to the transmission being worked on should be available and consulted before carrying out this task.

Remove transmission and torque converter as one assembly as detailed in the 'Remove and refit' worksheet. Do not turn the transmission unit upside down during or after removal. Clean and inspect the transmission casing. Inspect torque converter flex plate and starter ring gear.

Remove torque converter and withdraw input shaft. Drain converter and inspect oil for residues contained within it. Inspect torque converter mounting lugs and locating stub.

If available, mount transmission with appropriate bracket on stand.

Remove sump downwards. This will prevent swarf and oil sludge from entering gearbox. If possible leave oil in sump during removal, this may be useful for diagnostic purposes.

Turn gearbox upside down and remove filter and valve body.

Inspect, measure and clean valve body (includes surfaces and bores, springs, valves, sleeves, retainers, brackets, check-balls, screens, spacers and gaskets).

Remove pump from front of gearbox. This may require removal of the converter casing first. Inspect pump gears and body for wear. Inspect oil delivery seal rings, ring grooves and sealing surfaces.

Remove rear extension housing.

Remove governor assembly and inspect.

Slacken brake band adjusting screws.

Remove and inspect brake bands, brake band drums, clutch and gearset assemblies. Depending upon the type of gearbox, these may be withdrawn from the front, rear or front and rear of the gearbox. Take care to note the relative location of components, especially thrust washers. Inspect bushings as appropriate.

Inspect roller and sprag clutches.

Remove and inspect parking pawl, shaft, spring and retainer

Inspect transmission case bores, passages, bushings, vents and mating surfaces.

Dismantle and inspect clutch assemblies using suitable press tools. Hydraulic pistons can be removed by pushing out with careful application of compressed air. Measure clutch pack clearance.

Inspect servo bores, pistons, seals, pins, springs, and retainers

Inspect accumulator bore, piston, seals, spring and retainer.

Reassembly is a reversal of the dismantling procedure.

Measure gearset and shaft end floats. Inspect and measure thrust washers and bearings.

Fit new seals to pistons and servos. Lubricate all components and seals with the correct type and grade of transmission fluid. Renew all gaskets disturbed during dismantling. Renew oil seals in converter and extension housing using appropriate tools.

Air test the operation of clutch and servo assemblies.

Refit torque converter to gearbox ensuring it is fully engaged in driving gear of hydraulic pump. This may involve taking a measurement between the face of the converter housing and front face of converter locating stub.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

172. Transmission assembly (FWD) – dismantle, inspect and reassemble.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: There are many types of automatic transmission, therefore the vehicle manufacturers service information relevant to the transmission being worked on should be available and consulted before carrying out this task. Do not attempt this task without the applicable service information.

Remove transmission and torque converter as one assembly as detailed in the 'Remove and refit' worksheet. Do not turn the transmission unit upside down during or after removal. Clean and inspect the transmission casing. Inspect torque converter flex plate and starter ring gear.

Remove torque converter and withdraw input shaft. Drain converter and inspect oil for residues contained within it. Inspect torque converter mounting lugs and locating stub.

If available, mount transmission with appropriate bracket on stand.

Remove sump downwards. This will prevent swarf and oil sludge from entering gearbox. If possible leave oil in sump during removal, this may be useful for diagnostic purposes.

Turn gearbox upside down and remove filter and valve body.

Inspect, measure and clean valve body (includes surfaces and bores, springs, valves, sleeves, retainers, brackets, check-balls, screens, spacers and gaskets).

Remove the converter casing, which will give access to the final drive components. Inspect final drive components for damage and wear.

Inspect link chains, sprockets, gears, bearings and bushings as appropriate.

Remove pump from front of gearbox. Inspect pump gears and body for wear. Inspect oil delivery seal rings, ring grooves and sealing surfaces.

Remove governor assembly and inspect.

Slacken brake band adjusting screws.

Remove and inspect brake bands, brake band drums, clutch and gearset assemblies. Depending upon the type of gearbox, these may be withdrawn from the front, rear or front and rear of the gearbox. Take care to note the relative location of components, especially thrust washers. Inspect bushings as appropriate.

Inspect roller and sprag clutches.

Remove and inspect parking pawl, shaft, spring and retainer

Inspect transmission case bores, passages, bushings, vents and mating surfaces.

Dismantle and inspect clutch assemblies using suitable press tools. Hydraulic pistons can be removed by pushing out with careful application of compressed air. Measure clutch pack clearance.

Reassembly is a reversal of the dismantling procedure.

Measure gearset and shaft end floats. Inspect and measure thrust washers and bearings.

Inspect servo bores, pistons, seals, pins, springs and retainers.

Inspect accumulator bore, piston, seals, spring and retainer.

Fit new seals to pistons and servos. Lubricate all components and seals with the correct type and grade of transmission fluid. Renew all gaskets disturbed during dismantling. Renew oil seals in converter and extension housing using appropriate tools.

Follow manufacturer's procedures for setting final drive assembly preloads.

Air test the operation of clutch and servo assemblies.

Refit torque converter to gearbox ensuring it is fully engaged in driving gear of hydraulic pump. This may involve taking a measurement between the face of the converter housing and front face of converter locating stub.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

173. Check/Inspect automatic transmission and torque converter.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Connect a remote starter switch from the main positive starter supply to the solenoid-operating terminal.

Raise the vehicle on a suitable hoist. Remember to make sure it is secure on the hoist and that the gear selector is in the 'P' (park) position. Make sure the ignition is turned OFF.

Inspect the transmission from above and under the vehicle. Report any problems such as oil leaks or loose mountings. Replace and realign weak mountings.

Check over all areas of the transmission by eye and by moving your hands over the surfaces. Take care of sharp objects. This is a good way to get a 'feel' for the system.

Check all housings for leaks and cracks. Check for leaks from output oil seals and all other extra components such as switches or sensors.

Check any linkages and cables for correct fitting and free movement. Get help from an assistant in the car if necessary.

Remove, where possible, the access cover for the torque converter.

Check the torque converter for leaks and other damage. Use the remote starter to move the engine so that all areas of the converter can be inspected.

Refit the torque converter access cover.

Inspect, leak test and flush transmission oil cooler lines. Replace as necessary.

Inspect speedometer drive gear/driven gear or vehicle speed sensor. Replace both gears if wear or damage is seen.

Inspect, adjust or replace (as applicable) vacuum modulator.

Inspect and repair or replace vacuum hoses connected to the transmission.

Lower the vehicle and remove the starter switch. Report your findings.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

174. Check/Diagnose automatic transmission system by stall testing.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: NOTE: Stall testing can be dangerous. Do not let anybody stand in front of the vehicle when this test is being carried out. The hand and foot brakes must be inspected for correct operation and then fully applied at all times during a stall test. Block the wheels as an added precaution.

A stall test involves measuring the maximum revolutions per minute of the engine, when the transmission is in gear and the vehicle is not moving. It is therefore essential to ensure the engine is capable of developing full power before the test commences.

Fit a car protection kit as appropriate.

Warm up the vehicle to normal operating temperature. Do this by driving the vehicle if possible so that the transmission oil also warms up.

Connect a tachometer to the engine and place it inside the vehicle so can be read easily.

Check the manufacturer's data for the maximum expected revolutions per minute readings (2500 to 2750 is a typical range).

Select a gear, apply the footbrake firmly and press the accelerator pedal to the floor. Do this slowly at first to make sure the vehicle will not move.

When the tachometer stops rising, ease off the accelerator pedal and note the reading. Do not hold the test for more than five seconds.

Select neutral and run the engine, at about 1000 rev/min for a minute or two, to cool off the transmission.

Repeat the previous three steps in each gear. Note the readings carefully each time.

A very low stall speed indicates a poorly performing engine. This can be caused by something as simple as incorrect ignition timing. A lower than specified stall speed indicates a poorly performing torque converter. The one-way clutch (sprag) may not be holding. When the engine stalls at a higher than normal speed, the clutch packs may not be holding. Pressure tests need to be run on the transmission to locate the fault. Check data for specific details.

Remove all test equipment and protection kit.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

175. Measure/Inspect automatic transmission system pressure.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain technical/procedural data from manuals and information from vehicle owner/driver.

Fit car protection kit as appropriate. Locate test specifications and test points in the manufacturer's manual. Connect a tachometer to the engine.

Check and top off the fluid level if necessary. Make sure the correct type of fluid is used.

Get an assistant inside the vehicle to operate controls as requested.

Raise the vehicle, on a wheel-free hoist, to a comfortable working height.

Make sure suitable extraction is fitted, and run the engine up to normal temperature.

Switch off the engine and connect a pressure gauge to the specified test port. Connect a vacuum gauge, using a 'T' piece, to the vacuum modulator or control diaphragm (if fitted).

NOTE: If you need to be under the vehicle to take pressure readings, take extreme caution because the driveline and wheels will be moving during the tests. The exhaust will also be very hot!

Start the engine and move the selector to the first test position. Run the engine at the specified revolutions per minute. Take the pressure and vacuum readings. Make a note of these readings for comparison to the manufacturer's data.

Reduce the engine speed and then press gently on the brake pedal to stop the wheels moving.

Connect the pressure gauge to other ports as specified and take readings as before.

Remove all test equipment and make sure the blanking plugs are refitted securely.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

176. Measure/Inspect automatic transmission brake bands.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: This is a generic procedure. There are differences in procedures between manufacturers and their models; always refer to specific instructions for the vehicle on which you are working.

Fit car protection kit as appropriate. Run the vehicle, on a road test if possible, until it is at normal operating temperature. A road test also warms the transmission.

Brake bands operate on to rotating drums. If the clearance is too large, individual drive ranges will not operate because the band will slip. If the clearance is too small, the result will be increased wear and overheating of the band.

Most adjustments are carried out externally. However, in some cases, it will be necessary to remove the transmission sump/pan and drain the oil.

Undo the lock nut, which is usually outside the adjusting screw.

Loosen the adjusting screw slightly and then tighten it back up by hand. Make sure the threads are clean if the adjuster is external, as this can affect the torque setting.

Fit a suitable torque wrench with adaptors as required and tighten the adjuster to the specified torque.

Repeat the previous three procedures on any other adjusters.

Alternative procedures include tightening the adjusters and then backing off a set number of turns, or using a dial gauge to set position of an adjuster.

Refit the pan (if removed), fill with the correct oil and then road test for correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

177. Road test vehicle for unknown faults in automatic transmission.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: It is important to obtain as much information as possible on the exact nature of the fault. If possible the driver should demonstrate the fault, or faults, to the technician.

Before the road test, check that the transmission is free from fluid leaks, and that the fluid level is correct. Check that the engine is able to develop full power. Check that the starter will only operate in P or N and that the reverse lights operate only in R.

Apply the brakes, and with the engine at normal idling speed, select N-D and N-R. Transmission engagement should be felt in each position selected.

Accelerate the vehicle with minimum throttle opening and note shift speeds. Compare to manufacturer's specification.

Check speed at which converter lock up occurs. This may be difficult to check, but is commonly noticed as a reduction in engine revs while accelerating similar to a gear change.

Accelerate the vehicle with full throttle opening and note shift speeds. Compare to manufacturer's specification.

When traveling in top gear at a speed above downshift speeds, depress the throttle to the kick down position and check for downshift.

Stop and select R. Reverse using wide throttle opening.

Stop vehicle facing downhill. Select P and check the transmission parking-pawl holds vehicle. Stop and select R, and reverse up the hill.

Turn vehicle round to face up the hill and stop. Check parking pawl holds vehicle.

Accelerate up the hill.

Note: During all of the above tests, check for slip and unusual noise from the transmission.

On return to the workshop, connect a scan tool to the appropriate serial connector. This will permit diagnosis of electronic transmission control system and retrieve any stored faults.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

Assignments

General Transmission and Transaxle Diagnosis

Task 1

a) Name the **four** main components of a single stage torque converter

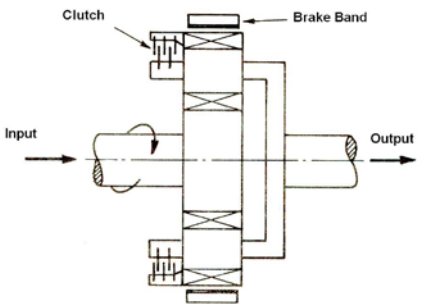
b) State the purpose of the stator and one-way clutch assembly in the operation of the torque converter

c) State the symptoms which would indicate the stator assembly rotates freely in both directions on its one-way clutch

Answer

Task 2

The picture shows a simple epicyclic gear train



a) Name the **four** component parts of the epicyclic gear train

b) State the direction and speed of the output shaft relative to the input shaft when the:

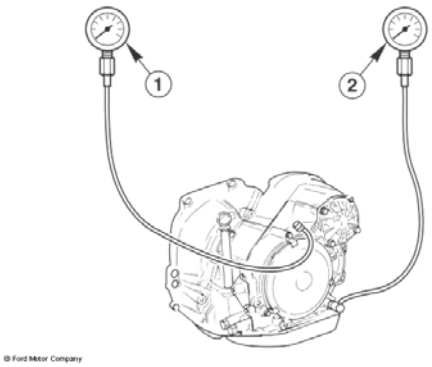
(i) brake band is applied and the clutch is released

(ii) clutch is engaged and the brake band released

Answer

Task 3

The picture shows a test being carried out on a transmission.



a) Name the test being carried out

b) Name **two** components within the transmission which can be tested with this equipment.

c) State **two** safety precautions which should be observed during this test

Answer

Task 4

a) Describe **one** method of checking the fluid level in an automatic transmission

b) Describe how an examination of fluid can be used to diagnose any **three** transmission faults

Answer

Task 5

A Stall Test is to be carried out on a vehicle. State

a) **four** essential safety precautions to be observed

b) how transmission fluid overheating can be avoided during the test

c) which transmission faults can be diagnosed by the test.

Answer

Task 6

A vehicle is to be road tested to identify transmission faults.

a) State **four** preliminary checks to be carried out before the road test.

b) Describe the symptoms that could be identified during a road test, for **each** of the following faults:

(i) leaking clutch servo

(ii) low transmission fluid level

(iii) excessive engine idle speed

(iv) incorrectly adjusted kick-down cable

Answer

Instructor Feedback:

Transmission and Transaxle Maintenance and Adjustment

Task 1

Describe a recommended procedure for adjusting and setting a manual selector cable.

Answer

Task 2

A throttle valve cable is to be removed and replaced on a vehicle.

a) List the tools and equipment required to carry out the task

b) Describe a procedure for the removal and replacement of the cable.

Answer

Task 3

State for each of the following, two symptoms that would indicate adjustment is necessary of the

a) throttle valve linkage

b) manual shift valve linkage

Answer

Task 4

A gear select indicator fails to illuminate. State six faults that could cause this symptom.

Answer

Task 5

Describe in sequence, a procedure for checking the transmission fluid level.

Answer

Task 6

The transmission fluid is diagnosed as overheating.

a) List four causes of transmission fluid overheating.

b) Name four components which could be affected by overheating transmission fluid.

Answer

Instructor Feedback:

In-Vehicle Transmission and Transaxle Repair

Task 1

Describe how electronic transmission control system faults can be diagnosed using a scan tool.

Answer

Task 2

Describe a procedure for inspecting, leak testing, flushing and replacing an automatic transmission oil cooler.

Answer

Task 3

State **two** reasons why each of the following may require replacement:

a) speedometer drive gear

b) speedometer driven gear

c) vehicle speed sensor

Answer

Task 4

State **three** symptoms that would indicate a need to inspect, repair or replace a governor assembly.

Answer

Task 5

State **three** typical locations/applications for each of the following within an automatic transmission:

a) gaskets

b) external seals

Answer

Task 6

Describe a procedure for inspecting, replacing and aligning powertrain mounts.

Answer

Instructor Feedback:

Off-Vehicle Transmission and Transaxle Repair

Task 1

The transaxle of a vehicle is to be removed, disassembled and overhauled. State **six** personal safety considerations which must be observed during the task.

Answer

Task 2

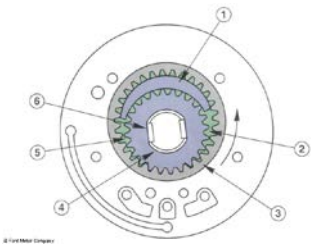
a) Name the chemicals/materials that may be hazardous to health which may be encountered during the dismantling and overhaul of a transmission.

b) Explain how **two** of these chemicals/materials should be handled, stored and disposed of in order to comply with local, state, and federal safety and environmental regulations.

Answer

Task 3

This picture shows a view of an engine oil pump.



a) State **three** clearances that should be measured to determine its serviceability.

b) State approximate values for each clearance given in your answer to a) above

Answer

Task 4

Name the equipment required to inspect and measure the following:

a) shaft end play

b) planetary gear assembly

c) transaxle link chain

Answer

Task 5

State **three** checks that should be made to **each** of the following during a transmission overhaul:

a) a servo assembly

b) an accumulator

Answer

Task 6

a) State **four** checks that should be made to a transmission case as part of an overhaul.

b) Apart from a cracked casing, state **two** faults which would render the casing unserviceable.

Answer

Instructor Feedback:

Engine Repair

Tasklist worksheets

178. Adjust valve clearances

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: OHV:

Run engine and listen for abnormal noises from top of engine. Check for misfire/cylinder balance. Disconnect battery earth/ground cable. Remove rocker cover.

Measure with feeler gauges all valve clearances at the 'back-of-the-cam' (heel) position. Check manufacturer's recommended procedure for positioning the engine e.g. rule of nine or valves rocking method.

Adjust each valve using a special tool or wrench and screwdriver as appropriate. Note that inlet and exhaust settings may vary.

Refit all and run engine to check for noise or misfire.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

179. Inspect and replace timing belt(s).

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Follow manufacturer's instructions exactly to ensure correct valve timing and belt tension. Risk of serious engine damage if the belt is incorrectly fitted.

Run engine and listen for abnormal noises from cam belt and tensioner. (Belt slap or bearing wear). Disconnect battery ground lead. Remove alternator and other drive belts to access cam belt cover. Remove cam belt cover and pulleys if necessary. Check for oil leaks onto the belt.

Turn engine in normal direction of rotation (DOR) until timing marks align. Insert locating pegs or locking devices if specified. If belt is to be reused mark DOR with an arrow in tire crayon for refitting in same direction.

Slacken tensioner and slide belt off toothed wheels. Inspect tensioner bearings and toothed pulleys for condition. Replace any leaking oil seals. (Refer to the engine lubrication-learning program).

Fit new or replace belt with tight side between the camshaft and crankshaft pulleys on DOR side. Slack side should be on tensioner side.

Check timing marks alignment. Adjust belt tension to manufacturer's specification. (General rule is a 90□ twist in the long side of the belt).

Remove pegs or locking devices if fitted. Turn engine through 2 or 3 full revolutions and recheck timing marks alignment and belt tension.

Replace cam belt cover, pulleys, belts (adjust) and battery ground lead. Start and run engine, check for abnormal noises from cam belt and tensioner. A whine indicates an over tightened belt or defective tensioner bearings.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

180. Routine maintenance inspections.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: General visual inspection - listen for abnormal noises.

Visual / oil level and condition. Replace oil and filter at specified intervals.

Visual / inspections for oil leakage.

Visual / inspection of exhaust smoke - at idle speed at mid-engine speed (3000 RPM) on overrun during road test.

Engine oil pressure test - check warning light operates (attach a pressure gauge and adapter and tachometer)

- pressure at idle speed
- stabilized pressure
- stabilized pressure engine RPM.

Crankcase ventilation system - check condition of hoses (visual and remove hoses and valves)

- orifice to inlet manifold clear
- air cleaner condition
- control valve condition.

Additional items - see manufacturer's schedule.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

181. Drain and top off coolant for winter usage or replace coolant.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain information from the driver on the frequency of topping off the coolant. Check coolant level. Check the water pump drive belt for condition and tension.

Pressure test the cooling system and the radiator cap. Look for leakage, condition of hoses, the pressure cap operating pressure, seals and vacuum valve. Report any defects and recommend rectification before adding new coolant.

Identify the coolant drain points in the radiator and engine block. Undo and drain coolant into a clean drain tray. Dispose of old coolant in accordance with local environmental regulations. Close the radiator and engine block drain taps or plugs.

Mix new coolant to the specified mixture of water and antifreeze with inhibitors or use a premixed coolant. Do not exceed a 50% to 60% ethylene glycol content as this does not improve the frost protection. (Over 70% reduces the protection).

Add coolant to the radiator until the system is full. Open bleed screws to allow air to flow from the system.

Run the engine and bleed air from the heater or high point in the system if required. Follow the engine manufacturer's instructions. Visually check for leaks.

Road test and check the operation of the cooling system and the heater temperature range. Check the operation of the engine coolant temperature gauge.

After road testing, visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

182. Remove and reinstall engine (RWD) without transmission (OBDI or newer).

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain crane, sling and lifting eyes with a SWL in excess of engine weight. Disconnect battery earth/ground cable. Fit lifting eyes to engine as per manufacturer's instructions.

Label and disconnect all electrical cables to engine including engine ground cable. Label and disconnect all vacuum pipes to engine. Remove air intake ducting and air cleaner, blank off open pipes. Depressurize, label and disconnect fuel lines to engine, blank off pipes. Label and disconnect throttle/choke and other control cables. Disconnect exhaust down pipe at manifold flange.

Remove, if necessary, the starter motor and clutch operating mechanism (cable or hydraulic). Slacken all clutch housing bolts and remove all but two, one either side. Slacken and remove, if safe to do so, the engine mounting nuts from the underside of vehicle.

When all underside work is completed, drain the coolant and remove radiator and all hoses. When air conditioning is fitted, do not disconnect refrigerant pipes/hoses before removing refrigerant. (Specialist task). If possible, remove and support the compressor with hoses attached.

Attach sling to lifting eyes and crane, tension sling. Check all connections to engine have been disconnected. Remove engine mounting nuts/bolts if not already removed. Operate crane to lift engine clear of mountings. Put a jack under the gearbox and lift slightly. Remove remaining clutch housing bolts. Pull engine forward away from the gearbox. Lift slowly and steadily making sure that the engine does not get caught in the compartment. Before replacing the engine, check the alignment of the clutch center plate and spigot (pilot) bush or bearing in the crankshaft. Check the engine to clutch housing locating dowels are in place. Select first or second gear in the gearbox.

To replace, carefully lower the engine into the compartment and push onto the gearbox. Keep the engine and gearbox square and centralized. Rotate the engine crankshaft to align the clutch and gearbox input shaft splines.

Push the engine fully home onto the locating dowels and fit two bolts to clutch housing and tighten. Remove the jack from under the gearbox and lower engine into the mountings. Fit and tighten engine mounting nuts/bolts and remove crane and sling.

Replace all components in reverse order. Make a systematic check of all components for correct fitting and security. Road test and recheck under hood.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

183. Remove and reinstall transverse engine and transmission (FWD) with crane.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain crane, sling and lifting eyes with a SWL in excess of engine weight. Disconnect battery earth/ground cable. Fit lifting eyes to engine as per manufacturer's instructions.

Label and disconnect all electrical cables to engine including engine ground cable. Label and disconnect all vacuum pipes to engine. Remove air intake ducting and air cleaner, blank off open pipes.

Depressurize, label and disconnect fuel lines to engine, blank off pipes. Label and disconnect throttle/choke and other control cables. Disconnect exhaust down pipe at manifold flange.

Disconnect the gear change remote linkage at the gearbox. Remove the speedo drive cable. Disconnect the clutch cable or hydraulic cylinder complete with pipes. Remove the drive shafts from the final drive (catch oil). Fit dummy shafts to retain sun wheels.

Slacken and remove, if safe to do so, the engine mounting nuts from the underside of vehicle.

When all underside work is completed, drain the coolant and remove radiator and all hoses. When air conditioning is fitted, do not disconnect refrigerant pipes/hoses before removing refrigerant. (Specialist task). If possible, remove and support the compressor with hoses attached.

Attach sling to lifting eyes and crane, tension sling. Check all connections to engine and gearbox have been disconnected. Remove engine mounting nuts/bolts if not already removed. Operate crane to lift engine clear of mountings.

Lift slowly and steadily making sure that the engine and gearbox do not get caught in the compartment.

To replace, carefully lower the engine and gearbox into the compartment and locate onto the engine mountings. Fit engine mounting nuts/bolts and tighten. Remove crane and sling. Refit drive shafts and check and top off gearbox oil.

Replace all components in reverse order. Make a systematic check of all components for correct fitting and security. Start and run engine, bleed cooling system, if necessary, check for correct operation.

Road test and recheck under bonnet.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

184. Remove and reinstall transverse engine and transmission onto trolley.

(Includes front sub frame and suspension, OBD1 or newer)

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Place vehicle on a suitable lift with the lifting points correctly positioned (see workshop manual). Obtain special or suitable trolley.

Disconnect battery ground cable. Underneath the vehicle remove exhaust down pipe, gear change linkage, speedo cable, clutch control cable or hydraulics, steering column coupling and brake connections (hoses or pipes). Blank off pipes.

Under the hood label and disconnect electrical terminals, vacuum connections, fuel feed and return pipes (plug or cap pipes), air ducting, throttle and other control cables. Drain coolant and remove radiator and hoses.

When air conditioning is fitted, do not disconnect refrigerant pipes/hoses before removing refrigerant. (Specialist task). If possible, remove and support the compressor with hoses attached.

Check all connections to the engine, transmission and sub frame have been disconnected.

Lower vehicle so that the sub frame rests on the trolley. Undo and remove sub frame to chassis mounting bolts. CHECK THAT BOLTS ARE NOT SUPPORTING A LOAD BEFORE REMOVAL.

Carefully lift the vehicle away from the sub frame, watching that the engine and transmission does not catch in the engine compartment.

Refit and reassemble in the reverse order. Tighten all nuts/bolts to specified torque settings. Make a systematic check of all components for correct fitting and security.

On - bleed and check brakes. Completion - check front wheel alignment. Run the engine, bleed cooling system, if necessary, and check for correct operation.

Road test and recheck all work under the vehicle and under the hood.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

185. Inspect and replace pans, covers, gaskets and seals.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery ground cable.

Paper gaskets - remove cover/housing and clean old gasket material and sealant from both gaskets faces. Check faces for flatness, rectify as necessary. Fit new gasket with sealant, if specified, refit bolts and tighten to specified torque.

Rubber gaskets - remove cover/housing and clean old gasket material from both faces. Check gaskets faces for flatness, rectify as necessary. Fit new gasket without sealant to clean and dry faces, refit bolts and tighten until gasket is pinched. Do not over tighten.

Cork gaskets - remove cover/oil pan and clean old gasket material and sealant from both gaskets faces. Check faces for flatness rectify as necessary. Fit new gasket with sealant, if specified, refit bolts and tighten to specified torque and in sequence.

Formed in place gaskets (tube applied) - remove cover/oil pan and clean old gasket sealant from both faces. check faces for flatness, rectify as necessary. Apply sealant bead gaskets as per manufacturer's instructions. Fit and torque in sequence within 3 minutes.

Oil seals - these are used with gaskets for sealing around bearing caps and oil molded rubber pans. Fit with recommended sealants or dry and then fit other types gaskets and oil pan. Fit and torque bolts in sequence. Check seals do not squeeze out.

Oil seals (lip) - remove pulley from housing and inspect seal land. Use a special tool to extract the seal. Press in new seal to shoulder or specified depth. Lubricate (in block) seal with clean engine oil. Clean and lubricate seal land, refit pulley and torque bolt.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

186. Remove and replace pistons and connecting rods - strip and reassemble.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Strip engine to access pistons, remove cylinder head and sump (oil pan). Check piston crown for front of engine marks (clean and mark if necessary). Check big end bearing caps and connecting rods for position (No 1,2, etc.) and the side toward the front of the engine. If not marked, mark with dots with a center punch or similar.

Undo and remove big end bearing cap bolts and remove bolts and caps. Tap connecting rods with a wooden block to push pistons upward and out of the engine block. Pull through and lay out in order. Inspect cylinder bores, pistons and piston rings for condition. Follow the manufacturer's instructions for separating the pistons from the connecting rods. (Remove circlips and push piston pin through the piston and little end bush.) (Press out the piston pin using special support and mandrel and a hydraulic press.)

Inspect connecting rods and big end bearings. (Press out little end bushes and press in new bushes - ream to size, if necessary.) Fit piston to connecting rod matching front marks on piston and connecting rod. Push through piston pin (heat piston in hot water if necessary) and fit circlips. Hold connecting rod in a vice and heat the little end to pale straw color. Locate piston over connecting rod matching front marks, quickly push the piston pin through the little end and centralize before the connecting rod cools and clamps the pin.

If new rings are being used on old pistons, clean the ring grooves. Use either a special tool or pieces of old rings as scrapers. Take care not to remove any metal but do remove all the carbon deposits. Remove cylinder wall ridge or use a ridge dodger top ring set.

Check the compression ring gaps in the cylinder bores. Push down with piston crown to square the ring in the cylinder. Measure with feeler gauges and file ends to increase gap if necessary. Hold connecting rod in a vice to support the piston and fit the piston rings, position ring gaps. Fit big end bearings to connecting rods and caps; locate tangs and oil way holes. Check bearing 'nip' by assembling cap and rod finger tight and measure gap between rod and cap. Remove cap and lubricate bearings, little ends, piston rings and cylinder walls with oil.

Offer a piston into its bore, match front to front, and fit a piston ring clamp around the rings and ring land. Tighten the clamp sufficiently to press the rings into the grooves but still allow the piston to be tapped through with light force from a wood block into the cylinders. Connect the big end to crankshaft journal, fit cap and tighten to specified torque, check that the engine rotates. Repeat with other pistons and check engine rotation after each big end is tightened. Make a systematic check of all components for correct fitting and security.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

187. Remove and replace crankshaft, vibration damper, flywheel and clutch pilot bush/bearing.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove gearbox and clutch, strip underside of engine, oil pan and front cover to access crankshaft. Check and record the end float on the crankshaft.

Undo front pulley/vibration damper bolt. (Lock flywheel to aid undoing of bolt). Pull off pulley/damper and inspect seal land and pulley vee faces. Remove the front cover and timing belt or chain. Check and mark direction of rotation and timing. Remove bolts securing the flywheel/flex plate/drive plate and carefully remove flywheel taking weight in both hands. Remove rear main oil seal housing. Inspect flywheel.

Check the big end and main bearing caps for position (No 1,2, etc.) and side to the front of engine. If not marked, mark with dots with a center punch or similar. Remove big end bearing caps and lay out in order. Remove main bearing caps and lay out in order. Lift out crankshaft. If working below vehicle remove center bearing and crankshaft together.

Inspect crankshaft for surface cracks and journal damage. Remove all bearing shells if they are to be replaced. Check oil passage condition. Measure journal wear. Fit new bearings into connecting rods and main bearings caps, locate tangs and oilway holes. Check new bearings for 'nip' by assembling finger tight and checking cap gap with feeler gauge.

Pull out clutch pilot bearing from crankshaft. If a bush, fill with grease and punch in with a suitable mandrel to push out bush. Otherwise use special puller. Check new bearing fits gearbox input shaft and then fit into crankshaft. There is no bush/bearing on some transaxles and auto gearboxes. Fit new oil seals to front and rear housings or around crankshaft if appropriate. Lubricate all bearings and journals with clean engine oil. Fit crankshaft into main bearings in the block. Check end float.

Fit main bearing caps and tighten the bolts to the specified torque and check engine rotation. Fit big end bearing caps and tighten to torque and check engine rotation. (Fit timing chain). Fit front and rear main covers, centralize and tighten bolts in sequence and to torque. Fit flywheel/drive plate to dowels and fit bolts, apply sealant or thread locking compound, if specified. Tighten bolts in sequence and to torque. Check run out. Fit timing belt and pulleys and covers. Fit pulley/vibration damper.

Before fitting new oil filter PRIME the pump with clean engine oil through the oil feed hole to the oil filter. Fit filter.

Make a systematic check of all components for correct fitting and security. Fit gearbox, sump/oil pan and other components. Fill engine with oil, start and run engine and check for correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

188. Remove cylinder wall ridges and hone cylinder walls.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Strip engine to bare block. Measure cylinder bores for acceptable wear limits for replacement pistons and/or rings.

Use special equipment ridge cutter to remove ridge at the top of the cylinders above the top piston ring.

Use cylinder honing tool fitted to a suitable power drill. Lubricate cylinder as per the honing manufacturer's instructions (kerosene or dry). Offer the honing tool cutters into a cylinder and operate the drill, move up and down to remove the glaze and provide a surface for the new piston.

(If new piston rings are fitted to a piston in a cylinder that does not have the wear ridge removed it is necessary to fit a ridge dodger top piston ring).

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

189. Remove and replace cylinder heads OHV

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check permissible conditions for head removal - allow engine to cool if required. Disconnect battery ground cable.

Label and remove all electrical terminals to components on cylinder head and manifolds. Label and remove all vacuum pipes/hoses to cylinder head and manifolds. Remove distributor cap and spark plug leads.

Obtain a clean drain tray and drain engine coolant. Remove radiator, top, bypass and heater hoses.

Remove air intake ducts, air cleaner, and PCV hoses as necessary, etc. Label and remove throttle and choke cables... Remove carburetor/monopoint injector body/inlet manifold and injectors - blank off all fuel pipes.

Remove exhaust at down pipe flange or manifold to head, pull clear of cylinder head.

Remove rocker cover and rocker shaft. Shake the push rods to free them from the followers. Remove push rods and store in order (drilled block or similar) so that they can be replaced in exactly the same positions.

Working in the reverse order to the tightening sequence, undo the cylinder head bolts by a small amount (1/4 of a turn). Fully undo and remove head bolts. Lay out in order if the bolts are reusable. Note any bolts that do not run cleanly in their threads. Clean threads.

Lift off cylinder head (twist first if wet liners are fitted). Clean faces of the cylinder head and block and inspect. Plug water jacket to prevent particles of dirt entering.

Fit new cylinder head gasket - follow manufacturer's instructions - use guide studs if necessary. Lower head into place on locating dowels. Fit head bolts and do up finger tight.

Follow manufacturer's instructions for head bolt tightening sequence and torque settings. Refit push rods, rocker shaft and rockers; adjust valve clearances (lash). Refit rocker cover. Refit exhaust, inlet, fuel electrical and coolant components. Top off coolant. Run engine, bleed heater if necessary, recheck coolant level and coolant circulation. Listen to engine for abnormal noises and oil/coolant leaks and operation of warning lights/gauges.

Road test and check operation of engine, coolant temperature, heater operation, etc. Recheck after road test inside engine compartment for oil/coolant leaks, security of all disturbed components and fittings and cleanliness - rectify and recheck if necessary.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

190. Remove and replace cylinder heads OHC.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check permissible conditions for head removal - allow engine to cool if required. Disconnect battery ground cable.

Label and remove all electrical terminals to components on cylinder head and manifolds. Label and remove all vacuum pipes/hoses to cylinder head and manifolds. Remove distributor cap and spark plug leads. Obtain a clean drain tray and drain engine coolant. Remove radiator, top, bypass and heater hoses.

Remove air intake ducts, air cleaner, and PCV hoses as necessary, etc. Label and remove throttle and choke cables... Remove carburetor/monopoint injector body/inlet manifold and injectors - blank off all fuel pipes. Remove exhaust at down pipe flange or manifold to head, pull clear of cylinder head. Remove cam housing cover and gasket.

Remove front/camshaft drive belt cover - mark direction of rotation (DOR) on belt and turn engine to align timing marks. Slacken tensioner and remove belt. DO NOT TURN the crankshaft or camshaft before the head is removed. Return to this position before the head is replaced.

Working in the reverse order to the tightening sequence, undo the cylinder head bolts by a small amount (1/4 of a turn). Fully undo and remove head bolts. Lay out in order if the bolts are reusable. Note any bolts that do not run cleanly in their threads. Clean threads. Lift off cylinder head (twist first if wet liners are fitted). Clean faces of the cylinder head and block and inspect. Plug water jacket to prevent particles of dirt entering.

Fit new cylinder head gasket - follow manufacturer's instructions - use guide studs if necessary. Check and position crankshaft and camshaft to align timing marks. Lower head into place on locating dowels. Fit head bolts and do up finger tight. Follow manufacturer's instructions for head bolt tightening sequence and torque settings. Refit camshaft drive belt, check timing marks align; tension belt and rotate 2/3 revolutions, recheck timing and belt tension. Fit cam housing cover with new gasket.

Refit exhaust, inlet, fuel electrical and coolant components. Top off coolant. Run engine,
bleed heater if necessary, recheck coolant level and coolant circulation. Listen to engine for abnormal noises and oil/coolant leaks and operation of warning lights/gauges.

Road test and check operation of engine, coolant temperature, heater operation, etc. Recheck after road test inside engine compartment for oil/coolant leaks, security of all disturbed components and fittings and cleanliness - rectify and recheck if necessary.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

191. Remove and replace valves, seals, springs and retainers, re-cut valves and valve seats.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove cylinder head and camshaft on OHC engines.

Clean cylinder and block faces. Clean combustion chambers in head and piston crowns.

Lay the cylinder head on wooden blocks and lightly tap each valve stem to free the valve keepers.

Lay cylinder head on side and using a suitable valve spring compressor, compress spring and remove the keepers. Release the spring compressor and remove the valve spring and retainers. Remove valve stem oil seal.

Check valve stem to valve guide clearance by rocking the valve in the guide. Remove the valve and lay out in order. (Drilled block). Repeat with all other valves. Check valve spring squareness, pressure and free lengths. Inspect valve spring retainers, locks and valve grooves.

Clean valve ports and valve heads with rotary wire brushes. Check valve seat and valve seat inserts for condition and security. Check valve guide condition and position. Check gasket surface for warpage and leakage. Check oil and coolant passage condition. Visually inspect for cracks.

Re-cut the valve seats using special equipment. Reface valve faces if suitable or replace with new valves. Lap valves to seats if permissible. Some valves are coated and cannot be lapped to the seat.

Clean all traces of paste from valves and seats. Lubricate the valve guides with clean engine oil. Fit new valve stem oil seals - lubricate seal face.

Fit valves into correct guides - fit springs and retainers - secure with keepers. Tap all valve stem heads to settle keepers. Check valve spring assembled height.

Refit cylinder head and adjust valve clearances. Road test and check engine performance, etc....

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

192. Remove and replace rocker shaft, pedestals and rockers, strip and rebuild.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery ground cable.

Remove rocker cover and make a general inspection of the rocker shaft assembly for obvious damage, wear and oil feed.

Remove bolts securing the rocker shaft pedestals to the cylinder head. Lift off the rocker shaft. Shake the push rods to free them from the cam followers, remove and inspect. Keep in order.

Remove retaining clip/pin/collet from end of rocker shaft and the rocker, pedestal and rocker until the shaft is stripped. Keep all parts in order during removal, storage and reassembly.

Inspect all parts for wear and condition - rectify or replace as necessary. Inspect and clean oil drillings in shaft and rockers. Replace and ream rocker bushes if required, reface rocker to valve pads.

Lubricate all parts before and during assembly with clean engine oil. Reassemble shaft in reverse order - secure with a new clip/pin/collet.

Reassemble to engine - tighten bolts to specified torque. Adjust valve clearances.

Refit rocker cover and battery ground cable.

Start and run engine - allow to warm up - readjust valve clearances if adjusted hot. Listen for abnormal noises. Road test and recheck.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

193. Remove and replace cam followers including hydraulic tappets.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Run engine and listen for abnormal noises from valve mechanism. Strip engine to access cam followers - in side of engine (OHV) or in cylinder head (OHC).

Alternatives - remove push rods and side covers - lift out followers. OHV - remove cylinder head and lift out followers - remove inlet manifold and covers (Vee engines) and lift out followers.

Alternatives - cam in head and rocker actuation - remove rockers which are cam followers OHC - direct acting cams require removal of the camshaft to access cam followers.

Check cam followers before removal, for free play across the bore and that the follower is free to rotate.

Lift out followers and lay out in order (they must be replaced in exactly the same position). Check thrust faces and sides of cam followers and the cam lobes. Inspect for signs that indicate that the follower has or has not been rotating.

For hydraulic tappets/followers check oil feed holes in the block/head/tappet are clean. Follow the manufacturer's instructions for stripping and inspecting hydraulic tappets.

Lubricate all parts before and during assembly with clean engine oil. Replace followers/tappets in correct position. Reassemble other components in reverse order. Check and adjust valve clearances.

Refit any other parts and battery ground cable.

Start and run engine - check for correct operation.

Road test and recheck.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

194. Remove and replace and adjust OHC tappets with shim/spacer adjustment.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Run engine and listen for abnormal noises from top of engine. Check for misfire/cylinder balance. Disconnect battery earth/ground cable. Remove cam-housing cover.

Measure with feeler gauges all valve clearances at the 'back-of-the-cam' (heel) position. Record all dimensions and note if inlet or exhaust if they have different clearances specified.

Remove the camshaft - follow the manufacturer's instructions. Lift out the cam followers and keep in exact order.

Working with one follower at a time, remove and measure with a micrometer the thickness of the spacer/shim. Record the dimension and then add or subtract a correction to give the correct clearance.

Select a replacement spacer/shim to the corrected dimension. Measure with a micrometer to check that it is correct and fit to follower.

Repeat with all other followers.

Lubricate all followers before and during assembly with clean engine oil. Refit into bores over valves - keep in strict order.

Refit the camshaft and tighten securing bolts to specified torque/sequence. Check all valve clearances are now correct - if not strip and rectify any errors. Reassemble and recheck.

Rebuild and check that the engine starts and runs. Listen for correct operation. Road test and recheck.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

195. Remove and replace chain driven camshaft drives on OHV and OHC engines.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Run engine and listen for abnormal noises (clatter/tapping at front of engine). Disconnect battery ground cable. Strip to access chain cover, either in situ or with the engine removed.

Remove crankshaft pulley and chain cover. Look at general condition for lubrication and tension. Check for mark or mark direction of rotation (DOR) on chain (paint mark).

Turn engine in DOR to align the timing marks on the sprockets. Remove or release the chain tensioner.

Undo sprocket-retaining bolts on the camshaft (lock the camshaft to prevent rotation). Pull off the sprocket and chain and remove the chain from the crankshaft sprocket.

If multiple chains are used - remove second chain linking to OHC. DO NOT TURN THE ENGINE UNTIL THE CHAINS ARE REPLACED.

Inspect chains, sprockets and tensioners. Check oil feeds are clear.

Refit chains and sprockets ensuring correct DOR and that timing marks align. Ensure location of pegs/dowels or other location devices. Torque bolts and lock securing devices (tab washers).

Refit or replace tensioner and release tensioner spring or adjust as per the manufacturer's instructions. Lubricate chain with clean engine oil. Check timing marks still align.

Turn engine through 2 or 3 full revolutions and check timing marks alignment and chain tension.

Refit chain cover with a new gasket and sealant if specified. Align the cover to the crankshaft with a special tool to centralize the oil seal. Fit bolts and tighten to specified torque/sequence. Remove centralizing tool.

Lubricate seal lips with clean engine oil and fit crankshaft pulley. Tighten bolt to specified torque. Reassemble all other components.

Start and run engine - check operation. Road test and recheck.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

196. Remove and replace camshaft and bearings (OHV) and auxiliary shafts and bearings.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Strip engine to access camshaft, remove push rods and cam followers, timing chain and camshaft sprocket and oil pan. (Remove distributor and oil pump drive gears if necessary.)

Check camshaft end float with feeler gauges or dial test indicator (dti). Undo securing bolts on camshaft retaining plate, remove plate and inspect for wear, particularly if end float is excessive.

Pull camshaft forward out of bearings - use care to avoid damage to the bearings. Inspect bearing journals, cam lobes and gear teeth on the camshaft. Inspect the bearings (bushes) for condition.

To remove the bearings, use the special tools and follow the manufacturer's instructions. It may be necessary to remove a plug to gain access to the rear bearing.

Fit a new set of bearings with the special tools and ream or scrape if specified.

Lubricate all bearings with clean engine oil. Feed the camshaft carefully through the bearings.

Fit the retaining plate and measure the end float, compare with the specification - replace if the end float is not within tolerance. Torque bolts.

Fit the drive chain and sprockets and check that the timing marks are correctly aligned. Turn engine for 2 or 3 complete revolutions and recheck timing and chain tension.

Rebuild the engine - run and check for abnormal noises and correct operation. Road test and recheck under hood for abnormal noises and oil leaks etc.

The procedure for auxiliary and balance shafts is similar to the above procedure for camshafts.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

197. Inspect camshaft lobes, journals and bearings, auxiliary shafts, bearings and drive mechanisms.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Strip to access the camshaft. Check the end float before removing.

Remove camshaft and visually inspect for condition of bearing journals and cam lobes. Inspect retaining/thrust plate for wear.

Inspect bearings in the engine block or head. Look for wear, scoring, pitting, or other deterioration.

Lay the camshaft in oiled paper supports in vee blocks on a surface table. Assemble a dial test indicator (dti) to a base and zero on center journal. Rotate shaft and observe variation in needle position to indicate if the shaft is bent.

Measure and record cam lift on all lobes. Compare with manufacturer's data.

Measure cam journals with external micrometer and record results. Measure for ovality. Measure internal dimensions of bearings and record. Compare readings with manufacturer's data for size and wear tolerances.

Reassemble shaft and other components. Run engine and listen for abnormal noises.

The inspection of auxiliary shafts is a similar procedure.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

198. Remove and replace oil pumps and drive mechanisms - time oil pump and distributor shaft.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: PLAN obtains technical/procedural data from manuals and information from vehicle owner/driver. Strip engine, as necessary, to access the oil pump and drive mechanism.

OIL PUMP DRIVES DISTRIBUTOR - If the oil pump and the distributor share the same drive from the camshaft, position the engine so that No1 cylinder is at tdc on the compression stroke. Remove the distributor cap and mark or record the position of the distributor and rotor arm.

Remove the distributor and record the position of the drive dogs (large 'D' position). Replaced oil pump must return to this position when reassembled. On the underside of the engine disconnect and remove the oil pick up pipe and strainer. Undo and remove the oil pump securing bolts and remove the pump. Clean old gasket from mating faces. Strip and inspect pump.

Refit pump with new gasket or 'O' ring and sealant ONLY if specified. Turn drive gear to the timing position and ease home on the camshaft gear. Check the 'D' drives dog position in the distributor-housing bore. Correct if necessary by pulling back and turning the gear appropriately.

When the distributor drive is correctly positioned fit and tightens the securing bolts to the specified torque. Fit the pick-up pipe and strainer using new seals and tighten securing bolts. Refit the distributor and set ignition timing. Finally adjust timing when the engine is running

OIL PUMP NOT TIMED - If the oil pump is driven from the crankshaft or camshaft or an auxiliary shaft independently of the ignition system, the pump drive mechanism need not be timed.

Remove pick up pipe and strainer if necessary. Undo oil pump securing bolts and remove. Clean old gaskets or 'O' rings from pump and engine. Strip and inspect oil pump. Prime new pump with clean engine oil. Fit new gaskets or 'O' rings and sealant ONLY if specified. Turn drive to locate with drive gear, dog or 'D' drive and fit pump. Fit and tighten securing bolts to specified torque.

Reassemble engine and top up with engine oil. Before fitting new oil filter PRIME the pump with clean engine oil through the oil feed hole to the oil filter. Fit filter.

Start and run engine - if oil warning light does not go out in normal time stop the engine and investigate. Look under the engine for oil leaks as soon as the oil warning light goes out

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

199. Remove and replace oil filters, oil coolers and turbo chargers.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: PLAN obtains technical/procedural data from manuals and information from vehicle owner/driver. Allow engine to stand and cool down before starting work. Components can be very hot. Disconnect battery ground lead.

Place a drain tray below work area to catch oil. Use a small tray/container to catch oil immediately below work area.

Many oil feed pipes and hoses are held with a union nut. Use two spanners, one to hold the pipe or hose or connector and the other to undo the union nut. Undo the highest point first to allow the pipe/hose to drain before removal.

Undo the lowest point and catch lost oil and with draw the pipe/hose. AVOID bending or distorting pipes.

Drain coolant from cooling system to oil circuit heat exchangers and disconnect hoses. Undo securing bolts on all types of oil coolers/heat exchangers and remove.

Refit oil coolers/heat exchangers, refit and tighten securing bolts.

Refit pipes/hoses by assembling both ends before tightening. Check the alignment and routing of the pipe/hose before tightening the union nuts. Use two spanners, one to hold the pipe, hose or connector and the other to do up the union nut.

Check and top off oil (and coolant) level.

Run engine and check for oil (coolant) leaks.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

200. Remove and replace oil pressure switch and oil pressure gauge sender units.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: PLAN obtains technical/procedural data from manuals and information from vehicle owner/driver. Allow engine to stand and cool down before starting work. Components can be very hot. Disconnect battery ground lead.

Place a drain tray below work area to catch oil. Use a small tray/container to catch oil immediately below work area.

Disconnect the electrical feed to the oil pressure switch or electronic sensor. Undo the switch using a spanner on the hexagon at the end of the threaded insert to the oil gallery.

Carry out a pressure test if low oil pressure is suspected. This tests would be sensible but not required if the oil switch were being replaced because of leakage.

Refit by screwing in the new switch or sensor until it is tight in the tapered thread or tight on a new sealing washer.

Reconnect the battery and run the engine to check the operation of the warning light or pressure gauge. Check the switch for oil leaks.

Check and top off oil level.

The oil level sensor will be located in the engine block or oil pan. Look up and follow the manufacturer's instructions for this task.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

201. Remove and replace hoses including radiator, heater and bypass hoses.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery ground lead. Drain the coolant into a clean drain tray.

Undo the hose clips and slide along the hose. If the hose is not free on its connector insert a blunt blade (screwdriver or special tool) under the lip of the hose and ease round to break the seal.

Pull the hose off from the connector. Take care with radiator couplings as these can be damaged by the use of excessive force.

Transfer or fit new hose clips to the hose for replacement. Fit the new hoses with a sealant on the joint if recommended, otherwise a dry joint will give a good seal. Slide the hose clips into place and tighten.

Refill the cooling system. Top off with a correct water and antifreeze mixture to make good any spilt or lost coolant during draining. Run the engine and bleed air from the system if necessary.

Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings.

After road testing, visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

202. Remove and replace drive belts and pulleys.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Identify the drive belt for the water pump - V, serpentine or toothed belt for the camshaft drive.

For water pumps driven by the camshaft drive toothed belt follow the manufacturer's instructions to access the belt. Match the timing marks or fit the locating dowels or pegs and mark the direction of rotation on the belt before removing.

For timed and non-timed belts slacken the tensioner and remove the belt. The tensioner may be a tensioning pulley or may be linked to a component such as the alternator. Remove any other component that prevents removal of the belt. Lift off and remove the belt.

Fit the new belt and adjust the tension to the manufacturer's specification. For vee belts the correct tension is usually about 13 mm or 1/2 inch of free play on the longest side. For toothed belts use a tension gauge or adjust so that the belt can be twisted through 90° on the long side.

Tighten the tensioner securing bolts. Refit other components in reverse order. Run the engine and check for abnormal noises. A whine would indicate that the belt tension is too tight and a slapping noise of the belt against the cover indicates that the belt is too loose.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

203. Remove and replace thermostat.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Drain the coolant into a clean drain tray.

Undo the bolts holding the thermostat housing and remove the bolts and housing. For thermostats fitted in hoses or integrated in housings remove the hose or housing.

Lift out the thermostat and inspect the thermostat housing gasket and the thermostat seal for signs of leakage and other deterioration. Test the thermostat if required.

Clean and inspect the thermostat housing and cover mating faces. Inspect for flatness with a straight edge or surface table. Rectify if necessary.

Fit the thermostat into the housing with new seals, if required. Fit the cover with a new gasket and sealant, if recommended, or grease. Fit the securing bolts with a thread sealant if they pass into the water passages and tighten to the specified torque.

Refill the cooling system. Top off with a correct water and antifreeze mixture to make good any spilt or lost coolant during draining. Run the engine and bleed air from the system if necessary.

Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings.

After road testing, visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

204. Remove and replace water pump and engine driven fan.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Drain the coolant into a clean drain tray. Identify the location of the water pump and drive belt arrangement.

For water pumps driven by the camshaft drive toothed belt follow the manufacturer's instructions to access the belt. Match the timing marks or fit the locating dowels or pegs and mark the direction of rotation on the belt before removing.

For engine driven fans attached to the water pump drive pulley, undo the securing bolts and pull off the fan. For some thermostatic viscous fans the hub will have to be drawn from the spindle after the water pump has been removed.

For timed and non-timed belts slacken the tensioner and remove the belt. The tensioner may be a tensioning pulley or may be linked to a component such as the alternator. Remove any other component that prevents removal of the belt. Lift off and remove the belt. Undo and remove the securing bolts for the water pump. Keep in order so that they are returned to their original positions - many vehicles have different length bolts around the water pump.

Ease out the water pump. They can be tight when corrosion has bonded the pump into the engine block. Use a penetrating fluid and lever out or twist carefully to release the tightness. If very tight check that all bolts have been removed!

Check the gasket for signs of leakage. Where bolts run into the water jacket check that the threads are clean and that the bolts run freely. Clean threads if necessary. Clean and check that the mating faces are in good condition.

Refit the pump using a new gasket or seal and a soft setting sealant on the gasket and all bolts that run into the water passages. Tighten bolts to manufacturer's specifications. Refit the drive belt and adjust the tension to the manufacturer's specification. For V belts the correct tension is usually about 13 mm or 1/2 inch of free play on the longest side. For toothed belts use a tension gauge or adjust so that the belt can be twisted through 90° on the long side.

Refill the cooling system. Top off with a correct water and antifreeze mixture to make good any spilt or lost coolant during draining. Run the engine and bleed air from the system if necessary.

Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings. After road testing, visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

205. Remove and replace radiator and electric fan motor and switches.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Drain radiator coolant into a clean drain tray.

Undo and remove top, bottom and expansion tank hose clips and pull off hoses.

Disconnect the electrical terminal block to the motor and switch. Leave the cowl, motor and switch in place. Remove the radiator and cowl as an assembly.

For radiators with integral transmission oil cooling, clamp the feed and return hoses, undo the hose clips and pull off the hoses. Catch the lost oil in a clean drain tray. OR undo the union nuts on steel pipes and remove the pipes. Catch the lost oil in a drain tray.

For radiators with an air conditioning radiator or condenser attached to the cooling radiator, undo the attaching screws and support the condenser. DO NOT undo the air conditioner refrigerant pipes unless the system has been discharged (specialist operation).

Undo and remove the radiator securing bolts and remove with the brackets. Carefully lift out the radiator assembly.

Detach the cowl, motor and fan from the radiator. Mark all bolts or screws for replacement in exactly the same places. Unscrew the switch from the radiator.

Reassemble in the reverse order. Ensure that the correct bolts or screws are replaced in their original positions. Some bolts may be longer than others and can puncture the radiator if fitted incorrectly.

Refill the cooling system. Top off with a correct water and antifreeze mixture to make good any spilt or lost coolant during draining. Run the engine and bleed air from the system if necessary.

Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings.

After road testing, visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

206. Perform visual and aural checks on running engine.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Lift hood - general impression - check oil and coolant levels. Start engine from cold and carry out checks as engine warms up.

Check cooling system operation as engine warms up. Check top hose remains cool until engine is hot and then top hose should suddenly heat up as the thermostat opens. Electric fan operation follows when the engine temperature rises higher - keep hands clear of fan.

Check fast idle speed (engine cold) and idle speed (engine hot).

Look at the color of the exhaust smoke, blip throttle and watch for changes.

Increase engine speed to about 3000 rpm and hold for 20 - 30 seconds - watch exhaust smoke. Release throttle to allow engine to idle - watch exhaust smoke on deceleration.

Look for oil leaks and oil flow from areas of leakage.

Look at engine security when blipping throttle - look for excessive movement. Listen for exhaust knocking on body/chassis.

Listen for abnormal noises - belt slipping squeal, scream/squeal from loose or leaking exhaust manifold or flange.

Listen for engine mechanical sounds - light knocking/tapping from valve gear or pistons... Heavy knocking from crankshaft big end bearings... Rumble from crankshaft main bearings...

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

207. Carry out oil pressure tests.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: PLAN obtains technical/procedural data from manuals and information from vehicle owner/driver. Check customer records for last engine oil and oil filter change. Obtain oil pressure test equipment and adapters.

Check engine oil level and condition, top off if necessary. Start engine and check oil warning light or oil pressure gauge reading at idle and about 2000 rpm.

Stop engine and remove the oil warning light switch or oil pressure gauge adapter into the main gallery.

Screw in and tighten a suitable adapter and attach the oil pressure gauge.

Run the engine at idles and, observe and record the gauge reading. Increase the engine speed to about 2000 rpm or until the oil pressure gauge reading becomes stable, observe and record the gauge reading.

Compare idle and maximum oil pressures with the manufacturer's specifications and tolerances. If readings are slightly low and an oil change is overdue recommend an oil and filter change and repeat of the test.

Low oil pressure can be caused by worn crankshaft bearings (listen for knock or rumble from crankcase), other leakage in the pressure circuit, a defective oil pump or oil pressure relief valve, and sludge build up in the pick-up pipe or strainer.

High oil pressure is caused by a defective oil pressure relief valve and will lead to erosion of crankshaft bearings and increase the risk of oil leaks.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

208. Inspect system for leaks and condition, pressure test, check coolant and antifreeze.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain a suitable cooling system pressure tester and an ethylene glycol coolant hydrometer.

Remove the radiator or expansion tank cap. Check the coolant for level, color and contamination such as oil or rust and dirt.

Check the ethylene glycol content with the hydrometer - adjust for temperature - and compare with manufacturer's specifications. Usually between 25% and 50% depending on the area of vehicle operation.

Top off the coolant if necessary and attach the pressure tester using a suitable adapter in the filler neck.

Apply a pressure equal to the system operating pressure, which is shown on the radiator filler cap - but should be checked from the manufacturer's data. DO NOT exceed the stated pressure.

Observe the reading on the tester pressure gauge - it should remain stable. If the gauge reading drops look for a good connection to the system and then for leaks in the system.

Look at all hoses, pipes, joints, gaskets, the water pump, the heater and water valve for external leaks. Look inside the vehicle under the heater for leaks from the heater matrix. If no external leaks are visible, check the coolant for oil contamination. (Possible internal leaks.)

Apply a pressure of about half the operating pressure and run the engine. Look for a rapid pressure rise, which would indicate a cylinder head gasket leak or crack between the cylinder or cylinder head and the water jacket.

If the pressure remains stable but internal leakage is suspected, use a combustion gas detector kit with the pressure tester. If the test fluid changes color during the test combustion gases have been detected in the coolant confirming an internal leak.

Fit the radiator/expansion tank pressure cap to the tester using an appropriate adapter and check that the operating pressure is held at the specified value. Remove the cap and check the vacuum valve seal operation and condition.

Compare all findings with manufacturer's data. Report faults found.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

209. Inspect crankshaft condition, journal and bearing dimensions and wear.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Strip to access the crankshaft. Check end float and general condition before removing. Check all bearing caps are marked for position and location to the front of the engine.

Remove crankshaft and bearings. Visually inspect bearings for condition, wear and abnormal markings.

Visually inspect the crankshaft journals and thrust faces for scores, pitting and abnormal wear or uneven markings.

Lay the crankshaft in oiled paper supports in vee blocks on a surface table. Set up a dial test indicator (dti) on a base. Measure the crankshaft for bow (support ends - rotate and measure center) and twist (compare matched pairs of journals, 1&4, 2&3, etc.).

Measure and record all journal sizes for nominal size, taper and ovality. Compare with manufacturer's data for wear tolerances.

Check oilways in the crankshaft are clear and clean. Flush through with low pressure jet on cleaning tank.

If crankshaft is reground wash thoroughly before refitting. Fit correct bearings (undersize if crankshaft has been reground). Check on journals before fitting.

Lubricate all bearings with clean engine oil. Check 'nip' of bearings before tightening. Torque bearing cap bolts to specified torque and check engine rotates. Check 'feel' of bearings and end float of crankshaft before reassembling engine.

When the engine is running check for abnormal noises and correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

210. Inspect pistons, piston rings and connecting rods and bearings

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove cylinder head and oil pan to access pistons and connecting rods.

Before removing pistons check the condition of the piston crowns and the 'fit' of the pistons in the cylinder bores. Rock the pistons from side to side to 'feel' the free play.

Visually inspect cylinder bores for scores indicating broken piston rings and for uneven wear to one side indicating misalignment or a bent connecting rod.

Before removing the connecting rod big end bearing caps check for free play by 'feel' by pulling and pushing the connecting rod on the crankshaft journal. Check end float by side to side movement and feeler gauge. Compare with manufacturer's data.

Remove connecting rods and pistons. Visually inspect the big end bearings for uneven wear indicating a possible bent connecting rod. Visually inspect the cylinder bore for matched wear.

Visually inspect the crankshaft journals and bearings. If the bearings are worn measure the crankshaft journals and compare with the manufacturer's specifications and tolerances for
fitting new bearings without regrinding the crankshaft.

Clean the piston crown and inspect for burning or overheating damage, pitting, particle damage such as broken piston rings and other deterioration.

Visually check and measure piston ring grooves and ring land for condition. Look for opening or taper of the ring grooves caused by the rings rocking. Look for ring breakage and particles cutting through the ring land.

Remove the piston from the connecting rod. Check the 'fit' of the piston pin to the connecting rod little end bearing/bush and in the piston.

If the piston is serviceable and new rings are to be fitted measure the cylinder bores and compare with the manufacturer's specifications and tolerance limits for new rings.

Gap new rings in the cylinder. Clean the piston ring grooves using a special tool. Fit rings to pistons and reassemble engine. Run engine and check for abnormal noises and correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

211. Inspect rockers, shaft, pedestals and push rods.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove rocker shaft. Check 'feel' of rockers on shaft.

Strip shaft and inspect rocker shaft bearing/bush surfaces for wear - visual and feel. Inspect rocker bearings/bushes for wear.

Inspect rocker thrust faces, valve, and push rod ends.

Check oil ways are clean. Use a cleaning tank low-pressure jet to provide a flow of fluid through the shaft. Look at all outlets for even flow.

Check pedestal oil way. Check cylinder head feed oil way. Check oil drillings in all rockers. If new bushes are fitted, ensure that the oil ways are not obstructed by the new bushes.

Reassemble and refit. Adjust valve lash (clearances). Run engine and listen for abnormal noises and correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

212. Inspect camshaft and shim adjust tappets

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: OHC with shims:

Run engine and listen for abnormal noises from top of engine. Check for misfire/cylinder balance. Disconnect battery earth/ground cable. Remove cam-housing cover.

Check condition of cams and followers.

Measure with feeler gauges all valve clearances at the 'back-of-the-cam' (heel) position. Record all dimensions and note if inlet or exhaust if they have different clearances specified.

Remove the camshaft - follow the manufacturer's instructions. Lift out the cam followers and keep in exact order.

Working with one follower at a time, remove and measure with a micrometer the thickness of the spacer/shim. Record the dimension and then add or subtract a correction to give the correct clearance.

Select a replacement spacer/shim to the corrected dimension. Measure with a micrometer to check that it is correct and fit to follower.

Repeat with all other followers.

Lubricate all followers before and during assembly with clean engine oil. Refit into bores over valves - keep in strict order.

Refit the camshaft and tighten securing bolts to specified torque/sequence. Check all valve clearances are now correct - if not strip and rectify any errors. Reassemble and recheck.

Rebuild and check that the engine starts and runs. Listen for correct operation. Road test and recheck.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

213. Inspect chain drive mechanisms.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Strip to access chain drive mechanism. Look for general condition, tension, lubrication and damage to covers.

Check chain tension and condition of chain self-tensioner device. Check chain wear or stretch and 'fit' on the sprockets.

Turn engine to align the timing marks and remove the chain and sprockets.

Check chain wear by observing the bend when the chain is held on its side. Check all rollers for tightness or seizure.

Check the condition of the teeth on the sprockets. Check sprocket to hub location and securing holes and devices.

Reassemble chain and sprockets keeping the timing marks aligned. Refit and set tensioner. Turn engine at least 2 full revolutions and recheck timing and chain tension. When engine is running listen for abnormal noises and correct operation of the engine.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

214. Inspect toothed belt drive mechanisms.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Strip to access belt and drive gears. Check the age/mileage of the belt from customer records.

Inspect for oil contamination. All oil leaks on to the belt must be rectified. Check belt tension. Check belt tooth to toothed wheel contact.

Turn engine to align the timing marks. Lock engine in position as per manufacturer's instructions. Mark direction of rotation (DOR) with an arrow on the belt. Slacken tensioner and remove the belt.

Check tensioner bearing by rocking and spinning. Look for free play and listen for bearing whine or seizure. Check toothed wheels for condition.

Check belt for signs of cracking, fraying, twist, tooth separation or other signs of deterioration. Always renew the belt if any doubt about its condition is suspected.

Reassemble keeping timing marks aligned. Turn the engine at least 2 full revolutions and recheck the belt tension and the timing.

Reassemble covers and other components. Run engine and listen for abnormal noises and correct operation of the engine.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

215. Inspect camshaft and bearings (OHC) and checks on valve timing.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Run engine and listen for abnormal noises. Disconnect battery ground cable and remove cam-housing cover. Carry out a general inspection.

Measure and record valve clearances. Remove cam belt cover and turn engine to align the timing marks. Lock in position if specified. Follow the manufacturer's instructions for chain driven camshafts.

Follow the manufacturer's instructions for removing or supporting the belt or chain and pulleys.

Check for position markings on the bearing caps - mark if necessary. Undo the camshaft cap bolts and remove caps, lay out in line for replacement in original position.

Inspect the camshaft for run out, journal wear and lobe wear. Inspect and measure camshaft bearings for wear, damage, out-of-round, and alignment.

Remove split bearings from housings and caps. Fit new bearings to housings and caps.

Lubricate bearings with clean engine oil. Fit camshaft into housing, fit caps and tighten bolts finger tight.

Torque bolts in sequence and to manufacturer's specifications. Refit camshaft drive gear and belt or chain; ensure correct alignment of timing marks. Tension belt or chain and recheck timing. Check and adjust valve clearances.

Turn engine 2 or 3 complete revolutions and check timing mark alignment, belt or chain tension, and valve clearances.

Verify camshaft(s) timing and camshaft sensor indexing according to manufacturer’s specifications and procedure

Refit other components - start and run engine and check for correct operation and abnormal noises.

Road test and recheck under hood for abnormal noises and oil leaks, etc.

When the task has been completed, record here how it went or how it could be improved next time

Instructor’s signature: **Grade: 1 2 3 4 5**

216. Inspect oil pumps and lubrication components

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: PLAN obtains technical/procedural data from manuals and information from vehicle owner/driver. Remove oil pump. Check end float on drive gear or shaft.

Inspect the drive gear for mesh markings, chipped teeth or other deterioration. Remove oil pump cover; carry out general inspection for obvious damage.

Check internal clearances in accordance with manufacturer's instructions and compare with specified tolerances. Look at and measure rotor/gear/vane to housing clearances and end floats. Look at and measure rotor-to-rotor clearance. Compare with specified tolerances.

Strip the pressure relief valve. Check the ball/plunger and spring condition. Measure the free length of the spring and compare with manufacturer's data

Closely inspect the valve seat for pitting, scoring, seating pattern, etc. Reassemble oil pump and pressure relief valve. Check plunger is free in the housing. Lubricate with clean engine oil.

Clean and inspect the oil pick up pipe for condition, security, cracks/fractures in the pipe, at the flanges or in the mounting brackets. Inspect inside the pipe for blockage and sludge build up.

Clean and inspect the strainer for blockage and sludge build up. Check if possible the blockage bypass valve in the strainer for correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

217. Inspect oil sealing devices, gaskets, seals. Etc.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: PLAN obtains technical/procedural data from manuals and information from vehicle owner/driver.
These inspections would follow oil leakage problems.

Look closely at the 'fit' of lip type seals in their housings for correct position, distortion, leakage bypassing the outside of the seal against the housing or any other possible routes.

Look closely at the seal lips for burning, hardening or cracks. Look closely at the seal land on the shaft for undercutting, underscoring or other abnormal wear. Always lubricate and protect seal lips before and during the fitting of the seals over shafts.

Check the tightness/torque of housings and covers with oil leakage from gaskets. Check the mating surfaces for flatness, distortion around bolt holes, etc. with straight edge and feeler gauges or a surface table and engineer’s blue.

Check pressed steel covers with cork or rubber gaskets for over tightening and distortion of the gaskets. Flatten stretched bolt holes with a hammer and flat surface.

Check through bolts into engine crankcase and crankshaft flanges that the correct type of thread sealant has been used and correctly applied.

Check other sealing devices for correct positioning, distortion incorrect sealant used, etc. follow closely manufacturer's instructions/specifications for all sealing applications.

When the task has been completed, record here how it went or how it could be improved next time

Instructor’s signature: **Grade: 1 2 3 4 5**

218. Inspect oil galleries and drillings in engine components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: PLAN obtains technical/procedural data from manuals and information from vehicle owner/driver. This inspection is carried out during rebuilds or when excessive slugging has occurred.

Strip the engine to access all galleries and oil drillings in the block. Identify galleries and drillings. Remove plugs in ends of main gallery to ensure full check is completed. Check the manufacturer's specifications for any special instructions of details.

Use a cleaning tank with a low-pressure jet to provide a flow of cleaning solvent through the galleries and drillings.

Flush through and check main gallery. Refit plugs with thread sealant. Flush through all other drillings, blank off each in turn to direct flow to other drillings. Check feeds to main bearings, camshaft, cylinder head and other components.

Flush through the crankshaft to check main bearing to big end feeds. Flush through connecting rods to check for oil throw to cylinder walls and underside of piston crowns.

Flush through all other hollow oil feed components.

If slugging has occurred it may be possible to clear without stripping the engine. Use a special flushing oil that is used in the engine for a short period of time at a high idle speed. Follow the oil manufacturer's instructions. Renew the oil and filter.

Where slugging is found recommend frequent oil and filter changes in the future.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

219. Reverse flush and test radiator flow rate. Inspect hoses.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Inspect hoses for security and condition.

Inspect the hoses systematically starting at the top hose. Look at the hose for signs of leakage, telltale markings at each end, and for cracking, perishing, chaffing and other damage or deterioration. Squeeze the hose to feel for internal damage from perishing.

If internal damage is suspected remove the hose for internal inspection. Look for a break up of the inner lining of the hose and particles of old hose in the coolant. Check all other hoses, bottom hose, heater hoses, by-pass hose and any other coolant hoses manifolds or pipes.

If the radiator and cooling system is to be cleaned by reverse flushing drain the coolant into a clean drain tray. Undo the bottom hose clip at the water pump inlet and pull off the hose. Inspect the hose internally for condition. Replace the hose if defective.

Remove the radiator pressure cap. Push a mains water hose into the bottom hose and plug with rag to seal the end.

Turn on the mains water and allow the water to flow from the radiator header tank filler neck until it is clean and flows freely. A poor flow indicates a blocked radiator.

In order to clean the engine block by reverse flushing, remove the thermostat and refit the housing cover. Refit the radiator cap and apply mains water pressure to the bottom hose. Allow the water to flow until it runs clean and freely from the water pump bottom hose connection.

Refit the thermostat with a new gasket and sealant on the gasket and any bolts that run into the water passages. Refit all hoses and tighten the clips. Mix new coolant to the specified mixture of water and antifreeze with inhibitors or use a premixed coolant. Do not exceed a 50% to 60% ethylene glycol content, as this does not improve the frost protection. (Over 70% reduces the protection).

Refill the cooling system. Run the engine and bleed air from the system if necessary.

Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings.

After road testing visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

220. Inspect water pump.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Drain the coolant into a clean drain tray. Remove the water pump. Look at the general condition, corrosion, cracks, sealing or other faults.

Check the spindle bearings for wear by rotating and rocking the spindle. Feel and listen for roughness, grating and other abnormalities.

Look closely at the water pump drive pulley flange to spindle joint, usually an interference fit, for signs of slippage.

Look closely at the impeller to spindle joint, also an interference fit, for signs of slippage. Grip the drive flange and impeller and attempt to twist in opposite directions to feel for slippage.

Clean the mating faces of the water pump and engine block and measure for flatness (true). Check by-pass drillings are clean and clear.

Report faults found.

Reassemble water pump to engine.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

221. Perform cylinder power balance tests; determine necessary action.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check engine manufacturer's data for suitability of this test. Connect engine to test equipment/engine analyzer.

Follow equipment manufacturer's instructions for test procedure. Increase idle speed if necessary. Record results for each cylinder.

Compare rpm drop for each cylinder against other cylinders. A low rpm drop indicates a defective cylinder. Compare range to manufacturer's specifications.

On old engines with contact breaker ignition it is possible to carry out this test with a tachometer and open circuiting the HT leads (remove leads from spark plugs with insulated pliers) or by short-circuiting the HT leads (short to earth with insulated handle screwdriver).

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

222. Perform cylinder compression tests; determine necessary action.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check engine manufacturer's data for suitability of this test and checking conditions (cold or hot). Disconnect LT (low tension) or primary circuit feed at coil to prevent HT current. (LT feed from coil to distributor).

Remove all spark plugs.

Connect compression tester into No. 1 spark plug hole. Fully open throttle.

Crank engine for 3 or 4 revolutions, record initial (first revolution) and final compression reading. (Seek assistance if necessary to hold the throttle and to crank the engine.)

Repeat for all other cylinders and record readings.

If some readings are low put a small drop of clean engine oil into the cylinder and repeat test. Record results.

Repeat for all cylinders.

Compare dry and wet readings with other cylinders and with the engine manufacturer's specifications.

Refit spark plugs, HT leads and coil LT lead - check engine starts and runs.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

223. Perform cylinder leakage tests; determine necessary action.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect vehicle battery ground lead.

Remove spark plugs.

Insert the whistle into No. 1 spark plug hole. Turn engine in normal direction of rotation (DOR) until whistle blows. This will give top dead center (tdc) on the compression stroke.

Remove the whistle and insert a probe or dial test indicator (dti) plunger onto the top of the piston. Rock the engine to find the exact tdc position. Tdc marks should align.

Fit cylinder leakage test adapter into the spark plug hole and attach the airline from the tester.
Keep hands clear of engine - risk of rotation if tdc is not accurately positioned.

Follow equipment manufacturer's instructions to increase the air pressure in the cylinder and hold. Observe the gauge readings and time taken for the pressure to drop.

If air pressure drops quickly maintain a continuous air supply and look and listen for leakage. Air may be lost from the inlet valves or exhaust valves and be heard in manifolds or air may bypass the piston and be found in the crankcase ventilation pipes - remove to see.

Repeat for all other cylinders and record readings.

Compare readings with other cylinders and with manufacturer's specifications.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

224. Perform engine vacuum tests; determine necessary action.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check engine manufacturer's data for suitability of this test. Check ignition timing and carburetor settings where appropriate.

Connect a vacuum gauge to the inlet manifold in accordance with the engine manufacturer's instructions or to a suitable position.

On old engines (distributor ignition) carry out cranking test by disconnecting coil to distributor low tension (LT) primary circuit lead. Crank engine and observe gauge needle. Record vacuum and variations (needle fluctuations).

Start engine and run at idle. Observe gauge readings and if needle is steady or fluctuating.
Record readings and variations.

Blip the throttle and observe readings. Record maximum and minimum readings. Repeat 3 or 4 times to obtain consistent or average results.

Increase engine speed to 2500 rpm. Observe and record readings.

Release throttle and observe readings as engine decelerates. Record readings. Repeat 3 or 4 times to obtain consistent or average readings.

Compare all readings with the engine and equipment manufacturer's specifications.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

225. Check operation of crankcase ventilation (PCV) system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: PLAN obtains technical/procedural data from manuals and information from vehicle owner/driver. Obtain driver information on oil and fuel consumption. Both are likely to be high if the system is blocked. Check for drivability problems resulting from failure of the PCV system.

Run engine and look for blue exhaust smoke and smoke leakage from PCV pipes and hoses. Exhaust smoke and engine smoke can indicate a blocked PCV system. Inspect the air cleaner element for oil contamination. If contaminated check oil separator.

Identify PCV system type (valve or restricted orifice into inlet manifold). Visually inspect all pipes and hoses for condition, blockage, fit onto connectors (leakage), oil contamination - pull off pipes in turn to assess internal and external condition.

Clean or replace pipes/hoses if required. Clean or replace PCV air intake filter (integral with oil filler cap on some engines).

Pull out and open PCV valve, clean and check operation or remove valve and shake to check that the valve is free, listen for a rattle. Check that airflow is toward manifold or air cleaner. Or 6

Check restricted orifice into carburetor or inlet manifold is clean and clear, blow through and listen. Clean out if necessary (Do not increase diameter by drilling clear with oversize drill).

Reconnect all pipes and run engine. Check for vacuum at feed into inlet manifold. Check for symptoms of blocked valve or orifice. Rough or uneven idle; stalling at low speeds, oil leaks, and smoke from engine oil filler cap.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

226. Inspect drive belt, water pump, cooling fan and radiator airflow.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery earth or ground lead. Check the coolant level (cold engine). Identify the drive belt for the water pump - inside the engine compartment or under the vehicle.

Check the condition of the belt, look for frays, cracks, glazing of the drive faces caused by slippage and check that the tension or free play is within manufacturer's tolerances. Free play of about 12 mm (1/2 inch) on the long side of a V belt is usually correct.

Rock the water pump at the pulley and feel for wear/free play in the spindle bearings. Look for signs of leakage at the water pump spindle seal and the housing to engine block gasket. Look under the pump for telltale stains of coolant leakage on and under the pump.

For engine driven and electrically driven cooling fans check for damage and security. Check the fan cowling for damage and security. This is particularly important for electrically driven fans where the cowling is also the support bracket for the motor and fan assembly.

Check the radiator matrix air passages for blockage. Blow through with an air line if a build up of dust or dirt is visible. Blow through in the reverse direction.

For engine driven fans with a viscous thermostatic coupling check that the fan is free on the hub when the engine is cold. For all fans check that the fitting is correct. Some old steel fans could be fitted the wrong way round.

For electrically driven fans check the motor spindle bearings by rocking and rotating the fan blades and feeling for free play, lumpiness and grinding in the bearings. (Ensure that the battery earth or ground lead is disconnected whenever handling electrically driven fans).

Reconnect the battery and run the engine. Check for airflow from the fan and a good air draw through the radiator. For electrically driven fans run the engine to the switch temperature so that the fan operates.

Do not allow engine to overheat if the fan switch does not operate or the fan fails to operate. Check the fan motor by disconnecting the switch terminal block and bridging the connections. The motor should run.

If the motor does not run check for an electrical feed at the terminal block. Connect a test lamp or voltmeter between each terminal and a good earth or ground - turn on the ignition if necessary. Check the switch continuity when cold (not continuous) and when hot (continuous).

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

227. Check system operating temperature - check thermostat opening temperature.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check the system from cold. Set the in car heater to the hottest setting. Insert a thermometer into the radiator header tank or attach to the top hose.

Run the engine. The coolant in the top hose should remain cool until the thermostat opens. Compare the top hose temperature to the heater hose temperature. The heater hose should warm up gradually and the top hose rapidly as the thermostat opens.

When the engine is at its normal operating temperature take a reading from the thermometer and compare with the manufacturer's specifications. Check engine temperature gauge reads correctly.

For electrically driven cooling fan types allow the engine to continue to heat up until the cooling fan operates. Check the temperature in the coolant is within the manufacturer's specifications. Check engine temperature gauge reads correctly.

To check a thermostat that has been removed from an engine use a thermostat tester. Put the thermostat into the water in the tester. Check that the water level is correct and that thermometer is correctly positioned. Turn on the tester to heat the water.

Observe the thermometer and the thermostat and look for the temperature when the thermostat begins to open and when it is fully open. Check the temperatures with the manufacturer's data.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

Assignments

General Engine Diagnosis; Removal and Reinstallation

Task 1

a) Name each stroke of a four stroke spark ignition engine.

b) State what is happening in the cylinder at the midpoint of **each** stroke.

Answer

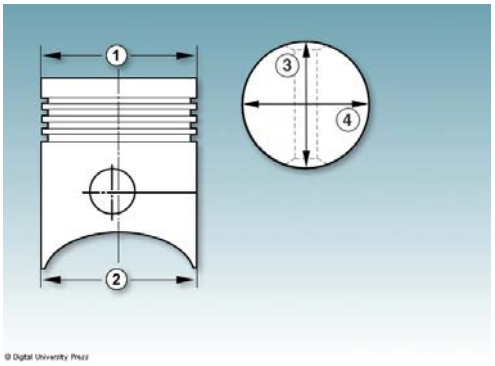
Task 2

This picture shows dimensions of a piston.

a) State the relationship between the dimensions 1& 2

b) State the relationship between dimensions 3 & 4

c) Explain why there is a difference between the dimensions



Answer

Task 3

An engine is to be tested for cylinder leakage.

a) State how the engine should be prepared before the test

b) Describe how the test can be used to identify

(i) a leak from the head gasket into the cooling system

(ii) cylinder bore and piston ring wear.

Answer

Task 4

State the vacuum gauge reading/needle behavior that indicates that an engine:

a) is in good condition when tested a slow running speed

b) has the ignition timing set correctly

c) has the correct mixture strength

Answer

Task 5

a) Describe how a compression test is carried out on an engine to diagnose its mechanical condition.

b) State typical readings expected from a compression test of a serviceable engine

c) State the reason why a wet test is often carried out in addition to a dry test

Answer

Task 6

State four possible causes of each of the following:

a) excessive oil consumption

b) unusual engine exhaust color

c) unusual engine noise.

Answer

Instructor Feedback:

Cylinder Head and Valve Train Diagnosis and Repair

Task 1

The picture show equipment that is used for a task to be carried out on a cylinder head

a) Name the tool

b) State the condition of the cylinder head which requires the use of the tool

c) The angle of the valve seat and valve differ by 1°. State **two** reasons for this difference

Answer

Task 2

This picture shows an engine overhaul procedure being carried out. State:

a) the purpose of the procedure

b) what the valve seat faces should look like after carrying out this procedure

c) what must be done to the cylinder head before reassembly

Answer

Task 3

Describe in sequence, a procedure for adjusting the valve clearances of a four cylinder in-line engine with an overhead valve drive.

Answer

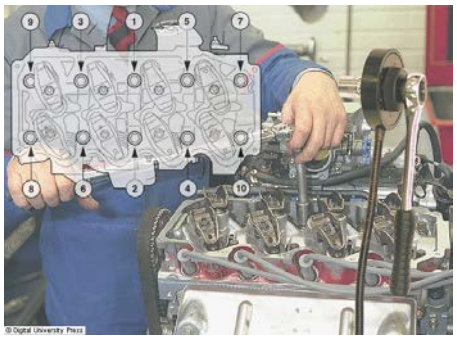
Task 4

a) Describe in sequence a procedure for the removal and refitting of the cam belt on a four cylinder in-line engine with an overhead camshaft drive.

b) State **two** checks which should be made before starting the engine following the removal and refitting in a) above

Answer

Task 5



The picture shows the refitting of a cylinder head.

a) List the order in which the cylinder heads bolts should be tightened

b) State the reason why this order must be followed

c) State why an aluminum cylinder head should not be removed unless the engine is cold

Answer

Task 6

Describe how a camshaft should be measured for:

a) run-out

b) journal wear

c) lobe wear

Answer

Instructor Feedback:

Engine Block Assembly Diagnosis and Repair

Task 1

This picture shows equipment in position to carry out a check during an engine overhaul.

a) State the purpose of the check being carried out.

b) The specified measurement should be between 0.14mm and 0.24mm; the check showed a measurement of 0.44mm. Describe how this defect can be rectified.

Answer

Task 2

Describe how cylinder walls should be inspected/measured for:

a) damage

b) wear

c) ridges

Answer

Task 3

During the inspection of an aluminum cylinder head, it is noted that the threads into which the spark plug is fitted are stripped.

a) List the equipment required to rectify this fault.

b) Describe in sequence, how this fault should be rectified.

Answer

Task 4

During an engine overhaul, the piston and bearing wear patterns indicate a connecting rod alignment concern. Describe how this diagnosis could be confirmed.

Answer

Task 5

New pistons and piston rings are to be fitted to a cylinder block.

a) State **three** checks that should be made before fitting the pistons.

b) List the equipment required to complete the task.

c) Describe a procedure for fitting **one** piston in the cylinder block.

Answer

Task 6

State **one** application **and** the procedure for applying **each** of the following, during the reassembly of an engine:

a) gaskets

b) seals

c) formed in place (tube type) sealants

d) thread sealers.

Answer

Instructor Feedback:

Lubrication and Cooling Systems Diagnosis and Repair

Task 1

This picture shows a view of an engine oil pump.

a) State **three** clearances that should be measured to determine its serviceability.

b) State approximate values for each clearance given in your answer to a) above

Answer

Task 2

a) Describe a procedure for checking engine oil pressure.

b) State **three** common causes of low engine oil pressure

Answer

Task 3

The picture shows equipment connected to an engine cooling system. Explain how this equipment can be used to identify combustion leakage.

Answer

Task 4

An electrically operated fan in a liquid cooling system is controlled by a thermostatic switch.

a) State where the thermostatic switch in a liquid cooling system is commonly fitted

b) Describe how the operation of a thermostatic switch should be checked.

Answer

Task 5

a) State **three** personal hazards that a technician should be aware of when working on the cooling system of a liquid cooled engine, which is at normal operating temperature.

b) Explain how personal injury from the hazards given in answer to a) could be prevented.

Answer

Task 6

A serviceable liquid cooling system has been drained, flushed and refilled with the recommended coolant. When the vehicle is next used, it is found that the heater will only supply cold air to the vehicle interior.

a) State the likely cause of this fault.

b) Describe how the fault should be rectified.

Answer

Instructor Feedback:

Heating and Air Conditioning

Tasklist worksheets

228. Routine maintenance inspections and replacement of cooling parts.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Visual / coolant level (Safety – do not remove cap from hot engine).

Measure antifreeze content with hydrometer (Safety – avoid skin contact with coolant).

Visual / all hoses for leakage and condition.

Visual / all gaskets for leakage.

Check with pressure tester if leaks suspected (Do not exceed system rated pressure).

Check pressure cap operating pressure. Inspect vacuum valve.

Check water pump drive belt condition and tension. Adjust if necessary.

Check operation of cooling fan and airflow through the radiator. Clean if necessary.

Check water pump bearing for free play. Listen for abnormal noises.

Check operation of heater, heater controls and blower motor.

At regular intervals replace coolant with new water and antifreeze solution (7.4.2).

Additional items – see manufacturer's schedule.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

229. Drain and top off coolant for winter usage or replace coolant.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain information from the driver on the frequency of topping off the coolant. Check coolant level. Check the water pump drive belt for condition and tension.

Pressure test the cooling system and the radiator cap. Look for leakage, condition of hoses, the pressure cap operating pressure, seals and vacuum valve. Report any defects and recommend rectification before adding new coolant.

Identify the coolant drain points in the radiator and engine block. Undo and drain coolant into a clean drain tray. Dispose of old coolant in accordance with local environmental regulations. Close the radiator and engine block drain taps or plugs.

Mix new coolant to the specified mixture of water and antifreeze with inhibitors or use a premixed coolant. Do not exceed a 50% to 60% ethylene glycol content as this does not improve the frost protection. (Over 70% reduces the protection).

Add coolant to the radiator until the system is full. Open bleed screws to allow air to flow from the system.

Run the engine and bleed air from the heater or high point in the system if required. Follow the engine manufacturer's instructions. Visually check for leaks.

Road test and check the operation of the cooling system and the heater temperature range. Check the operation of the engine coolant temperature gauge.

After road testing, visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

230. Check operation of heating and ventilation system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Start the engine and run until it is warm (use extraction if indoors).

Check that the booster fan runs at all speeds. Switch off AC if fitted.

Set the temperature control to cold and the fan speed to a medium setting.

Run through all direction settings and check that COOL air is supplied.

Set the temperature control to hot and the fan speed to a medium setting.

Run through all direction settings and check that HOT air is supplied.

Check that a range of temperatures can be selected and that external or recirculated air can be used.

Make sure all ventilation grills open and allow directional control.

Check heated rear screen operation.

Check heated front screen operation (if fitted).

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

231. Remove and replace heater unit, strip and rebuild.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check heater operation before starting removal. Note faults. Disconnect battery earth or ground lead. Drain the coolant into a clean drain tray.

Follow the manufacturer's instructions for the removal of the heater unit and the blower motor assembly. These may be in one unit below the fascia, or two units with the heater matrix and air control below the fascia and the blower motor and air intake ducts inside the engine compartment.

Undo the lower fascia securing screws and remove the fascia and sound deadening panels below the fascia.

Label and disconnect the cables for temperature control and air direction control and the electrical terminals to the blower motor.

Undo the heater hose clips and pull off the hoses - catch any lost coolant in a small dray train, bundle of rag or other suitable device.

Undo the securing nuts/bolts for the heater and withdraw the complete assembly.

Separate the heater unit to remove the heater matrix. Inspect the control flaps for smooth operation and the sealing strips at the fully open and closed apertures. Replace the sealing strips if necessary.

Reassemble and refit in reverse order. Fit and adjust control cables to give full hot and cold air operation and to match the air direction to the control position indicators.

Refill the cooling system. Top off with a correct water and antifreeze mixture to make good any spilt or lost coolant during draining. Run the engine and bleed air from the system if necessary.

Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings.

After road testing visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

232. Check operation of air conditioning system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Start the engine and run until it is warm (use extraction if indoors).

Check the condenser fan operates.

Check for unusual noises in the A/C system.

Check operation of electrical controls.

Check operation of automatic and semi-automatic HVAC control systems.

Check that the booster fan runs at all speeds.

Set the temperature control to cold, switch AC on and run the fan at maximum speed.

Set air to recirculate and check that COLD air is supplied. Some manufacturers specify a temperature at the ventilation outlets of about 5oC.

Leave the A/C switched on and set the temperature control to hot. Reset the fan speed to a medium setting.

Run through all direction settings and check that HOT air is supplied. Adjustment of operating cables may be required.

Check that a range of temperatures can be selected.

Make sure all ventilation grills open and allow directional control. Adjustment of operating cables may be required.

Inspect heater ducts, hoses and outlets.

Check heated rear screen operation.

Check heated front screen operation (if fitted).

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

233. Remove and refit air conditioning condenser.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Drain the AC system as described in the Repair and Maintenance section worksheet.

Remove plastic trims and the hood slam panel as required to gain access.

Drain the cooling system and remove radiator (if necessary).

Undo and remove the inlet and outlet pipes from the condenser. Plug the pipes to prevent contamination.

Remove condenser securing screws and note the positions if different sizes are used.

Withdraw the condenser from the vehicle.

Inspect the condenser for air flow restrictions.

Refitting is a reversal of the removal process, but ensure that dirt does not enter the new condenser or the pipes at any time. Use sealant tape on the pipe connections as instructed by the vehicle manufacturer.

Consult manufacturer's data for the amount of oil to be added to the system.

Evacuate the AC system as described in the Repair and Maintenance section worksheet.

Refill the AC system as described in the Repair and Maintenance section worksheet.

Carry out a full check of the AC system operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

234. Remove and refit air conditioning compressor.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Drain the AC system as described in the Repair and Maintenance section worksheet.

Remove electrical connections to the compressor clutch.

Loosen the mounting and belt adjustment bolts. Remove and inspect the belt. Note that the belt, if in good condition, can be left in place on the engine ready for refitting. Renew if in any doubt.

Undo and remove the inlet and outlet pipes from the compressor. Plug the pipes to prevent contamination.

Remove the compressor securing bolts and withdraw the compressor from the vehicle.

The quantity of oil in the old compressor should be drained and measured.

Remove, inspect and test the compressor clutch.

Test the compressor clutch control system.

Drain the oil from the new compressor and replace with a quantity equal to that drained from the old compressor.

Refitting is a reversal of the removal process, but ensure that dirt does not enter the new compressor or the pipes at any time. Use sealant tape on the pipe connections as instructed by the vehicle manufacturer.

Adjust the drive belt tension to its recommended settings.

Evacuate the AC system as described in the Repair and Maintenance section worksheet.

Refill the AC system as described in the Repair and Maintenance section worksheet.

Carry out a full check of the AC system operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

235. Remove and refit air conditioning receiver/drier.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Drain the AC system as described in the Repair and Maintenance section worksheet.

Remove plastic trims and the hood slam panel as required to gain access.

Undo and remove the inlet and outlet pipes from the receiver/drier. Plug the pipes to prevent contamination.

Remove receiver/drier securing screws.

Withdraw the receiver/drier from the vehicle.

Refitting is a reversal of the removal process, but ensure that dirt does not enter the new receiver/drier or the pipes at any time. Use sealant tape on the pipe connections as instructed by the vehicle manufacturer.

Consult manufacturer's data for the amount of oil to be added to the system.

Evacuate the AC system as described in the Repair and Maintenance section worksheet.

Refill the AC system as described in the Repair and Maintenance section worksheet.

Carry out a full check of the AC system operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

236. Remove and replace evaporator unit and expansion valve, strip and rebuild.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Follow the manufacturer's instructions for the removal of the evaporator unit and the blower motor assembly. These may be in one unit below the fascia or be two units with the evaporator and air control below the fascia and the blower motor and air intake ducts inside the engine compartment.

Check AC operation before starting removal. Note faults. Disconnect battery earth or ground lead.

Drain the AC system as described in the Repair and Maintenance section worksheet.

Undo the lower fascia securing screws and remove the fascia and sound deadening panels below the fascia.

Label and disconnect the cables for temperature control and air direction control and the electrical terminals to the blower motor.

Undo the hose connections and disconnect the hoses from the evaporator and expansion valve. Undo the securing nuts/bolts for the unit and withdraw the complete assembly. Inspect evaporator housing water drain for blockages.

Separate the unit to remove the evaporator. Inspect the control flaps for smooth operation and the sealing strips at the fully open and closed apertures. Replace the sealing strips if necessary.

Reassemble and refit in reverse order. Ensure that dirt does not enter the new evaporator or the pipes at any time (keep blanking plugs in position until just before connecting. Use sealant tape on the pipe connections as instructed by the vehicle manufacturer. Fit and adjust the control cables to give correct operation and to match the air direction to the control position indicators.

Consult manufacturer's data for the amount of oil to be added to the system. Evacuate the AC system as described in the Repair and Maintenance section worksheet. Refill the AC system as described in the Repair and Maintenance section worksheet. Carry out a full check of the AC system operation.

Refill the cooling system. Top off with a correct water and antifreeze mixture to make good any spilt or lost coolant during draining. Run the engine and bleed air from the system if necessary.

Road test and check the engine temperature gauge, the heater and AC operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings. After road testing visually recheck the system for leaks.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

237.Remove and replace hoses including radiator, heater and bypass hoses.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery ground lead. Drain the coolant into a clean drain tray.

Undo the hose clips and slide along the hose. If the hose is not free on its connector insert a blunt blade (screwdriver or special tool) under the lip of the hose and ease round to break the seal.

Pull the hose off from the connector. Take care with radiator couplings as these can be damaged by the use of excessive force.

Transfer or fit new hose clips to the hose for replacement. Fit the new hoses with a sealant on the joint if recommended, otherwise a dry joint will give a good seal. Slide the hose clips into place and tighten.

Refill the cooling system. Top off with a correct water and antifreeze mixture to make good any spilt or lost coolant during draining. Run the engine and bleed air from the system if necessary.

Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings.

After road testing, visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

238.Remove and replace drive belts and pulleys.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Identify the drive belt for the water pump - V, serpentine or toothed belt for the camshaft drive.

For water pumps driven by the camshaft drive toothed belt follow the manufacturer's instructions to access the belt. Match the timing marks or fit the locating dowels or pegs and mark the direction of rotation on the belt before removing.

For timed and non-timed belts slacken the tensioner and remove the belt. The tensioner may be a tensioning pulley or may be linked to a component such as the alternator. Remove any other component that prevents removal of the belt. Lift off and remove the belt.

Fit the new belt and adjust the tension to the manufacturer's specification. For vee belts the correct tension is usually about 13 mm or 1/2 inch of free play on the longest side. For toothed belts use a tension gauge or adjust so that the belt can be twisted through 90° on the long side.

Tighten the tensioner securing bolts. Refit other components in reverse order. Run the engine and check for abnormal noises. A whine would indicate that the belt tension is too tight and a slapping noise of the belt against the cover indicates that the belt is too loose.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

239.Remove and replace thermostat.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Drain the coolant into a clean drain tray.

Undo the bolts holding the thermostat housing and remove the bolts and housing. For thermostats fitted in hoses or integrated in housings remove the hose or housing.

Lift out the thermostat and inspect the thermostat housing gasket and the thermostat seal for signs of leakage and other deterioration. Test the thermostat if required.

Clean and inspect the thermostat housing and cover mating faces. Inspect for flatness with a straight edge or surface table. Rectify if necessary.

Fit the thermostat into the housing with new seals, if required. Fit the cover with a new gasket and sealant, if recommended, or grease. Fit the securing bolts with a thread sealant if they pass into the water passages and tighten to the specified torque.

Refill the cooling system. Top off with a correct water and antifreeze mixture to make good any spilt or lost coolant during draining. Run the engine and bleed air from the system if necessary.

Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings.

After road testing, visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

240.Remove and replace water pump and engine driven fan.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Drain the coolant into a clean drain tray. Identify the location of the water pump and drive belt arrangement.

For water pumps driven by the camshaft drive toothed belt follow the manufacturer's instructions to access the belt. Match the timing marks or fit the locating dowels or pegs and mark the direction of rotation on the belt before removing. For engine driven fans attached to the water pump drive pulley, undo the securing bolts and pull off the fan. For some thermostatic viscous fans the hub will have to be drawn from the spindle after the water pump has been removed.

For timed and non-timed belts slacken the tensioner and remove the belt. The tensioner may be a tensioning pulley or may be linked to a component such as the alternator. Remove any other component that prevents removal of the belt. Lift off and remove the belt.

Undo and remove the securing bolts for the water pump. Keep in order so that they are returned to their original positions - many vehicles have different length bolts around the water pump. Ease out the water pump. They can be tight when corrosion has bonded the pump into the engine block. Use a penetrating fluid and lever out or twist carefully to release the tightness. If very tight check that all bolts have been removed!

Check the gasket for signs of leakage. Where bolts run into the water jacket check that the threads are clean and that the bolts run freely. Clean threads if necessary. Clean and check that the mating faces are in good condition. Refit the pump using a new gasket or seal and a soft setting sealant on the gasket and all bolts that run into the water passages. Tighten bolts to manufacturer's specifications.

Refit the drive belt and adjust the tension to the manufacturer's specification. For V belts the correct tension is usually about 13 mm or 1/2 inch of free play on the longest side. For toothed belts use a tension gauge or adjust so that the belt can be twisted through 90° on the long side.

Refill the cooling system. Top off with a correct water and antifreeze mixture to make good any spilt or lost coolant during draining. Run the engine and bleed air from the system if necessary. Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings. After road testing, visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

241.Remove and replace radiator and electric fan motor and switches.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Drain radiator coolant into a clean drain tray.

Undo and remove top, bottom and expansion tank hose clips and pull off hoses.

Disconnect the electrical terminal block to the motor and switch. Leave the cowl, motor and switch in place. Remove the radiator and cowl as an assembly.

For radiators with integral transmission oil cooling, clamp the feed and return hoses, undo the hose clips and pull off the hoses. Catch the lost oil in a clean drain tray. OR undo the union nuts on steel pipes and remove the pipes. Catch the lost oil in a drain tray.

For radiators with an air conditioning radiator or condenser attached to the cooling radiator, undo the attaching screws and support the condenser. DO NOT undo the air conditioner refrigerant pipes unless the system has been discharged (specialist operation).

Undo and remove the radiator securing bolts and remove with the brackets. Carefully lift out the radiator assembly.

Detach the cowl, motor and fan from the radiator. Mark all bolts or screws for replacement in exactly the same places. Unscrew the switch from the radiator.

Reassemble in the reverse order. Ensure that the correct bolts or screws are replaced in their original positions. Some bolts may be longer than others and can puncture the radiator if fitted incorrectly.

Refill the cooling system. Top off with a correct water and antifreeze mixture to make good any spilt or lost coolant during draining. Run the engine and bleed air from the system if necessary.

Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings.

After road testing, visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

242. Remove and replace heater unit strip and rebuild and reassemble.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check heater operation before starting removal. Note faults. Disconnect battery earth or ground lead. Drain the coolant into a clean drain tray.

Follow the manufacturer's instructions for the removal of the heater unit and the blower motor assembly. These may be in one unit below the fascia or be two units with the heater matrix and air control below the fascia and the blower motor and air intake ducts inside the engine compartment.

Undo the lower fascia securing screws and remove the fascia and sound deadening panels below the fascia.

Label and disconnect the cables for temperature control and air direction control and the electrical terminals to the blower motor.

Undo the heater hose clips and pull off the hoses - catch any lost coolant in a small dray train, bundle of rag or other suitable device.

Undo the securing nuts/bolts for the heater and withdraw the complete assembly.

Separate the heater unit to remove the heater matrix. Inspect the control flaps for smooth operation and the sealing strips at the fully open and closed apertures. Replace the sealing strips if necessary.

Reassemble and refit in reverse order. Fit and adjust control cables to give full hot and cold air operation and to match the air direction to the control position indicators.

Refill the cooling system. Top off with a correct water and antifreeze mixture to make good any spilt or lost coolant during draining. Run the engine and bleed air from the system if necessary.

Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings.

After road testing visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

243. Inspect system for leaks and condition, pressure test, check coolant and antifreeze.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain a suitable cooling system pressure tester and an ethylene glycol coolant hydrometer.

Remove the radiator or expansion tank cap. Check the coolant for level, color and contamination such as oil or rust and dirt.

Check the ethylene glycol content with the hydrometer - adjust for temperature - and compare with manufacturer's specifications. Usually between 25% and 50% depending on the area of vehicle operation.

Top off the coolant if necessary and attach the pressure tester using a suitable adapter in the filler neck.

Apply a pressure equal to the system operating pressure, which is shown on the radiator filler cap - but should be checked from the manufacturer's data. DO NOT exceed the stated pressure.

Observe the reading on the tester pressure gauge - it should remain stable. If the gauge reading drops look for a good connection to the system and then for leaks in the system.

Look at all hoses, pipes, joints, gaskets, the water pump, the heater and water valve for external leaks. Look inside the vehicle under the heater for leaks from the heater matrix. If no external leaks are visible, check the coolant for oil contamination. (Possible internal leaks.)

Apply a pressure of about half the operating pressure and run the engine. Look for a rapid pressure rise, which would indicate a cylinder head gasket leak or crack between the cylinder or cylinder head and the water jacket.

If the pressure remains stable but internal leakage is suspected, use a combustion gas detector kit with the pressure tester. If the test fluid changes color during the test combustion gases have been detected in the coolant confirming an internal leak.

Fit the radiator/expansion tank pressure cap to the tester using an appropriate adapter and check that the operating pressure is held at the specified value. Remove the cap and check the vacuum valve seal operation and condition.

Compare all findings with manufacturer's data. Report faults found.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

244. Check air conditioning system for leaks.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Two methods are recommended for this task. The first is an electronic leak detector; the second is an ultra violet lamp and an additive for the refrigerant.

Set up the detector as instructed by the equipment manufacturer. Select R12 or R134a as appropriate.

Visually inspect all connections and components for signs of an oily deposit (a sign of refrigerant leak). When testing for leaks hold the probe under suspected areas because refrigerant is heavier than air.

Using the test probe, check for leaks from connections/components as follows:

Charge/test connection valves.

Condenser.

Receiver drier.

Compressor.

Evaporator and control valve.

Pressure switches.

Leaks are commonly the result of loose connections or split or damaged O-rings. If a leak is found, the system must be drained as described in the Repair and Maintenance section worksheet. The appropriate repair made and the system refilled as described in the Repair and Maintenance section worksheet.

Finally, make sure all caps and any covers that were removed are replaced securely.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

245. Draining, evacuating and filling an air conditioning system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: Always follow the unit manufacturer's instructions when evacuating of filling a system. At no times should refrigerant be released into the atmosphere. Many types of servicing units are available so the instructions here are intended to be generic. Any oil lost must be replaced. It is important to ensure the refrigerant handling equipment manufacturers instructions are followed during this task. Particularly with respect to the correct operation and maintenance of the equipment.

Determine the recommended lubricant type and quantity required for the system. Run the engine and operate the AC system for a few minutes (this distributes existing refrigerant evenly and makes extraction easier). Connect the blue servicing unit hose to the low pressure connector and the red hose to the high pressure connector. Open the high and low-pressure valves on the gauges to read pressures. If no pressure exists then the system has been leaking. In this case it should not be drained as air would get into the servicing unit.

Switch the servicing unit to 'Drain' mode. Some systems are fully automatic others need to be switched off manually. After draining, wait ten minutes and check the pressure. If it has risen there is still refrigerant in the system. Repeat the process again if necessary.

The system can now be opened for work to be carried out. The refrigerant in some servicing units is cleaned and recycled automatically. To completely evacuate the system, switch the servicing unit to its 'Evacuation' mode. This process can take about thirty minutes. Air conditioning systems are refilled with gaseous refrigerant through the low-pressure connector or liquid refrigerant through the high-pressure connector. Systems should be evacuated before refilling.

High-pressure filling (the preferred method). Check data for the correct quantity of refrigerant and then open the high pressure valve.

Switch the servicing unit to 'Fill' mode and let the specified quantity of refrigerant flow in. Switch off the unit, close valves and disconnect the hoses. Low-pressure filling. Check data for the correct quantity of refrigerant and then open the low pressure valve. Switch the servicing unit to 'Fill' mode and let about half the specified quantity of refrigerant flow in.

Operate the AC system briefly to distribute the refrigerant and then continue to fill. Start the engine and switch on the AC and a high blower speed. This ensures the compressor takes the refrigerant residues from the servicing unit. Switch off the unit, close valves and disconnect the hoses. Inspect condition of discharged oil. On completion of the task, recycled refrigerant should be stored and labeled having consideration for its toxicity and fire hazard.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

246.Reverse flush and test radiator flow rate. Inspect hoses.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Inspect hoses for security and condition.

Inspect the hoses systematically starting at the top hose. Look at the hose for signs of leakage, telltale markings at each end, and for cracking, perishing, chaffing and other damage or deterioration. Squeeze the hose to feel for internal damage from perishing.

If internal damage is suspected remove the hose for internal inspection. Look for a break up of the inner lining of the hose and particles of old hose in the coolant. Check all other hoses, bottom hose, heater hoses, by-pass hose and any other coolant hoses manifolds or pipes.

If the radiator and cooling system is to be cleaned by reverse flushing drain the coolant into a clean drain tray. Undo the bottom hose clip at the water pump inlet and pull off the hose. Inspect the hose internally for condition. Replace the hose if defective.

Remove the radiator pressure cap. Push a mains water hose into the bottom hose and plug with rag to seal the end.

Turn on the mains water and allow the water to flow from the radiator header tank filler neck until it is clean and flows freely. A poor flow indicates a blocked radiator.

In order to clean the engine block by reverse flushing, remove the thermostat and refit the housing cover. Refit the radiator cap and apply mains water pressure to the bottom hose. Allow the water to flow until it runs clean and freely from the water pump bottom hose connection.

Refit the thermostat with a new gasket and sealant on the gasket and any bolts that run into the water passages. Refit all hoses and tighten the clips. Mix new coolant to the specified mixture of water and antifreeze with inhibitors or use a premixed coolant. Do not exceed a 50% to 60% ethylene glycol content, as this does not improve the frost protection. (Over 70% reduces the protection).

Refill the cooling system. Run the engine and bleed air from the system if necessary. Road test and check the engine temperature gauge, the heater operation for hot, cold and intermediate settings. Check airflow temperature agrees with heater settings.

After road testing visually recheck the system for leaks Allow the engine to cool and check the coolant level. Top off if necessary. Do not overfill.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

247.Inspect water pump.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect battery earth or ground lead. Drain the coolant into a clean drain tray. Remove the water pump. Look at the general condition, corrosion, cracks, sealing or other faults.

Check the spindle bearings for wear by rotating and rocking the spindle. Feel and listen for roughness, grating and other abnormalities.

Look closely at the water pump drive pulley flange to spindle joint, usually an interference fit, for signs of slippage.

Look closely at the impeller to spindle joint, also an interference fit, for signs of slippage. Grip the drive flange and impeller and attempt to twist in opposite directions to feel for slippage.

Clean the mating faces of the water pump and engine block and measure for flatness (true). Check by-pass drillings are clean and clear.

Report faults found.

Reassemble water pump to engine.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

248. Inspect heater core for leaks and flow rate.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Pressure test the cooling system and hold a pressure at the system operating pressure. Shown on the radiator pressure cap and engine data.

Look inside the vehicle under the fascia and heater unit for signs of coolant loss. Feel the carpets and check for the distinctive odor of dried coolant and antifreeze.

Check in the engine compartment for leaks from the heater hoses or coolant loss outwards from the heater matrix. Look at the water control valve and hose connections for leakage.

To check the heater matrix for blockage carry out a reverse flow test by disconnecting the heater feed and return hoses. Connect a mains water hose into the return hose and plug with rag to seal the connection. Run the mains water supply until clean water flows freely from the heater.

If the flow is poor the heater matrix is probably blocked and will need either specialist cleaning or replacement.

Report faults found.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

249. Inspect heater controls and heater blower motor.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain information from the driver regarding heater function. Turn the heater control to the coldest setting (with air conditioning off).

Check that the engine warm up time is correct by feeling that the top hose remains cool until the thermostat begins to open. The top hose should then rapidly heat up. If in doubt apply a thermometer to the top hose or in the radiator header tank to check engine temperature.

Check engine heat temperature range. Leave on the cold setting and run the blower motor at all speeds in its range. Does air at the outside temperature flow from the heater ducts. If yes, the cold adjustment is correct.

If warm air flows from the heater check and adjust the temperature control cable to the air mixture flap in the heater or to the water control valve. If this does not give cold air the seals on the control flap or in the water control valve are probably defective.

Turn the heat control to the hottest position and check for hot air from the heater ducts with the blower motor operating.

Check that as the heat control is moved slowly towards the cold position the air temperature from the heater ducts becomes steadily cooler. For water control valve and automatic systems some delay in reducing the temperature may occur.

To check automatic temperature systems allow the engine to cool. Set the temperature control to an intermediate position and check that the air temperature remains stable as the engine warms up.

Check the air directional control by selecting each position in turn and feeling for air flow from the appropriate positions. If incorrect move the control slightly to either side of the proper position to find the adjustment error and then adjust the cable accordingly.

If the heater blower motor fails to operate, check the fuse and electrical feed to the fuse box. If correct check for voltage at the motor terminal block with a voltmeter or test lamp. Follow a wiring diagram for feed and earth or ground cables. Check earth or ground continuity.

If voltage is correct at the terminal block and earth or ground is continuous check the motor brushes and commutator for condition. Brushes may be available as a replacement part but usually a new or replacement motor will be required.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

250. Measure heater blower motor current.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove covers and trim panels as required to gain access to the blower motor and fan.

Check that the fan rotates freely. Note, if access to the motor is difficult, run the motor and listen for unusual noises such as dry bearings.

Switch OFF the ignition and locate the blower motor fuse.

Using a special adaptor or clips and terminals as required, connect an ammeter (a zero to twenty amps scale would be ideal) in place of the fuse. Take particular care now as the motor will be run without fused protection.

Turn the blower switch OFF and the ignition ON.

Turn the blower switch to each speed setting in turn and note the current draw.

Compare the readings to the manufacturer's data if available.

If data is not available, readings in the range as follows would be reasonable: Slow speed 3A, medium speed 5A and full speed 8A.

High readings would indicate a motor fault, low readings would indicate a high resistance in the switch, motor, relay, resistor pack or wiring. Perform volt drop test on components and connections to identify location of high resistance.

Refit the fuse and any other components.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

251. Measure AC pressures, inspect system and report on condition.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Fit a manifold gauge set to the high and low pressure connection points.

Allow the vehicle interior to reach normal room temperature (about 22oC).

Run the engine and set the AC to maximum with recirculated air.

Check for abnormal operating noises in AC system.

Note the pressures and compressor cycle times. Compare to the following table:

Carry out repairs as required.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

252.Inspect drive belt, water pump, cooling fan and radiator airflow.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery earth or ground lead. Check the coolant level (cold engine). Identify the drive belt for the water pump - inside the engine compartment or under the vehicle.

Check the condition of the belt, look for frays, cracks, glazing of the drive faces caused by slippage and check that the tension or free play is within manufacturer's tolerances. Free play of about 12 mm (1/2 inch) on the long side of a V belt is usually correct.

Rock the water pump at the pulley and feel for wear/free play in the spindle bearings. Look for signs of leakage at the water pump spindle seal and the housing to engine block gasket. Look under the pump for telltale stains of coolant leakage on and under the pump.

For engine driven and electrically driven cooling fans check for damage and security. Check the fan cowling for damage and security. This is particularly important for electrically driven fans where the cowling is also the support bracket for the motor and fan assembly.

Check the radiator matrix air passages for blockage. Blow through with an air line if a build up of dust or dirt is visible. Blow through in the reverse direction.

For engine driven fans with a viscous thermostatic coupling check that the fan is free on the hub when the engine is cold. For all fans check that the fitting is correct. Some old steel fans could be fitted the wrong way round.

For electrically driven fans check the motor spindle bearings by rocking and rotating the fan blades and feeling for free play, lumpiness and grinding in the bearings. (Ensure that the battery earth or ground lead is disconnected whenever handling electrically driven fans). Reconnect the battery and run the engine. Check for airflow from the fan and a good air draw through the radiator. For electrically driven fans run the engine to the switch temperature so that the fan operates.

Do not allow engine to overheat if the fan switch does not operate or the fan fails to operate. Check the fan motor by disconnecting the switch terminal block and bridging the connections. The motor should run.

If the motor does not run check for an electrical feed at the terminal block. Connect a test lamp or voltmeter between each terminal and a good earth or ground - turn on the ignition if necessary. Check the switch continuity when cold (not continuous) and when hot (continuous).

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

253.Check system operating temperature - check thermostat opening temperature.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check the system from cold. Set the in car heater to the hottest setting. Insert a thermometer into the radiator header tank or attach to the top hose.

Run the engine. The coolant in the top hose should remain cool until the thermostat opens. Compare the top hose temperature to the heater hose temperature. The heater hose should warm up gradually and the top hose rapidly as the thermostat opens.

When the engine is at its normal operating temperature take a reading from the thermometer and compare with the manufacturer's specifications. Check engine temperature gauge reads correctly.

For electrically driven cooling fan types allow the engine to continue to heat up until the cooling fan operates. Check the temperature in the coolant is within the manufacturer's specifications. Check engine temperature gauge reads correctly.

To check a thermostat that has been removed from an engine use a thermostat tester. Put the thermostat into the water in the tester. Check that the water level is correct and that thermometer is correctly positioned. Turn on the tester to heat the water.

Observe the thermometer and the thermostat and look for the temperature when the thermostat begins to open and when it is fully open. Check the temperatures with the manufacturer's data.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

254. Check operation of in-car heating including air distribution and fan operation

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Set heat control to the coldest setting and run the engine up to normal operating temperature. As the engine heats up check the air distribution control and heater blower motor operation.

Check inside the engine compartment that the heater feed and return hoses are hot and cold, respectively, for water valve types and that both hoses are hot for air mixing types.

Keeping the heat setting on the coldest position turn on the blower fan and check that the airflow from the heater is similar to the outside air temperature.

Check that the fan increases in speed for each of the speed settings and that the airflow increases as the motor speed increases.

Move the heat setting progressively from the coldest to the hottest setting and feel the airflow for a gradual increase in temperature. Do not operate the air conditioning system if fitted.

Check the air distribution control by moving to each position in turn and checking that airflow is directed from the correct outlets.

FOR AIR COOLED ENGINES it is important to check for exhaust gas leakage inside the heat exchanger. Check the heater outlets for odor.

ALTERNATIVELY, for increased SAFETY, use a gas analyzer with the probe inserted into a side window. Seal the window opening with tape. Set the heater controls to the highest temperature. Run the engine and look for the presence of exhaust gases in the vehicle interior. Check for CO, which is toxic.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

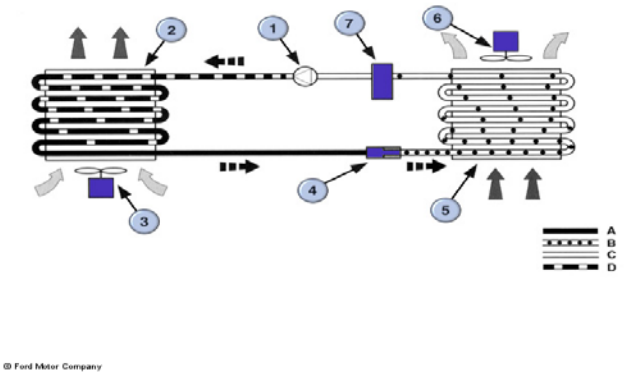
Assignments

A/C System Diagnosis & Repair

Task 1

This picture shows an air conditioning layout.

Name **and** state the purpose of the components labeled 1 to 7



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Answer

Task 2

Describe the basic operation of an air conditioning system using the picture and names of components identified in Task 1.

Answer

Task 3

a) State **three** sources of abnormal operating noises in an air conditioning system

b) State **three** air conditioning system faults that would cause insufficient cooling

Answer

Task 4

a) Name the type of refrigerant most commonly used in modern air conditioning systems.

b) State the main property of refrigerant that makes it suitable for air conditioning systems

c) Explain why the earlier type refrigerant (R12) should not be used in a modern system

Answer

Task 5

Describe **two** methods of checking for refrigerant leaks on an air conditioning system.

Answer

Task 6

a) Name **one** type of lubricant used in an air conditioning system.

b) State how the compressor of an air conditioning system is lubricated.

c) Describe a method of determining an air conditioning system has the correct amount of oil in it.

Answer

Instructor Feedback:

Refrigeration System Component Diagnosis and Repair

Task 1

An air conditioning system compressor clutch will not engage, but there is a 12V supply and a good ground at the clutch coil connector.

a) State the most likely cause of this fault.

b) Describe how this fault cause could be diagnosed.

Answer

Task 2

a) State **three** faults that would cause an air conditioning compressor drive belt to be unserviceable.

b) Describe **two** methods of checking the drive belt tension after replacement.

Answer

Task 3

The picture shows an air conditioning compressor.

Describe a procedure for removing a compressor from a vehicle (include safety procedures that should be adopted at each stage).

Answer

Task 4

a) State **two** precautions that should be observed when fitting O-rings and seals in an air conditioning system.

b) Describe **two** faults that would make an air conditioning hose unserviceable.

Answer

Task 5

When replacing an air conditioning system evaporator, it is important to measure the quantity of oil in the system. Explain how the quantity of oil is measured.

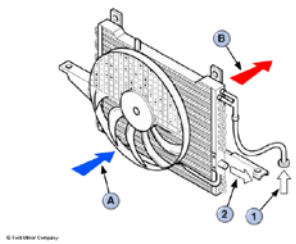
Answer

Task 6

The picture shows an air conditioning system condenser.

a) State the symptoms produced by a condenser that has clogged fins.

b) Describe a method of clearing the blockage from the fins.



Answer

Instructor Feedback:

Heating, Ventilation, and Engine Cooling Systems Diagnosis and Repair

Task 1

The picture shows a test being carried out on a cooling system component.

a) Name the component being tested.

b) State how the test would show that the component is serviceable.

Answer

Task 2

A serviceable liquid cooling system has been drained, flushed and refilled with the recommended coolant. When the vehicle is next used, it is found that the heater will only supply cold air to the vehicle interior.

a) State the likely cause of this fault.

b) Describe how the fault should be rectified.

Answer

Task 3

The picture shows a test being carried out on a liquid cooling system. State:

a) The purpose of the test.

b) The approximate value for the reading on the gauge shown.

c) Where the specification for the gauge can be found.

Answer

Task 4

An electrically operated fan in a liquid cooling system is controlled by a thermostatic switch.

a) State where the switch is fitted in the system.

b) Describe how the operation of the switch should be checked.

Answer

Task 5

The picture shows a test being carried out on a liquid cooling system.

a) Name the instrument being used.

b) State the function of the instrument.

c) Describe how the instrument is used.

Answer

Task 6

State **three** personal safety precautions that should be observed when working on a liquid cooling system.

Answer

Instructor Feedback:

Operating Systems and Related Controls Diagnosis and Repair

Task 1

The picture shows an air conditioning-heater blower assembly.

a) State **three** checks that should be made to the assembly to determine its serviceability.

b) State **three** faults that would cause the fan motor not to run.

Answer

Task 2

Describe **one** fault that would give **each** of the following readings in an ammeter test of a heater fan motor:

a) high readings

b) low readings

Answer

Task 3

Describe **one** check that should be made to **each** of the following to determine their serviceability:

a) switch

b) relay

c) wiring

Answer

Task 4

a) State **two** faults in a compressor clutch control system that would cause a compressor to fail to operate.

b) List the tools and equipment required to test a compressor clutch control system.

c) Describe **one** test that would diagnose a fault in a compressor clutch control system.

Answer

Task 5

a) Describe the symptoms produced by an incorrectly adjusted air conditioning-heater control cable.

b) Describe a method of adjusting an air conditioning-heater control cable.

Answer

Task 6

The picture shows a component being removed from an air conditioning – heater system.

a) Name **and** state the purpose of the component.

b) State **two** factors that would indicate the component needed replacing.

Answer

Instructor Feedback:

Refrigerant Recovery, Recycling and Handling

Task 1

a) State **three** safety precautions that should be observed when using refrigerant handling equipment.

b) State **three** maintenance tasks that should be carried out on refrigerant handling equipment.

Answer

Task 2

a) Name **two** types of refrigerant commonly used in vehicle air conditioning units.

b) Describe how the two types of refrigerant are identified.

Answer

Task 3

Describe how refrigerant should be safely labeled and stored.

Answer

Task 4

Describe **one** method of testing recycled refrigerant for non-condensable gases.

Answer

Task 5

Describe a procedure for draining refrigerant from an air conditioning system.

Answer

Task 6

Describe a procedure for evacuating and charging an air conditioning system following the replacement of a compressor.

Answer

Instructor Feedback:

Manual Drive Train and Axles

Tasklist worksheets

255. Check and adjust clutch freeplay.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Check manufacturer's data.

Check and set pedal height – usually by adjusting a stop bolt.

Visually inspect cable/hydraulics, automatic adjustment mechanism, brackets, bushing, pivots, springs, hydraulic clutch slave cylinder & master cylinder, lines and hoses as appropriate.

With and assistant, check pedal movement BEFORE clutch lever moves.

Adjust to recommended settings.

OR Replace automatic adjuster if setting is incorrect.

Report findings.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

256. Service transmission system.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Important note: Always check manufacturers' data for the correct lubricant type and if transmission drained and refilled or just checked.

Jack up and support the vehicle or raise it on a hoist.

Check Transmission Oil Level

Remove the plug in the side of the gearbox. Note that two plugs are fitted, one to drain the oil at the bottom and the top one for filling up.

If the oil is not at the bottom of the opening, use a pump or 'squeeze' bottle to top off until the oil just runs out of the hole.

Refit the plug.

If appropriate, repeat the previous procedure for the overdrive unit and final drive assembly.

Drain and refill

Drain and refill transmission oil. Note this is best done after the transmission is warm i.e. after a road test.

Inspect transmission/transaxle case, extension housing, case mounting surfaces and vents.

Clean the areas around the plugs and any seals by wiping with a cloth.

Road test the vehicle and then check for leaks.

Double check that any plugs and covers, which were removed, have been refitted securely. Lower the vehicle to the ground.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

257. Service rear wheel drive propshaft.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Apply the handbrake and raise the vehicle on a hoist.

Check propshaft for security and signs of damage.

Check that any balance weights are secure.

Check for oil leaks from the gearbox output seal where the propshaft sliding joint fits.

Check universal joints for signs of leakage (grease).

Using a grease gun, pump new grease into each universal joint (if possible).

Clean off excessive grease.

Check all mounting bolts for security.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

258. Service front wheel drive driveshafts.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Apply the handbrake and raise the vehicle on a hoist.

Check driveshafts for security and signs of damage.

Check that any balance weights and dampers are secure.

Check for oil leaks from the final drive output seals.

Check constant velocity joint gaiters/boots for signs of leakage (grease).

Replace gaiters/boots if any cuts or damage is evident.

Repack with the correct grease. Clean off any excessive grease from the shaft and general area.

Check main driveshaft nut and any other flange bolts for security.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

259. Service final drive and differential.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Jack up and support the vehicle or raise it on a hoist.

Inspect the area around the final drive and differential unit for oil leaks. If necessary clean off old oil, road test and check again. Pay particular attention to the main gasket seals and the driveshaft output oil seals and/or the pinion input seal.

Remove the filler/level plug and check the oil level. The oil should be level with or just below the threads of the plug. Check with a finger or probe if necessary.

If topping off is necessary, refer to the manufacturer's specifications for the correct oil. On most front wheel drive cars, the oil for the final drive and differential is the same as for the main gearbox because the units are combined.

Some vehicles should have the oil changed at certain intervals. If this is the case, drain out the old oil into a tray. It is better to do this after a road test during which time the oil will become warmer and therefore drain out more easily. Some rear axle final drive and differential units do not have a drain plug. In this case, the cover must be removed to drain oil.

On rear wheel drive vehicles with fixed axles and halfshafts, it may be necessary to check for oil leaks into the brake drums on the rear. This would normally be carried out during servicing of the brakes.

Refit any plugs and covers that were removed. Lower the vehicle to the ground.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

260. Service 4WD/AWD final drives and differentials.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This operation is similar to the previous task. However, 4WD/AWD vehicles have three differentials and a transfer box.

Raise and support the vehicle or use a hoist.

Check and top off oil levels; front gearbox/ final drive and/or transfer box and rear differential.

Check all seals and gaskets for leaks.

Check security and condition of all mountings and drive joints.

Inspect front wheel bearings and locking hubs.

If fitted, carry out fault code check of electronic systems.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

261. Replace clutch assembly.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain and follow manufacturer's procedures.

Disconnect battery (ground first), fitting a memory keeper if necessary.

Raise vehicle. Remove starter and driveline components.

Remove clutch cable/slave cylinder and transmission - following procedures.

Remove clutch fork and release bearing assembly.

Remove any dust using recommended health procedures.

Mark the clutch cover if necessary and remove the ring of bolts.

Remove clutch cover and plate.

Inspect, repair, replace as necessary (it is usual to replace as a set).

Inspect engine block, clutch (bell) housing and transmission/transaxle case mating surfaces.

Inspect, remove or replace crankshaft pilot bearing or bushing as applicable.

Check condition of flywheel using dial gauge (see next worksheet). Check ring gear for wear and cracks (measure ring gear run out). Measure crankshaft end play.

Using alignment tool, replace new disc and cover.

Refit all in reverse procedure.

Bleed clutch hydraulic system.

Test operation.

Road test and report findings.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

262. Remove and refit transmission gearbox (transaxle type).

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove

Support the vehicle on a suitable hoist. Fit car protection kit as required and disconnect the battery. Remember to fit a memory keeper if necessary.

Drain the gearbox oil.

Remove any ancillary components as necessary that allow easier access - the exhaust for example.

Mark the gear change linkage and then remove parts as required. Remove the minimum number of parts or remove the linkage as a complete unit where possible. This makes refitting easier.

On some vehicles, it is necessary to remove the suspension on one side to allow access to the gearbox, and for removal of the driveshafts. Remove the driveshafts (a separate worksheet is available).

Remove the speedometer cable or speed sensor. Remove the reverse (backup) light switch wires. Tie these components out of the way if necessary. Remove the starter motor if necessary.

Fit engine support bar as required; remove and inspect mountings, and cross members.

Support the gearbox on a transmission jack if necessary and remove the gearbox or bell housing bolts.

Move the gearbox straight out of the clutch assembly, away from the vehicle and place on a suitable bench.

Refit

As usual – refitting is a reversal of the removal process! However, it is normal to remove and check the clutch assembly. When this is refitted, make sure it is aligned correctly because this makes refitting the gearbox much easier.

Remember to refill with the correct lubricant and that all fixings are tightened correctly.

A road test is recommended to ensure correct operation when the job is completed.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

263. Remove and refit gear change mechanism.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove

Disconnect the earth/ground cable from the battery.

On some cars, it will be necessary to remove the passenger's or driver's seat. Disconnect any electrical wires

Remove the knob at the top of the gearstick. Most will unscrew but some are held with a small screw.

Remove console covers, gaiters and panels as necessary to gain access.

Disconnect the shift rod levers or unscrew the ball joint cover as appropriate.

Disconnect the electrical wiring for the overdrive switch (if fitted).

Remove the gearstick.

Refit

Place the gearstick in position and install the ball joint cover or shift rod levers.

Adjust the linkage if necessary.

Connect the overdrive electrical switch wiring (if disconnected).

Reinstall the covers, panels and other components as appropriate.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

264. Remove and refit wheel bearings.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Front hub assembly. Apply the handbrake and slacken the front road wheel nuts, raise the front of the vehicle, support it on stands and remove the road wheel. Remove the drive shaft nut split pin, use an assistant to apply firm pressure to the brake pedal and, while the brake is applied, unscrew the drive shaft nut. Remove the brake caliper and support it to prevent straining the hose. Remove the disc.

Using a ball joint breaker tool, disconnect the ball joint from the steering lever. Unscrew the nuts and remove the bolts to release the strut from the hub assembly. Unscrew the nut and remove the clamp bolt securing the lower ball joint to the hub assembly and, using a suitable lever placed between the lower arm and the anti-roll bar, lever downwards to release the ball joint from the hub. Remove the hub assembly from the drive shaft. Extract the inner oil seal and spacer and the outer oil seal. Drive out one of the bearings, invert the hub and drive out the remaining bearing. Inspect the bearings for signs of wear and damage, renew as necessary. Pack the bearings with suitable grease and press them into the hub. Fit the oil seal spacer against the inner bearing. Fit the oil seals.

Locate the hub on the drive shaft, fit the flat washer and drive shaft nut and tighten the nut finger tight. Fit the hub assembly to the lower ball joint, fit the clamp bolt and tighten the nut. Fit the hub to the strut, fit the bolts and tighten the nuts to the correct torque. Connect the ball joint to the steering lever and fit and tighten the nut. Fit the disc to the drive flange and tighten the securing screws. Fit the brake caliper. Use an assistant to apply firm pressure to the brake pedal and, while the brake is applied, tighten the drive shaft nut to the correct torque. Lock the nut with a new split pin. Fit the road wheel and nuts.

Rear hub assembly. Chock the front wheels and slacken the rear wheel nuts, raise the rear of the vehicle, support it on stands and remove the road wheel. Withdraw the grease retainer cap from the center of the hub and extract the split pin from the stub shaft. Unscrew the hub nut, remove the flat washer and withdraw the hub and brake drum assembly. Extract the hub oil seal, drive the inner bearing out and collect the spacer. Invert the hub and brake drum assembly and drive out the outer bearing. Inspect the bearings for signs of wear and damage, renew as necessary. Pack the bearings with suitable grease and press the outer bearing into the hub with the side marked 'THRUST' facing outwards. Invert the hub, fit the spacer and press the inner bearing, with the side marked 'THRUST' outwards into the hub. Dip the new oil seal in oil and press it into the hub (sealing lip facing inwards).

Fit the hub and brake drum assembly to the stub shaft, fit the flat washer and fit and tighten the hub nut to the correct torque. Lock the nut with a new split pin. Measure drive axle flange run out and shaft endplay. Fit the grease retainer cap, then fit the road wheel and nuts.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

265. Remove and refit driveshaft.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Apply the handbrake and slacken the road wheel nuts.

Raise the front of the vehicle, support it on stands and remove the road wheel.

Remove the driveshaft nut split pin or lock tab.

Use an assistant to apply the footbrake and then remove the driveshaft nut and washer.

Split the steering track rod end from the steering arm and remove it.

Remove the bolts securing the hub to the suspension strut.

Pivot the hub outwards to the limit of its movement but take care not to strain the brake hose.

Maneuver the drive shaft from the hub.

Carefully lever between the driveshaft inner joint and the differential housing to release the spring ring. Withdraw the driveshaft.

To refit, slide the shaft into the differential housing until the spring ring engages.

Maneuver the outer end of the drive shaft into the hub and fit the nut and washer. A new nut may be required by some manufacturers.

Refit the suspension strut and the steering joint.

Use an assistant to apply the footbrake and then tighten the driveshaft nut to the specified torque. Fit a new split pin or knock in the tab as required.

Refit the road wheel and lower the vehicle. Torque the wheel nuts and road test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

266. Remove and refit differential oil seals (FWD).

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove

Raise the front of the vehicle and support it on stands.

Place a receptacle under the differential to catch oil when the drive shaft is removed, or alternatively, drain sufficient oil from the gearbox to reduce the level below the differential oil seals.

Disengage the driveshaft from the differential and/or…

Remove the road wheel, release the tie rod from the steering arm and disconnect the swivel hub from the front strut. Disengage the drive shaft from the differential.

Pries out the differential oil seal.

Refit

Fit a new differential oil seal, seal lips towards the differential. Use special press tools as required.

Lubricate the seal lips and insert the driveshafts. Connect the swivel hub and tie rod and fit the road wheel.

Lower the vehicle, check the gearbox oil level and top off as necessary.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

267. Remove and refit final drive and differential (FWD & RWD).

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove FWD: Drain the oil from the gearbox and refit the drain plug. Remove the gearbox from the vehicle (separate worksheet). Position the gearbox on its bell housing face and remove the gear case, selector shafts and forks, the mainshaft and countershaft. Lift out the final drive gear and differential assembly.

Remove the roller bearing from the bell housing. Remove the carrier bearings. Remove the differential oil seals. Remove the bolts securing the final drive gear to the differential housing and withdraw the final drive gear. Remove the roll pin securing the differential pinion shaft and remove the pinion shaft. Remove the planet gears, thrust washers and the sun gears. Clean all components and examine for wear and damage.

Refit FWD: Fit the pinion roller bearing to the bell housing. Lubricate and fit the sun gears and planet gears and the differential pinion shaft. Ensure that the roll pinhole is aligned with the differential housing and fit a new roll pin. Select a thrust washer, which will provide the correct backlash. Thrust washer dimensions must be equal in both gears. Backlash may be checked using the vehicle drive shaft inner couplings to centralize the sun gears.

Ensure that the mating faces of the final drive gear and the differential housing are clean and free of burrs. Fit the final drive gear and secure the bolts to the correct torque. Fit the carrier bearings. Fit the final drive and differential assembly to the bell housing. Fit the gear case and secure it to the bell housing.

Ensure that the final drive assembly is fully in position in the bell housing. Check the clearance between the gear case carrier bearing and the gear case bearing recess. If there is no clearance or excessive clearance, slacken the gear case bolts and remove the circlip type shim through the oil seal location. Substitute an alternative shim as required, tighten the gear case bolts and recheck final drive end float. Fit the differential oil seals using special tools as required. Lubricate the seal lips. Fit the gearbox components. Apply sealant to the gear case face and fit the gear case. Fit the gearbox to the vehicle and fill with the correct grade and quantity of oil.

Remove RWD: Jack up and support on stands. Remove the wheels. Undo and remove brake drums. Inspect wheel studs and replace if threads are worn or damaged. Unscrew the bolts holding the bearing clamp and pull out the halfshafts. A slide hammer may be required. Remove the propshaft. Drain oil from the unit if possible – or use a tray to catch the oil as the whole unit is removed. Undo the ring of bolts around the final drive housing. Remove the final drive assembly – with assistance if necessary.

Clean off any old gaskets. Inspect and replace seals. Renew gaskets and use sealant as required. Refit RWD: This is a reversal of the removal process. Top off with the correct new oil. Measure flange run-out and shaft endplay.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

268. Remove and refit transmission gearbox (transaxle 4X4 type).

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: There are many types of transmission gearboxes, therefore the vehicle manufacturer's service information relevant to the transmission being worked on should be available and consulted before carrying out this task.

Remove: Support the vehicle on a suitable hoist. Fit car protection kit as required and disconnect the battery. Remember to fit a memory keeper if necessary.

Inspect seals and vents for signs of leakage and blockage of the vents. Drain the gearbox oil. Remove any ancillary components as necessary that allow easier access - the exhaust for example.

Mark the gear change linkage and then remove parts as required. Remove the minimum number of parts or remove the linkage as a complete unit where possible. This makes refitting easier. If the vehicle has selectable 4WD the selector mechanism for this will need to be disconnected. This may be either mechanically or electrically operated.

On some vehicles, it is necessary to remove the suspension on one side to allow access to the gearbox, and for removal of the driveshafts. Remove the driveshafts (a separate worksheet is available).

Remove the propshaft (a separate worksheet is available). Remove the speedometer cable or speed sensor. Remove the reverse (backup) light switch wires. Tie these components out of the way if necessary. Remove the starter motor if necessary.

Fit engine support bar as required; remove and inspect mountings, and cross members.

Support the gearbox on a transmission jack if necessary and remove the gearbox or bell housing bolts.

Move the gearbox straight out of the clutch assembly, away from the vehicle and place on a suitable bench.

Separate transfer box from gearbox. Disassemble, service and reassemble transfer box following manufacturer's procedures.

Refit: As usual – refitting is a reversal of the removal process! However, it is normal to remove and check the clutch assembly. When this is refitted, make sure it is aligned correctly because this makes refitting the gearbox much easier.

Remember to refill with the correct lubricant and that all fixings are tightened correctly.

Note: the transfer box and gearbox may require different lubricants. A road test is recommended to ensure correct operation when the job is completed.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

269. Remove and replace propshaft and replace universal joint (UJ) and center bearing.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Removal: Jack up vehicle and support on axle stands. If necessary disconnect exhaust to improve access and removal of propshaft. Mark the rear UJ flange and final drive flange in relation to each other.

Remove bolts securing the propshaft to the final drive. Remove bolts securing the center bearing to its support bracket on the underbody, noting the location and number of slotted shims between the bearing and bracket.

Disconnect the propshaft front end from the gearbox by pulling the shaft rearwards. To prevent loss of transmission oil, a suitable plug should be inserted into the oil seal.

Replacement of Universal Joint: Note: Not all universal joints are replaceable. If not, a replacement propshaft will need to be obtained.

Clean away all traces of dirt from the four UJ circlips and remove. If they are difficult to remove, tap the bearing surface resting on the spider with a mallet.

Remove the bearing cups and needle rollers by tapping the yoke at each bearing with a mallet. With the bearing cups removed extract the spider from the yokes.

Thoroughly clean the yokes, journals and circlip grooves. Fit the new spider on the yoke. Refit the bearing cups on the spider and press the bearings home using a press or vice. Replace the circlips.

Center Bearing Replacement: Mark the front and rear sections of the propshaft in relation to each other, and also mark the position of the U-shaped washer located beneath the head of the bolt in the center UJ.

Loosen the bolt in the central UJ so that the U-shaped washer can be removed.

With the U-shaped washer removed, slide the rear section of the propshaft from the front.

Remove the center bearing using a suitable puller. Refitting is a reversal of removal. Ensure the U-shaped washer is fitted in the previously marked position. Refitting the propshaft

Refitting is a reversal of removal. Ensure that previously noted slotted shims are returned to their original location.

Using a straight edge of suitable length, check that the two sections of the propshaft are aligned. Check manufacturer's data for maximum joint angles. Adjustment will be by adding or removing shims from the center bearing. Check transmission fluid level.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

270. Check clutch for chatter/judder.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Apply handbrake, depress the clutch and start the engine. Select first gear.

Increase engine speed to about 1500 rev/min and slowly release clutch pedal.

Note clutch operation as pressure plate first makes contact.

Select reverse gear and repeat as above. Stop engine.

If chatter/judder occurs, raise vehicle on hoist.

Check for loose engine mountings, loose or missing bell housing bolts and for a damaged linkage.

Correct any faults found. Lower vehicle and repeat as above.

Report findings.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

271. Check for clutch drag.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Apply parking brake, depress clutch and start the engine.

Select first gear. Do not release the clutch.

Select neutral but again do not release the clutch. Wait ten seconds.

Select reverse and check for a clash.

If a clash is noticed, raise the vehicle and check clutch linkage.

Inspect hydraulic clutch slave and master cylinders, lines and hoses. A leaking master or slave cylinder will prevent proper release of the clutch and it will therefore drag.

Correct any faults found and repeat the above tests.

Report findings.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

272. Check clutch for slippage.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Apply parking brake and chock all wheels.

Run engine until it reaches normal operating temperature.

Select a high gear (e.g. fourth) and run engine at about 2000 rev/min.

Release clutch pedal slowly until, if possible, it is fully engaged.

The engine should stall. If not, raise vehicle on a lift and check clutch linkage.

Correct any problems found.

If linkage was at fault, repeat the previous tests.

Report findings.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

273. Check for clutch pedal pulsation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Apply parking brake and start the engine.

Slowly depress the clutch until it just begins to disengage. Note any pedal pulsations (some minor pulsations are to be expected).

Depress further and note any further pedal pulsations.

If pulsations are noted, check crankshaft damper/shock absorber and other engine ancillaries.

Correct any faults and repeat the above tests.

Report findings.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

274. Check transmission operation.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Preliminary procedure

Make a visual inspection as part of the preliminary diagnosis routine prior to the road test; note anything that does not look right. Check tire pressures; look for fluid leaks, loose nuts and bolts and bright spots where components may be rubbing against each other. Check the luggage compartment for unusual loads. Check the transmission oil levels.

Establish a route that will be used for all diagnosis road tests. This allows you to get to know what is normal and what is not! The roads selected should have reasonably smooth sections.

Road test the vehicle and define any unusual condition by reproducing it several times throughout the road test. Check for noise, hard shifting and jumping out of gear. Use ALL gears and during the test recreate the following conditions:

Normal driving speeds of 20 to 80km/h (15 to 50mph) with light acceleration.

Harder acceleration and deceleration.

Low speed and high speed.

Over run or coast down.

Coasting with the clutch pedal down or gear lever in neutral and engine idling.

Various engine speeds.

Tight turning circles.

After the road test, continue to inspect the vehicle after raising it on a hoist.

Report any faults found.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

275. Check gear change operation and adjust linkage.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Raise vehicle on hoist or use a jack and stands as required.

Check and top off fluid levels.

Using a lever, check rubber transmission mountings.

Move (with help from an assistant if necessary) the gear change linkage and check for damage or wear.

Make sure each gear is selected during the checking process.

If adjustment is required, refer to the manufacturer's specific recommendations. Some require a special tool to be fitted; others recommend measurements to be taken and the lengths of threaded rods to be set.

If a linkage has to be removed for repair work, a good tip is to mark it carefully first. Use small scratches or dot punch marks.

Complete the checks or adjustment routines with a road test.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

276. Check driveline components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: RWD and 4WD systems

Select neutral position and raise the vehicle on a hoist.

Check for oil leaks from the propshaft sliding joint at the gearbox output and from the differential/final drive input.

Check for leaks from the universal joints.

Hold one part of each UJ in turn and rotate the other part back and forth. Check for freeplay.

Check the security of all fixing bolts (usually four at each end).

Check that any balance weights on the shaft are secure.

If a center bearing is fitted, check the bearing by rotating the propshaft (free the wheels for this). Make sure the mountings are secure and that the rubber is in good condition.

If a donut drive is fitted, check it for security and condition.

FWD and 4WD systems

Check for leaks from the differential output seals.

Check for leaks from the driveshaft boots/gaiters. Make sure the clips hold the boots securely.

Check the security of all fixing bolts (used on the inner part of some driveshafts).

The driveshaft should have some axial (back and forth lengthways) movement. However there should be little of no rotational movement in the CV joints. Check this by holding either side of the joints and rocking.

Check that any balance weights on the shaft are secure.

If fitted, check that the damper is secure.

Check the driveshaft main nut for security and that the locking method is intact (split pin or lock tab usually).

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

277. Checking for noise, vibration and harshness (NVH).

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Carry out a thorough visual inspection of the vehicle before carrying out the road test. Look for leaks and loose nuts and bolts. Also, check for bright spots that may indicate components rubbing. Check the tire pressures.

Establish a route that will be used for all diagnosis road tests. This allows you to get to know what is normal and what is not.

Carry out the following during the road test:

Normal driving speeds of 20 to 80km/h (15 to 50mph): With light acceleration.

Acceleration/Deceleration: With slow acceleration and deceleration.

High speed: A vibration may felt in the front floor pan or seats with no visible shake.

Engine rev/min sensitive: A vibration may be felt whenever the engine reaches a particular speed. It may disappear in neutral coasts. Operating the engine at the problem speed while the vehicle is stationary can duplicate the vibration. It can be caused by any component

Normal driving speeds of 20 to 80km/h (15 to 50mph): With light acceleration.

Noise and vibration while turning: Clicking, popping, or grinding noises may be due to the following: Damaged CV joint; loose front wheel, driveshaft joint, boot clamps; another component contacting the driveshaft; worn, damaged, or incorrectly installed wheel bearing; damaged powertrain/drivetrain mountings.

After the road test:

Raise and support the vehicle with all the wheels running free. Explore the speed range of interest using the road test checks as previously discussed.

Carry out a coast down (overrun) in neutral. If the vehicle is free of vibration when operating at a steady indicated speed and behaves very differently in drive and coast, a transmission concern is likely.

Note, however, that a test on the lift may produce different vibrations and noises than a road test because of the effect of the lift. It is not unusual to find a vibration on the lift that was not noticed during the road test. If the condition found on the road can be duplicated on the lift, carrying out experiments on the lift may save a great deal of time. Carry out repairs as required.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

278. Check transmission operation by road testing.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Road test procedure

Make a visual inspection as part of the preliminary diagnosis routine prior to the road test; note anything that does not look right. Check tire pressures, but do not adjust them yet, look for fluid leaks, loose nuts and bolts and bright spots where components may be rubbing against each other. Check the luggage compartment for unusual loads.

Establish a route that will be used for all diagnosis road tests. This allows you to get to know what is normal and what is not! The roads selected should have sections that are reasonably smooth. If a customer complains of a noise or vibration on a particular road and only on a particular road.

Road test the vehicle and define the condition by reproducing it several times throughout the road test. During the road test recreate the following conditions:

Normal driving speeds of 20 to 80km/h (15 to 50mph): With light acceleration, a moaning noise may be heard and possibly a vibration is felt in the front floor pan. It may get worse at a certain engine speed or load. Acceleration/Deceleration: With slow acceleration and deceleration, a shake is sometimes noticed through the steering wheel seats, front floor pan, front door trim panels, etc.

High speed: A vibration may felt in the front floor pan or seats with no visible shake, but with an accompanying sound or rumble, buzz, hum, drone or booming noise. Coast with the clutch pedal down or gear lever in neutral and engine idling. If vibration is still evident, it may be related to wheels, tires, front brake discs, wheel hubs or wheel bearings.

Engine speed: A vibration may be felt whenever the engine reaches a particular speed. It may disappear in neutral coasts. Operating the engine at the problem speed while the vehicle is stationary can duplicate the vibration. It can be caused by any component, from the accessory drive belt to the clutch or torque converter, which turns at engine speed when the vehicle is stopped.

Noise and vibration while turning: Clicking, popping, or grinding noises may be due to the following: Damaged CV joint; loose front wheel driveshaft joint boot clamps; another component contacting the driveshaft; worn, damaged, or incorrectly installed wheel bearing; damaged powertrain/drivetrain mounts.

Check that the vehicle steers in a straight line when required. Note: faults on 4WD vehicle transmission may be incorrectly diagnosed as steering faults. After the road test, continue to inspect the vehicle after raising it on a hoist.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

279. Checking the viscomatic lock in the rear differential.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Release the handbrake.

Slacken the wheel nuts of one of the rear wheels.

Jack up the rear of the vehicle and remove the wheel (the front wheels must remain in contact with the ground).

Apply a torque wrench to the hub nut and turn the wheel approx. half a turn within one second with the torque wrench.

A torque reading of 70 ± 30 Nm must be obtained.

Note: The free wheel must turn in the opposite direction to the wheel turned with the torque wrench. If the driveshaft turns as well, it must be immobilized.

If the specified torque reading is not obtained, the viscomatic lock must be changed complete.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

280. Inspect and measure clutch components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Visually check all parts for scoring, burning and other faults.

Check flywheel and cover for warping.

Use a straightedge and a set of feelers.

Place straightedge across pressure plate and check any gaps. Compare to specifications.

Check flywheel for run-out.

Fit dial test gauge to rear of engine on a stand as required.

Set gauge against flywheel and rotate one full revolution by hand.

Compare results to manufacturer's specifications. It is possible to skim a flywheel if necessary.

Report findings.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

281. Inspect and measure gearbox components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disassemble the gearbox following the manufacturer's procedure, cleaning components as necessary.

Ball and roller bearings

Wash the bearings in a solvent and dry. Rotate the inner and outer races. Listen for noises and feel for any tight spots. Renew if in any doubt.

Main gears, final drive gears & differential gears

Look for signs of wear and chipped teeth. Use a wire to check any oil passages.

Mainshaft

Check all areas for wear and damage. The shaft bearing surfaces can be measured with a micrometer and compared to data. Remember to check inside the bearings as well as the shaft.

Layshaft/Counter gear assembly

On many gearboxes, this is a single assembly. The gears should be checked for wear and chipping; the bearing surfaces for wear and ovality using a micrometer.

Synchronizers

The main parts to check are the synchronizer cone clutches and the dog clutches. Also, check where the selector forks run for wear.

Reverse gear and shaft

Look for signs of wear and chipped teeth. Use a wire to check any oil passages. Check bearing surfaces on the shaft.

Input shaft assembly

Look for signs of wear and chipped teeth on the main gear. Use a wire to check any oil passages. Check the bearing surfaces and the oil seal. Seals are normally renewed as a matter of course.

Selector rods and forks

Check for wear and signs of overheating, which may occur if the forks have been rubbing. This may occur if the driver holds the gearstick after a gear is selected.

Detent mechanism

Make sure the balls and springs are in good order. Renew if in any doubt.

Interlock mechanism

This mechanism should prevent two gears being selected at the same time. Examine all components for wear and correct operation.

Gearbox casing

Check for cracks and porosity. Check case mating surfaces with a straight edge. Check bores, bushings and vents. Use new gaskets, seals and sealants when rebuilding.

Other components

Any other parts such as the speedometer drive gear and the reverse light switch should be checked for security and correct operation.

Lubrication devices

Check oil pump or slingers.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

282. Measure propshaft/driveshaft run out.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Raise the vehicle on a hoist and free the driven wheels.

Clean three bands around the propshaft/driveshaft at the front, center and rear.

Mount a dial gauge on a magnetic stand and fit the stand to a solid part of the vehicle body.

Take run out readings at the front, center and rear of the propshaft/driveshaft.

If necessary, unbolt and disconnect the propshaft/driveshaft at one end, turn it half a turn and reconnect.

Take run out readings at the front, center and rear of the propshaft/driveshaft once again.

Compare readings to the manufacturer's specifications.

If necessary replace the propshaft/driveshaft.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

283. Strip down CV joint and assess condition.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove the driveshaft from the vehicle as described in the appropriate worksheet.

Release the two clips securing the outer joint gaiter/boot.

Peel back the boot to expose the joint and use a hide mallet to drive the joint from the shaft.

Remove the spring ring from the shaft and remove the gaiter/boot.

Examine the shaft, gaiters/boots and joints for wear and damage. Renew as required.

On many systems, the complete shaft must be replaced if the inner joint is damaged as it forms part of the main shaft.

To rebuild, fit the gaiter/boot and a new spring ring. Compress the ring to facilitate fitting of the outer joint on to the shaft.

Use a hide mallet to drift the joint in to place over the spring ring.

Pack the joints with grease as specified by the manufacturer and secure the gaiters/boots.

Refit the driveshaft to the vehicle as described in the appropriate worksheet.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

284. Inspect and measure differential bevel gears.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note, self-locking differentials are normally factory set and must be changed as a complete unit. Check the specific manufacturer's recommendations.

Remove the final drive unit and then strip out the crown wheel and differential.

On many systems, halfshaft gears (sun gears) can be examined for excessive play using a feeler gauge.

If the reading is above the recommended value (often about 0.15mm but check data), thrust plates must be renewed.

Before separating the two halves of the differential, mark their relative positions.

Examine all the components for wear and damage.

Renew the thrust plates and check that the halfshaft bevels run smoothly.

Use Loctite, or similar thread locking material, and tighten the bolts, in sequence, to the specified torque.

Rebuild final drive unit.

Refit to vehicle and top off with oil.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

285. Inspect and measure crown wheel backlash, final drive tooth wear and pinion turning torque.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove final drive and differential assembly from the vehicle. Note that the figures listed here are typical but always refer to data specific to the vehicle.

Backlash describes the movement of the crown wheel before it contacts and moves the pinion. It is adjusted by setting the position of the two main bearings.

Tighten bearing cap bolts and slacken off again. Then tighten the cap bolts finger tight.

Screw the two adjusting nuts, with a special tool if necessary, lightly against the bearings.

Set a dial gauge on a magnetic stand and against one tooth of the crown wheel.

Tighten the adjusting nut on the crown wheel side until a backlash of 0.01mm is obtained.

Next, preload the bearing on the differential side.

Measure the backlash at four opposing points and adjust the nut until a reading of 0.1 to 0.2mm is obtained.

Spin the pinion gear several times, recheck and tighten the bearing caps to the prescribed torque.

Coat the crown wheel teeth with touch-up paint or ‘engineer’s blue’. Spin the drive flange several times while braking the crown wheel with a hardwood wedge. Check the wear pattern and adjust the backlash as required within the specified limits as necessary.

Fit lock tabs to the main adjusting nuts.

Finally, measure the drive pinion turning torque. If this is incorrect, a new collapsible spacer must be fitted and the pinion nut torque set. Alternatively, shims are used to set the pinion.

Refit to the vehicle and top off with oil. Use new gaskets as required.

When the task has been completed, record here how it went or how it could be improved next time

Instructor’s signature: **Grade: 1 2 3 4 5**

286. Inspect and reinstall limited slip differential clutch components.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Note: some limited slip differentials may be factory set and therefore must be changed as a complete unit. Check the specific manufacturer's recommendations.

Remove the final drive unit and then strip out the crown wheel and differential.

Flush differential housing

On many systems, halfshaft gears (sun gears) can be examined excessive play using a feeler gauge.

Before separating the two halves of the differential, mark their relative positions.

Examine clutch cone or plates for wear and damage.

Examine all other components for wear and damage.

Rebuild final drive unit.

Use Loctite, or similar thread locking material, and tighten the bolts, in sequence, to the specified torque.

Refit to vehicle and top up with oil.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade: 1 2 3 4 5**

Assignments

General Drive Train Diagnosis

Task 1

State **two** clutch and **two** non-clutch faults which could cause judder when a vehicle moves off from rest.

Answer

Task 2

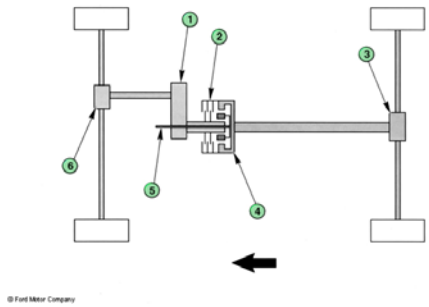
Describe **three** faults in a manual drive train that could cause difficulty in selecting gears.

Answer

Task 3

The picture shows the drive train and axles of a vehicle.

Name and state the purpose of the components labeled 1, 2 and 6.



Answer

Task 4

a) State **four** sources of vehicle service information that may be required during the diagnosis of vehicle drive train faults.

b) Give **two** examples of drive train faults and the information required to diagnose **each** of them.

Answer

Task 5

a) State **three** common sources of transmission oil leakage.

b) A final drive assembly is suspected of having been filled with the wrong grade of lubricant. Describe the procedure that should be taken by a technician to correct this situation.

Answer

Task 6

Describe a procedure for draining and refilling a manual transmission transaxle with lubricant.

Answer

Instructor Feedback:

Clutch Diagnosis and Repair

Task 1

These pictures show clutch center plates.

a) State the purpose of the crimped springs in picture A.

b) State the purpose of the coil springs in picture B.

c) State how the clearance between the release bearing and the diaphragm spring is affected as the linings wear.

Picture A

Picture B

Answer

Task 2

State **two** clutch faults, other than contaminated friction surfaces, which would cause:

a) Noise, b) Pulsation, c) Slippage, d) Chatter

Answer

Task 3

The driver of a vehicle report the 'gears clash' when gear changing. The vehicle has a hydraulic clutch release mechanism and it is suspected this is the source of the fault.

a) State the most likely cause of this fault.

b) Describe a test procedure to identify the fault.

c) State **two** alternative clutch faults that may cause this symptom.

Answer

Task 4

The picture shows a tool that is required during the replacement of a clutch.

a) Explain the purpose of this tool.

b) State the most likely outcome if the tool is not used.

c) State **four** checks that should be made to a clutch friction plate to determine its serviceability

Answer

Task 5

a) Describe a procedure for bleeding a hydraulic clutch release mechanism

b) Explain why it is necessary to bleed the system.

Answer

Task 6

a) With the aid of simple sketches, explain how to measure

(i) Flywheel run out, (ii) Crankshaft Endplay

b) Explain the symptoms produced by **each** of the above, if the measurements are excessive.

Answer

Instructor Feedback:

Transmission/Transaxle Diagnosis and Repair

Task 1

A Transaxle is to be removed from a vehicle for overhaul.

a) List the tools and equipment required to complete this task.

b) State **four** components that may need to be removed/disconnected before the removal of the transaxle from the vehicle.

Answer

Task 2

State **two** transmission faults which could cause the following symptoms:

a) noise

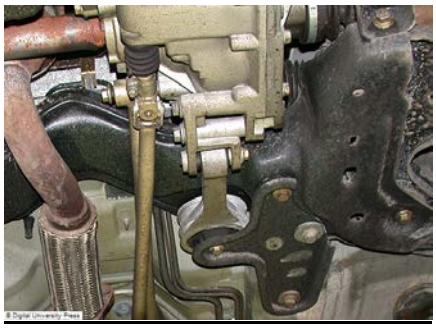
b) hard shifting

c) jumping out of gear

Answer

Task 3

The picture shows a gearbox rubber mounting.



a) State **two** faults that would cause the mounting to be unserviceable.

b) State **two** symptoms the driver would notice if the mounting was unserviceable.

Answer

Task 4

State **two** symptoms a driver would notice for **each** of the following faulty components:

a) selector fork – severely worn

b) detent spring – very weak

c) interlock - broken

Answer

Task 5

Explain with the aid of a sketch, how endplay is measured on a transaxle shaft.

Answer

Task 6

State **two** reasons why each of the following may require replacement:

a) speedometer drive gear

b) speedometer driven gear

c) vehicle speed sensor

Answer

Instructor Feedback:

Drive Shaft and Half Shaft, Universal and Constant-Velocity (CV) Joint Diagnosis and Repair

Task 1

A vehicle is diagnosed as having noise and vibration concerns from a constant-velocity (CV) joint.

a) Describe the driving conditions where these symptoms are most pronounced.

b) Explain how to diagnose the faults that cause these symptoms.

Answer

Task 2

a) Give **two** reasons why a universal joint may be noisy and cause vibration in service.

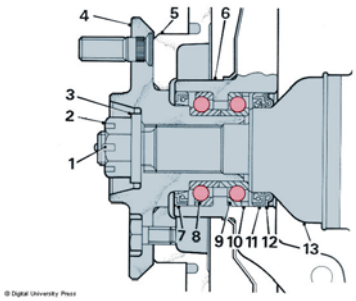
b) Explain how to diagnose faults that cause these symptoms.

Answer

Task 3

The picture shows a FWD hub and wheel bearing assembly.

Describe in sequence, a procedure for replacing the bearing assembly.



Answer

Task 4

The picture shows a constant-velocity joint boot.

Describe a procedure for replacing a split/damaged boot.

Answer

Task 5

State **three** faults which would cause a propshaft center support bearing to be unserviceable.

Answer

Task 6

The picture shows part of a propshaft.

a) State the purpose of the plate marked X which is welded to the shaft.

b) Describe a method of measuring shaft run-out.

Answer

Instructor Feedback:

Drive Axle Diagnosis and Repair

Task 1

The picture shows a measurement being made on a final drive assembly.

a) Name the measurement

b) Describe **one** method of correcting an excessive measurement.

Answer

Task 2

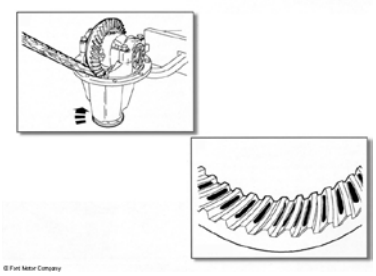
Describe how to measure the rotating torque of a limited slip differential.

Answer

Task 3

The pictures show the checking of a final drive gear tooth contact pattern.

Describe a procedure used to check the gear tooth contact pattern.



Answer

Task 4

A limited slip differential has been filled with the wrong grade of lubricant.

a) State the symptoms this would produce if it were not corrected.

b) Describe how this should be corrected.

Answer

Task 5

a) State **two** faults which would make an axle shaft wheel stud unserviceable.

b) Describe a method of replacing a wheel stud.

Answer

Task 6

A driveshaft seal is leaking and the bearing is known to be in good condition.

a) State **two** possible causes of the seal failure.

b) Describe a method of replacing the seal.

Answer

Instructor Feedback:

Four-wheel Drive/All-wheel Drive Component Diagnosis and Repair

Task 1

A vehicle fitted with a four-wheel drive transmission has unusual steering symptoms reported.

Describe **two** transmission faults that would give this symptom.

Answer

Task 2

A faulty transmission transfer case is to be replaced and refitted to the vehicle.

a) List the tools and equipment required to dismantle the transfer case when removed from the vehicle.

b) State **four** safety precautions that should be observed when refitting the transfer case to the vehicle.

Answer

Task 3

State **six** checks which should be made to components within a transfer case during an overhaul.

Answer

Task 4

Describe how to check the following for serviceability:

a) Front wheel bearings

b) 4WD locking hubs

Answer

Task 5

A four-wheel drive gearbox/transfer case assembly has a blocked vent.

a) State **four** common locations of leaks of transmission lubricant.

b) Explain why a blocked vent is likely to cause leaks.

Answer

Task 6

Describe in sequence, a method of adjusting a shift control cable.

Answer

Instructor Feedback:

General Diagnostics

Tasklist worksheets

287.Oscilloscope diagnostics

Worksheet Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, oscilloscope.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This worksheet can be applied to several different vehicle systems. Add several components in addition to the ones listed, and complete the table:

Sensor/Actuator	Scope settings (time/volts)	Sketch of waveform
Fuel injector		
ABS wheel sensor		
Ignition secondary		

Sensor/Actuator	Scope settings (time/volts)	Sketch of waveform

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

288.On-Board Diagnostics

Worksheet Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual, scanner, etc.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: This worksheet can be applied to several different vehicle systems. Depending on the equipment in use, you may be able to check body and chassis systems as well as the powertrain.

Follow manufacturers' instructions to connect a scanner to the OBD socket.

Scan for fault codes

Correct any faults found

Reset the fault memory

Use the features available on the scan tool to gain live readouts of operation data such as engine speed, lambda sensor output and engine temperature.

Check the status of the main OBD2 monitors

Record your findings here:

Remove the equipment from the vehicle.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

Assignments

Diagnostics

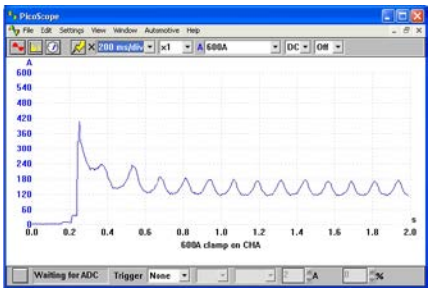
Task 1:

List **four** advantages of using an oscilloscope for testing the output of a mass airflow (MAF) sensor.

Answer:

Task 2:

Using the screen shot of cranking current shown here, explain how this is used to compare cylinder compressions.



Answer:

Task 3:

Describe the process of checking a Hall effect sensor using **each** of the following:

a multimeter, an oscilloscope, a logic probe

Answer:

Task 4:

Outline a suitable test procedure for diagnosing a fault in an ABS systems. Remember to work in a logical sequence.

Answer:

Task 5:

Assuming the problem in the previous task was an open circuit connection to one of the wheel speed sensors, make a short report for a warranty claim. Keep in mind the 'three Cs': concern, cause and correction.

Answer:

Task 6:

Explain what is meant by 'OBD Monitors'. Give examples to illustrate your answer.

Answer:

Instructor Feedback:

Diesel

Tasklist worksheets

289. R&R diesel injector pump electronic sensors, diesel control module (DCM) and actuators

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery ground lead. Refer to a workshop manual for data on electronic systems.

Electronic control systems vary. There are systems with full control of the injector pump which use solenoid valves and data sent from a range of sensors to an electronic diesel control (EDC) module (DCM).

Other systems have fewer sensors and control cold start, injection advance and in some cases the exhaust gas recirculation valves.

To remove components follow manufacturer's data for location and workshop procedures. The EDC/EDM are in some cases programmed to individual vehicles and are not suitable for substitute testing. (Vehicles with immobilizer systems).

Actuators are mainly injector pump components and replaced parts must exactly match the pump and vehicle/engine application.

Test on completion with dedicated/specialist test equipment. Road test for correct operation.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

290. Inspect diesel injectors and glow plugs.

Tools and Equipment: Diesel fuel injector test rig, high capacity ammeter (50+ amps), vehicle body protection kit, standard tool kit, service manual.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Remove injectors from engine. Observe clean working conditions. OBSERVE SAFETY PRECAUTIONS - PROTECT SKIN FROM DIESEL CONTAMINATION.

Fit diesel injectors into test rig. Keep hands clear during operation of the tests. Operate the test equipment in accordance with the manufacturer's instructions.

Check opening pressure. Observe spray pattern and check against manufacturer's data.

Check for leaks from the nozzle tip by holding a pressure just below the opening pressure for the specified time (see manufacturer's data) fully release pressure and check tip for fuel with absorbent paper (blotting paper or similar). Compare size of blot with manufacturer's data.

For adjustable injectors they should be stripped, cleaned and adjusted at this stage. Recheck to ensure cracking pressure and sealing at the nozzle tip.

Check glow plugs with a high capacity (50+ amps) ammeter. Disconnect the glow plug terminals and connect the ammeter between the feed cable and the glow plug terminal. Turn on the ignition and take readings of the current draw. Compare with manufacturer's data.

Remove glow plugs and fit into a glow plug tester (special equipment). Apply an electrical current and observe volts and amps readings. Look at the glow plug tip for the heat pattern. Compare readings and heat pattern with data.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

291. Carry out exhaust smoke test (diesel) Check engine for misfire, hesitation, lack of power

Tools and Equipment: Diesel smoke meter, vehicle body protection kit, standard tool kit, service manual.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Obtain information from driver/owner on performance, last oil change, abnormal noises, etc. Check engine oil level and condition. Check coolant level.

Run engine until warm. Check engine oil temperature with probe on smoke test meter. Listen to engine for misfire, uneven running, exhaust blow and mechanical noises. Blip throttle and look at exhaust smoke. If smoke is obvious investigate condition of air cleaner.

Connect smoke meter sensor pipe into exhaust tail pipe. Follow the prompts on the smoke meter to raise the engine speed to maximum governed speed, release throttle on prompt and observe reading on the smoke meter.

Carry out three times on prompts and compare average reading with statutory requirement or manufacturer's specifications. Turbocharged engines have a slightly higher tolerance than naturally aspirated engines.

If first test (3 sequences) fails wait about 5 minutes before re-testing. Do not repeat test if second test fails. Investigate and rectify faults before further re-testing.

DO NOT carry out tests on cold engines, if the engine oil level is low or if scheduled services have been missed.

White smoke, which is particularly evident when the engine is cold, indicates incorrect injection timing or water from the coolant entering the combustion chamber. Blue smoke indicates the burning of engine oil and is most obvious on engine overrun. Black smoke indicates excess fuel being burnt - check air cleaner for blockage before other components. Report any faults found.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

292. R&R diesel injectors (adjust injection pressure) and glow plugs.

Tools and Equipment: Diesel injector test equipment, vehicle body protection kit, standard tool kit, service manual.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery ground lead. Clean outside and around injectors and glow plugs before removal. Obtain a deep socket for pintle/pintaux injectors. Undo and pull off high pressure pipe unions, cap or plug injector and pipe to prevent dirt from entering. Avoid bending pipes. Pull off leak off pipes and plug. Use the deep socket to unscrew injectors, remove injector and retrieve the sealing ring in the bottom of the injector hole in the cylinder head. Inspect for gas leaks on the sealing ring.

For multi-point injectors undo the high pressure pipes - support the injector with a second spanner to prevent twist, pull off leak off pipes and cap and plug injectors and pipes. Undo securing screws and using special tool pull out the injector. Inspect seals.

KEEP HANDS CLEAR OF INJECTORS DURING PRESSURE TESTS. Check injector cracking pressure and spray pattern using special equipment. Check injector leakage by applying and holding a pressure just below the cracking pressure.

Follow manufacturer's instructions for cleaning and adjusting injectors. Special equipment is required. Some injectors are not serviceable and must be replaced if defective. Always renew the sealing devices when refitting injectors. See manufacturer's fitting instructions.

Refit in reverse order with new sealing washers - ensure that they are the correct way round. Reconnect pipes and tighten to specified torque. Run engine and check for diesel and gas leakage. Disconnect battery ground lead before removing glow plugs. Disconnect and remove electrical terminals on the glow plugs. Unscrew the glow plug from the cylinder head using a deep socket. Inspect. Clean threads and sealing faces (taper seat) if glow plugs are to be refitted. Apply a heat resistant grease to the threads and seal faces before fitting. Screw in hand tight and then tighten to specified torque. Reconnect electrical terminals.

Check engine starts from cold. Glow plugs are supplied with an electrical current through a time relay. To remove and replace the relay identify its location in the main or auxiliary fuse box from a workshop manual and pull out to replace.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5

293. R&R diesel injector pumps adjust injection timing.

Tools and Equipment: Vehicle body protection kit, standard tool kit, service manual.

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand tools; power equipment; proper ventilation; and the handling, storage, and disposal of chemicals/materials in accordance with all appropriate safety and environmental regulations.

Procedure: Disconnect the battery earth/ground lead. WORK IN CLEAN CONDITIONS ONLY. This task must be carried out exactly in accordance with the engine manufacturer's instructions.

Turn the engine in normal direction of rotation to align the timing marks or to insert the timing pins in the camshaft, crankshaft and diesel pump drive pulley. Do not slacken or remove any pump securing bolts until specified in the manufacturer's data.

Disconnect and plug or cap the high pressure pipes as an assembly. Cap the outlets on the pump Disconnect and remove the low pressure feed and return fuel pipes/hoses and cap all connections. Disconnect throttle and cold start cables.

Disconnect electrical terminals and pipes to turbocharged inlet manifold. DO NOT ALTER BASIC PUMP SETTINGS.

Remove timing belt or gear cover to access pump drive gear. Undo and remove pump drive bolts, securing bolts and support bracket bolts. Remove pump and check alignment (timing) marks for reference on reassembly.

Refit in reverse order. Time injector pump to engine in accordance with manufacturer's instructions. Old type rotary pumps require special equipment and dial test indicators. New type pumps have locating dowel settings.

Rotate engine and recheck timing. Ensure correct alignment of timing marks and drive devices. Reassemble pipes, cables and electrical terminals.

Bleed air from the pump and injector pipes before starting engine (old type systems). Prime pump before starting engine (new type systems). Refer to manufacturer's instructions for pre-start procedures.

Run engine and check for correct operation. Check for fuel leaks on high and low pressure pipes.

When the task has been completed, record here how it went or how it could be improved next time

Instructor's signature: **Grade:** 1 2 3 4 5