Examples from the ATT support book

Automotive Technician Training (ATT)

Online editions may also be available for this title.

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Forward

To date I have published several automotive textbooks, for example:

Automobile Electrical and Electronic Systems

Advanced Automotive Fault Diagnosis

However, this series is special. This is because the combination of materials (textbook, multimedia, worksheets, linked questions, assignments etc.) means learning about automobiles is not only more fun, it is more effective. Further, it means instructors and students can work smarter – not just harder.

This 'Support Book' should be used in conjunction with the associated Textbook/Workbook and, most importantly, the DVD or web based materials.

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I have worked in the automotive trade all my life and I still appreciate learning new things. I hope you enjoy your career as much as I have, and still do today. Remember, the key thing about this product is that it is a computer based learning system with a textbook attached – not the other way round. So, go and log in and enjoy!

Good luck with your studies and automotive career.

Tom Denton, ATT, 2007

CONTENTS

Introduction

For the completion of the worksheet tasks and assignments in this book, these recommendations must be followed at all times.

It is assumed that:

- in all areas, appropriate theory, safety, and support instruction will be required for performing each task;
- the instruction has included identification and use of appropriate tools and testing and measurement equipment required to accomplish certain tasks;
- the student has received the necessary training to locate and use current reference and training materials from accepted industry publications and resources;
- all diagnostic and repair tasks described in this document are to be accomplished in accordance with manufacturers' recommended procedures and safety precautions as published.
- all students will receive instruction in the storage, handling, and use of Hazardous Materials and hazardous and toxic materials will be handled, removed and recycled or disposed of according to regulations.

For every task in the workshop, the following safety requirement must be strictly enforced:

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

A key piece of advice:

If in doubt – ASK!

Job card

Driver Name & Address	Job Number	Technician Name
Contact No:		

Account No.	Order No.	Department	Dealer	Date Last Visit

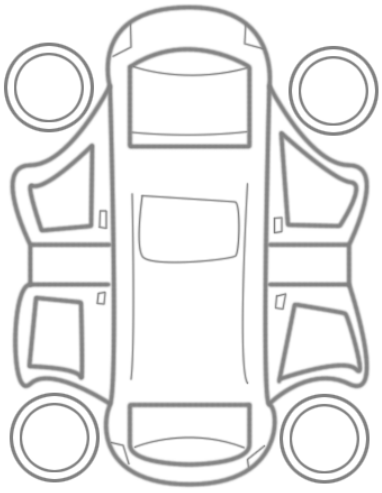
Type	Make/Model	Reg. Date	Chassis/VIN No.	Reg. No.

Colour/Trim	Engine	Warranty	Date In	Date/Time Out
		Y/N		

Customer's Instructions
I agree to the above work being undertaken.
Customer Signature:

Mileage:	
Fuel Reading:	E ¼ ½ ¾ F
Keep Parts:	Y/N
Consumables Used:	Y/N

Make a note here of any noticeable damage to the vehicle bodywork:



Work Carried Out	Time Taken
Total	

Parts Used	Price
Total	

Data and Specifications Used (include the actual figures)
Total

Report	Assessor name, signature and notes

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 that 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 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 pipes

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

Safety: Comply with personal and environmental safety practices associated with clothing; eye protection; hand 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 spanners, 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 labelled 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 labelled 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 centre 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.

Manoeuvre 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.

Manoeuvre 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 centre and towards the outer edge.

Compare the readings to the manufacturer's specifications. Some manufacturers stamp the minimum thickness just inside the centre 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:

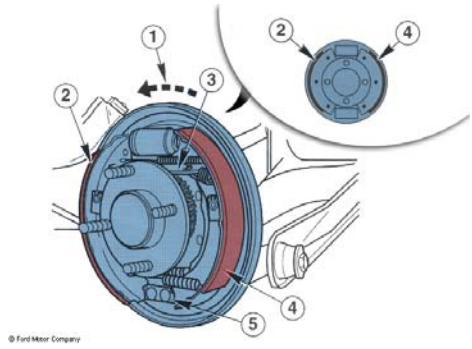
Task 3:

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:

Glossary

A.B.S: Anti-lock braking system.

A.P.I.: American Petroleum Institute. Engine lubricating oil classification suitable for modern engines.

A/C: Air Conditioning

A/C - Air Conditioning: Air conditioning system that uses a refrigerant to remove heat from the air entering the passenger compartment.

A/D Converter: An electronic device used to convert analog values to digital signals for electronic control units and instruments.

A/F: Air/Fuel Ratio

A/T: Automatic transmission.

Abrasion: Wearing away.

ABS: Antilock braking system.

Absolute Pressure: The pressure that exists when the forces of gravity are excluded from the actual pressure. Absolute pressure is equal to gauge pressure plus atmospheric pressure.

Absorption: Of heat. Takes in heat energy. Of sound. Takes in sound energy.

ABSV: Air Bypass Solenoid Valve

AC: Alternating Current

AC - Alternating Current: An electrical current that flows in forward and reverse bias alternately.

Acceleration: Increasing velocity or speed.

Accelerator Pump: Carburettor pumping system that introduces flow of fuel into the carburettor choke (venturi) on acceleration, particularly when accelerating from low speeds.

Accumulator: A hydraulic device that dampens the pulses and retains a residual pressure in a hydraulic circuit.

ACEA: Association des Constructeurs Europeens d'Automobiles. The European organization that sets specifications for lubricants. There are three categories for engine oils. A for petrol/petrol engines. B for light vehicle diesel engines. C for commercial vehicle diesel engines.

Acid: A corrosive liquid. Sulphuric acid forms part of the electrolyte in a battery.

Acidic Compounds: Harmful chemicals that are formed during combustion and can contaminate engine oil. Sulphur in fuel can form sulphuric acid, which can cause corrosion, sludging and lubricating oil defects.

Ackerman Principle: System of steering that produces wheel turning axes around a common point.

ACS: Air conditioning switch.

ACT - Air Charge Temperature: Air charge temperature sensor measures the intake air temperature on fuel injection systems.

ACTS: Air Charge Temperature Sensor

Actuating Pin: A pin that actuates (operates or move) something.

Actuators: Electronic components that receive signals from an electronic control unit (ECU) and operate to make a system work.

Adapter: General term used to describe a device that allows one component to fit with another.

Adaptive Memory: A computer memory process that allows for changes in an open-loop mode.

Additive: A chemical added to improve the properties or performance of something.

Adhesion: The oiliness property of a lubricant that gives it the property to stick and remain on a surface.

ADJUST: To bring components to specified operational settings.

Adjuster: General term used to describe a component that changes the adjustment of something (brake shoes or brake bands for example).

Advance Meter: Timing light that is able to show degrees of ignition advance.

Aeration: Air mixture in a hydraulic liquid that reduces the performance of a hydraulic system.

Aesthetic Value: A value put on how nice or appealing something looks.

AFC: Air Flow Control

AFM: Air Flow Meter

AFS: Air Flow Sensor

Air Bleed Valve: An automatic device used on fuel injection systems to provide fast idle during cold start and warm up.

Air Charge: Description of the amount of air taken into an engine on the induction stroke.

Air Charge Temperature: Temperature of the air taken in on the induction stroke.

Air Cleaners/Filters: Canisters holding paper, plastic foam or gauze elements to trap dirt and grit.

Air Flow: Movement of a quantity of air past a point in a set time.

Air Gap: The gap between two parts of a component, such as the spark plug electrodes, an inductive sensor or an armature and field shoes of a motor or generator.

Air Horn: The air inlet side of a carburettor or throttle body assembly.

Air Injection: An emission control device that adds air to the exhaust to add oxygen for the conversion of hydrocarbons and carbon monoxide to water and carbon dioxide. Usually fitted up stream of a catalytic converter.

Air Intake Duct: A pipe or similar used as part of the intake manifold or general system.

Air Lock: A bubble of air in a hydraulic system that can be compressed and therefore reduces the performance or causes failure of the system.

Air Resistance: Friction force caused by, for example, a vehicle moving through the air.

Air Temperature Sensor: Electronic device that provides information for engine management systems and frost warning indicator.

Air-fuel Ratio: The air and fuel mixture strength ratio.

Airflow Meter: Provides information to fuel injection system electronic control unit (ECU) on engine load. Measures the mass of air entering an engine.

Airflow Sensor Plate: Mechanical fuel injection component that moves in proportion to the air intake and sets fuelling accordingly.

Airline: A pipe that delivers compressed air.

ALCL: Assembly Line Communications Link

ALCL/ALDL: Assembly line communication or diagnostic link. A multisocket connector for attaching a diagnostic tool to a vehicle electronic system.

ALDL: Assembly Line Data Link

ALIGN: To bring to precise alignment or relative position of components.

Alignment: Bringing into line.

Allen: A name used to describe a hexagonal key.

Alloy: A mixture of metals and other elements to form a metal with specific properties such as phosphor bronze used for bushes.

Alternator: An electrical generator attached to and driven by a motor vehicle engine.

Alternator Brushes: Soft carbon brushes that conduct electricity to the field windings via the slip rings.

Ambient Pressure: Air pressure in the surrounding area.

Ambient Temperature: Ambient means surrounding, so ambient air temperature is a surrounding air temperature.

Ammeter: Instrument for measuring electrical current.

Amperage: Strength of an electrical current in amperes.

Ampere (Amp): Electrical unit for measuring the flow of electricity in a circuit.

Ampere-hour-rate: Discharge rate used to describe what a battery would produce. For example, a 40Ah battery will produce 2A for 20Hrs. The 20hrs is an agreed value used to allow comparisons to be made.

Amplification: An increased electrical voltage and/or current compared to say the original signal.

Amplifier: An electronic device that increases or allows an increased electrical voltage and/or current to flow.

Amplitude: The maximum distance moved by a point on a vibrating body or wave measured from its equilibrium position. It is equal to one-half the length of the vibration path i.e. half the peak-to-peak value of a wave.

Amps: Short for Ampere (unit of electrical current)

Anaerobic: Used to describe a sealant that dries when air or oxygen is excluded.

Analog: A measuring process that uses a variable electrical current to provide a signal for computers and instruments.

Analog Gauge: An instrument readout that displays using a moving needle or similar method.

Analyze: To examine the relationship of components of an operation.

Annulus: The outer gear with internal teeth on an epicyclic gear train.

Anode: A positive connection.

Anodized Aluminium: A surface treatment for aluminium that adds an oxidized coating to harden the surface of the component.

Anti-freeze: A chemical such as ethylene glycol, added to the cooling water of an engine to lower the freezing point for winter operation.

Anti-knock: Usually used to refer to an additive that is added to fuel, which makes the burning process more controllable, resulting in reduced tendency to knock.

Anti-roll Bars: Suspension component that reduces vehicle roll.

Anti-trap Function: Facility to prevent electric windows closing and trapping something - your fingers for example! See also Bounce Back.

Antimony: A metal, which is added to lead, to improve its mechanical strength. Batteries were traditionally constructed with lead-antimony.

APS: Absolute Pressure Sensor

APS - Absolute Pressure Sensor: A barometric pressure sensor used to compare atmospheric and manifold pressures in electric fuel injection systems.

Arcing: Conduction of electricity across a gap. An arc is caused as contacts open.

Armature: Electrical windings around the magnets fixed to the spindle of a motor or dynamo.

Asbestos: Fibrous silicate material that can be woven into an incombustible fabric. Requires special handling as it is a hazardous substance.

ASDM: Airbag System Diagnostic Module

Aspect Ratio: Ratio of two axes at right angles to each other such as the long and short sides of a rectangle. When applied to low profile tires it refers to the width and depth and is shown as a percentage value in the tire size marking.

Aspiration: Breathing or induction process of an engine. Non-turbocharged engines may be described as naturally aspirated.

ASSEMBLE (REASSEMBLE): To fit together the components of a device.

Asymmetrical: A description of objects that are different on each side of their centreline.

ATDC: After Top Dead Centre

ATDC - After Top Dead Centre: The position of the crankshaft when the piston has passed the top of the cylinder and is on the way down.

ATF: Automatic Transmission Fluid.

Atmosphere: The air that surrounds the Earth's surface

Atmospheric Pressure: Pressure in the atmosphere produced because of the Earth's gravity. Measured at sea level it has a value of 1 bar, 14.7 psi or 100 kPa.

Atom: Smallest particle in a chemical element that can take part in a chemical reaction. A single particle of an element.

Atomic: Relating to the atom...

Atomization: Breaking up of fuel into fine particles during induction into an engine.

Atomized: The stage in which the metered air/fuel emulsion is drawn in to the air stream in the form of tiny droplets.

ATS: Air Temperature Sensor

Auto-box: See Automatic Transmission

Automatic Adjusters: Brake components that automatically take up wear to keep brake shoes or pads close to the drum or rotor.

Automatic Choke: A carburettor component using a bimetallic strip that operates at low engine temperatures to improve cold start and idle performance. Operates independently of the driver.

Automatic Transmission: A vehicle gearbox with automatic gearshifts based on engine speed and load conditions. Does not require individual gearshifts by the driver.

Auxiliary Air Valve: A valve used to control auxiliary airflow.

Auxiliary Lights: Extra, non-essential lights such as front spotlights or driving lights.

Auxiliary shafts: Shafts that are used on some engines for balance or to drive other components.

Avalanche Diode: A diode that conducts when a value voltage is applied. Used to protect circuits from overload.

AWD: All Wheel Drive

AWD - All Wheel Drive: Transmission system that uses all four wheels of a vehicle to provide a drive. This term is usually used on vehicles with a permanent four-wheel drive that transfers drive to another axle when some loss of drive occurs on the main drive axle. The term 4WD or 4x4 is used for used for vehicles with selectable four-wheel drive.

Axial Loading: Along the axis of a shaft.

Axial Motion: Movement along or parallel to the axis of a shaft.

Axial Piston: A piston that moves in an axial (along an axis in a straight line) direction.

Axis: The centreline through a shaft or axle. The centre about which an object rotates or where the object is in equilibrium.

Axle: Horizontal transverse shaft or beam with spindles on which road wheels are mounted.

Axle Loading: Term used to describe the forces acting on an axle.

Axle Mounting: Method of fixing the axle to the body or springs.

Axle Stands: Vehicle support equipment manufactured with a rated weight capacity. Used to support a vehicle when wheels are removed or when access to the underside is needed. Also known as jack stands.

Axle Windup: A condition in an axle where the driven component locks and the axle casing attempts to rotate on its mountings. Usually caused when a differential lock or limited slip device is used and wheel spin is not possible such as on a dry road.

B+: Battery Positive Voltage

B.A.: British Association old standard size of threads.

B.S. Kite Mark: British Standards Kite Mark. The symbol of the British Standards Institute consisting of a triangle on its point with a capital B on its side above the triangle and a capital S inside the triangle.

B.S.F.: British Standard Fine size of thread.

Babbitt Metal: An alloy of tin, copper, antimony and lead used as a coating for plain steel bearings.

Back EMF: A voltage produced that tends to oppose the voltage that created it.

Back Plate: (1) Non-rotating plate carrying the shoes of a drum brake. (2) Metal member carrying friction material of pad of disc brake.

Back Pressure: The pressure build up in the exhaust caused by the resistance to exhaust flow by pipe diameters and muffler baffles. Used in design to balance an exhaust to an engine. A pressure acting in the opposite direction to normal operation.

Backfire: Combustion of fuel in the intake or exhaust resulting in a loud explosive noise.

Backlash: The clearance between two components usually used to measure the running clearance of gear teeth.

Baffle: A plate that restricts the flow of a gas (muffler) of fluid (fuel tank) in a container.

Baffle Plate: A plate that restricts fluid or air flow.

BALANCE: To establish correct linear, rotational or weight relationship.

Balance Shaft: A rotating shaft geared to another shaft, usually the crankshaft that carries counterbalance weights to bring the shafts into harmonic balance.

Balance Valve: A hydraulic device that controls the pressure in different parts of a hydraulic circuit. Used to balance front and rear brake actuation.

Balance Weights: Small weights used to balance a shaft or a wheel.

Balk Ring: A component of a synchromesh gear hub that provides a cone clutch and guidance of the outer hub to the gear dog teeth.

Ball Bearing: A bearing consisting of inner and outer tracks with a series of ball bearings in between. A single surface hardened steel ball.

Ball Flange: Flexible exhaust connection.