



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: AUTOMOTIVE

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MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 16 pages.

QUESTION 1: MULTIPLE-CHOICE (Generic)

- 1.1 B ✓ (1)
- 1.2 C ✓ (1)
- 1.3 A ✓ (1)
- 1.4 C ✓ (1)
- 1.5 A ✓ (1)
- 1.6 C ✓ (1)
- [6]**

QUESTION 2: SAFETY (Generic)**2.1 Machine safety rule:**

- Know how to switch the machine off / emergency stop. ✓
- Wear personal protective equipment (PPE). ✓
- Know how to use the machine. ✓
- Ensure that all guards are in place. ✓
- No tools lying on the machine. ✓
- Work piece is properly secured. ✓
- Check the condition of the machine. ✓
- Follow manufacture's specifications before operating a machine. ✓
- Operator must have authorization to working on a machine. ✓
- Make sure the machine is not locked out. ✓
- Ensure that the machine setup is correct and safe. ✓
- Ensure that the machine area is clean and safe. ✓

(Any 1 x 1) (1)

2.2 Drill press safety precautions:

- To prevent injuries. ✓
- To improve accuracy. ✓
- To prevent work piece rotating/moving. ✓
- To prevent the drill bit from breaking. ✓

(Any 1 x 1) (1)

2.3 Hydraulic press safety rules:

- Make sure the press is in a good working condition. ✓
- Take notice of the pre-determined maximum pressure of the hydraulic press. ✓
- Make sure the area around the press is clean and free of oil, grease and water. ✓
- Ensure that the platform is rigid and square to the cylinder. ✓
- Ensure that suitable jigs and prescribed equipment is available. ✓
- Check hydraulic pipes for leaks or cracks. ✓
- Check supporting pins are not worn out and fitted properly. ✓

- Check fluid levels. ✓
- Compressive force must be applied at 90° to the object. ✓
- Check cable and pulleys on the platform if equipped. ✓
- Correct PPE. ✓
- Pressure gauge must be checked and calibrated. ✓
- Ensure that all guards are in place. ✓

(Any 2 x 1) (2)

2.4 **Reasons for wearing surgical gloves:**

- To prevent HIV/AIDS or any blood related infections being transmitted. ✓
- To prevent contamination of the open wounds. ✓

(2)

2.5 **Safe handling of portable electrical equipment:**

- Ensure the electrical cord and plug, are in a good condition. ✓
- Ensure all safety guards are in place. ✓
- Ensure that the correct attachments (drill bits, blades etc.) are fixed in the correct way. ✓
- Do not force the machine/equipment. ✓
- Operate according to manufacturer instructions. ✓
- Avoid contact with water. ✓
- Keep the cable away from heat, oil, sharp edges and moving parts. ✓
- Make sure that the wires don't wrap around each other. ✓
- Avoid dropping the machine. ✓
- Check the condition of the equipment. ✓

(Any 2 x 1) (2)

2.6 **Responsibility of employer:**

- Provide and maintain working systems, work area, equipment and tools in a safe condition. ✓
- Eliminate or reduce any potential hazard. ✓
- Produce, handle, store and transport goods safely. ✓
- Ensure that every person employed complies with the requirements of this OHS Act. ✓
- Enforce measures if necessary in the interest of health and safety. ✓
- Appoint a person who is trained and who have the authority to ensure that the employee takes precautionary measures. ✓
- Inform employees of the hazards to his health and safety attached to any duty or work situation. ✓
- Provide first aid equipment. ✓

(Any 1 x 1) (1)

2.7 Responsibility of employee:

- Pay attention to their own and other people's health and safety. ✓
- Co-operate with the employer regarding the OHS Act. ✓
- Carry out a lawful order given to them. ✓
- Report any situation that is unsafe or unhealthy. ✓
- Report all incidents and accidents. ✓
- Not to interfere with any safety equipment or misuse such equipment. ✓
- Obey all safety rules. ✓

(Any 1 x 1)**(1)
[10]****QUESTION 3: MATERIAL (Generic)****3.1 Filing test:**

- Use the right ✓ filing skills. ✓
- File on the tip or edge ✓✓ of the metal.
- By applying chalk ✓ to the file surface. ✓

(Any 1 x 2)**(2)****3.2 Purpose of heat treatment of steel:**

Heat treatment of steel is done to change ✓ the properties/grain structure ✓ of steel.

(2)**3.3 Reasons for tempering hardened steel:**

- To reduce ✓ the brittleness ✓ caused by the hardening process.
- To relieve ✓ strain ✓ caused during hardening process.
- To increase ✓ the toughness ✓ of the steel.
- To give hardened work piece a more ✓ fine-grained structure. ✓

(Any 2 x 2)**(4)****3.4 Heat treatment processes on steel:****3.4.1 Annealing:**

- The steel is heated to the prescribed temperature. ✓
- The steel is soaked at that temperature for the required time. ✓
- The steel is then cooled very slowly to produce maximum softness. ✓

(3)**3.4.2 Hardening:**

- The steel is heated slightly higher than the upper critical temperature. (AC_3) ✓
- The steel is soaked at that temperature for the required time. ✓
- The steel is then rapidly cooled by quenching in rapid cooling medium. ✓

(3)**[14]**

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (Specific)

- 4.1 A ✓ (1)
- 4.2 C ✓ (1)
- 4.3 D ✓ (1)
- 4.4 B ✓ (1)
- 4.5 C ✓ (1)
- 4.6 D ✓ (1)
- 4.7 A ✓ (1)
- 4.8 B ✓ (1)
- 4.9 C ✓ (1)
- 4.10 B ✓ (1)
- 4.11 C ✓ (1)
- 4.12 D & B ✓ (1)
- 4.13 B ✓ (1)
- 4.14 B ✓ (1)

[14]**QUESTION 5: TOOLS AND EQUIPMENT (Specific)****5.1 Cylinder leakage tester:****5.1.1 Labels:**

A – Pressure control valve/Knob/Regulator ✓

B – Gauge/Meter ✓

C – Compressor hose/Air hose/Pipe ✓

D – Spark plug connector/adapter/Hose/Pipe ✓

(4)

5.1.2 Purpose of cylinder leakage tester:

- To determine the percentage ✓ of gas leakage from a cylinder. ✓
- To determine the location ✓ of gas leaks from a cylinder. ✓

(Any 1 x 2)

(2)

5.1.3 Procedure for cylinder leakage test:

- Turn the crank shaft until both valves on cylinder no. 1 are closed (piston no.1 is on power stroke). ✓
- Remove the spark plug and connect the spark plug adaptor (tester) to the spark plug hole. ✓
- Use a spanner to lock the crankshaft pulley so that it cannot turn. ✓
- Release air into the cylinder according to the prescribed pressure. ✓
- The reading will indicate the percentage gas leakage. ✓
- A hissing sound at various points indicates the location of the leak. ✓

(6)

5.2 Compression tester:**5.2.1 Purpose of compression test:**

- To determine the amount of compression pressure ✓ from a specific cylinder during compression stroke (BDC – TDC). ✓
- To determine the condition ✓ of the engine's valves, valve seats and piston rings. ✓

(Any 1 x 2)

(2)

5.2.2 Compression tester release valve:

- Remove the pressure from the gauge ✓ to ensure an accurate reading. ✓
- Remove the pressure from the gauge ✓ to prevent damage to the gauge. ✓

(Any 1 x 2)

(2)

5.3 Gases analysed:

- Carbon monoxide (CO) ✓
- Hydrocarbon (HC) ✓
- Carbon dioxide (CO₂) ✓
- Nitrogen oxide (NO_x) ✓
- Sulphur dioxide (SO₂) ✓
- Oxygen (O₂) ✓

(Any 2 x 1)

(2)

5.4 Purpose of turn tables:

Turn table makes it possible to turn ✓ the front wheels when conducting wheel alignment settings. ✓

(2)

5.5 Outcomes of dynamic wheel balancing is to check:

- The plane of imbalance. ✓
- The extent of unbalancing forces. ✓
- The direction of these forces. (clockwise or counter-clockwise) ✓
- Wheels balanced on all planes. ✓
- Less vibration on the steering. ✓
- Even tyre wear. ✓

(Any 3 x 1)

(3)

[23]

QUESTION 6: ENGINES (Specific)**6.1 Crankshaft vibration:**

- The action upon the shaft of unbalanced forces. ✓
- The torsional or twisting effect of the power strokes upon the shaft. ✓
- Worn vibration damper. ✓
- Uneven flywheel wear. ✓
- Unbalanced crankshaft. ✓

(Any 2 x 1) (2)**6.2 Vibration Damper:**

6.2.1 Vibration damper ✓ (1)

6.2.2 Labels:

- A – Crankshaft ✓
- B – Crankshaft flange/pulley ✓
- C – Secondary flywheel ✓
- D – Friction disc/Rubber ✓
- E – Friction spring ✓
- F – Spring plate/Disc ✓

(6)

6.2.3 The vibration damper adds mass to the crankshaft on the opposite side ✓ of the normal flywheel in order to counteract the torsion of the crankshaft. ✓ (2)

6.3 Firing order of an engine:

- The position of the cranks on the crankshaft. ✓
- The arrangement of the cams on the camshaft. ✓

(2)

6.4 'V8' angle:

90° ✓ (1)

6.5 Intercooler:

To cool the air that has been compressed by the turbo-charger. ✓ (1)

6.6 Purpose of a supercharger:

- To fill the cylinder with an increased air pressure ✓ that is higher than atmospheric pressure. ✓
- To increase ✓ the compression pressure ✓ in the cylinder.
- To increase ✓ the volumetric efficiency ✓ of the engine.
- To improve ✓ the performance. ✓

(Any 1 x 2) (2)**6.7 Centrifugal supercharger:**

6.7.1 Centrifugal supercharger/blower ✓ (1)

6.7.2 Labels:

- A – Air inlet ✓
- B – Air outlet/Exhaust ✓
- C – Casing/Housing/Cover/Body ✓
- D – Impeller/Turbine ✓
- E – Fins/Vanes/Blades ✓

(5)

6.7.3 Operation:

- This blower can be driven mechanically by means of a belt drive from the crankshaft. ✓
- The shaped fins on the impeller move the air around to the outer edge of the impeller into the housing. ✓
- The rotating fins leave a low pressure behind it. ✓
- Due to atmospheric pressure, air rushes in to fill the low pressure at the centre of the impeller. ✓
- The impeller rotates so fast that a continuous movement of air is present, which now builds up a pressure as it is thrown at the rim or the edge. ✓

(5)
[28]**QUESTION 7: FORCES (Specific)****7.1 Swept volume:**

Volume when the piston moves ✓ from bottom dead centre to top dead centre. ✓

(2)

7.2 Method to increase compression ratio:

- Remove shims between the cylinder block and cylinder head. ✓
- Fit thinner cylinder head gasket. ✓
- Machine metal from cylinder head. ✓
- Fit a piston with a higher crown. ✓
- Fit a crankshaft with a longer stroke/through. ✓
- Increase the bore of the cylinders/bigger pistons. ✓

(Any 3 x 1) (3)

7.3 Compression ratio:**7.3.1 Swept volume:**

$$\begin{aligned} \text{Swept Volume} &= \frac{\pi D^2}{4} \times L \quad \checkmark \\ &= \frac{\pi(9,0)^2}{4} \times 10,0 \quad \checkmark \\ &= 636,17 \text{ cm}^3 \quad \checkmark \end{aligned}$$

(3)

7.3.2 Original clearance volume:

$$\begin{aligned} \text{Compression Ratio} &= \frac{SV+CV}{CV} \\ CV &= \frac{SV}{CR-1} \quad \checkmark \\ &= \frac{636,17}{10,5-1} \quad \checkmark \\ &= \frac{636,17}{9,5} \\ &= 66,97 \text{ cm}^3 \quad \checkmark \end{aligned}$$

(3)

7.3.3 **New bore diameter:**

$$\text{New compression ratio} = \frac{SV}{CV} + 1 \quad \checkmark$$

$$11:1 = \frac{SV}{66,97} + 1 \quad \checkmark$$

$$SV = 66,97 \times 10$$

$$\frac{\pi D^2}{4} \times L = 669,7 \quad \checkmark$$

$$D^2 = \frac{669,7 \times 4}{\pi \times 10}$$

$$D = \sqrt{85,27} \quad \checkmark$$

$$= 9,23 \text{ cm} \quad \checkmark$$

$$= 92,34 \text{ mm} \quad \checkmark$$

(6)

7.4 **Power:**7.4.1 **Indicated Power:**

$$IP = P \times L \times A \times N \times n$$

$$P = 1300 \text{ kPa}$$

$$L = \frac{160}{1000}$$

$$= 0,16 \text{ m} \quad \checkmark$$

$$A = \frac{\pi D^2}{4}$$

$$= \frac{\pi 0,12^2}{4}$$

$$= 1,13 \times 10^{-2} \text{ m}^2 \quad \checkmark$$

$$N = \frac{4500}{60 \times 2}$$

$$= 37,5 \text{ ps/s} \quad \checkmark$$

$$n = 4 \text{ cylinders}$$

$$IP = P \times L \times A \times N \times n$$

$$= (1300 \times 10^3) \times 0,16 \times (1,13 \times 10^{-2}) \times 37,5 \times 4 \quad \checkmark$$

$$= 352560$$

$$= 352,56 \text{ kW} \quad \checkmark$$

(5)

7.4.2 **Brake Power:**
 $BP = 2\pi \times N \times T$

$$= 2\pi \times 610 \times \frac{4500}{60} \quad \checkmark \checkmark$$

$$= 2\pi \times 610 \times 75$$

$$= 287455,73 \text{ W} \quad \checkmark$$

$$= 287,46 \text{ kW} \quad \checkmark$$

(4)

7.4.3 **Mechanical efficiency:**

$$\text{Mechanical efficiency} = \frac{BP}{IP} \times 100\%$$

$$= \frac{287,46}{352,56} \times 100\% \quad \checkmark$$

$$= 81,54\% \quad \checkmark$$

(2)

7.5 **Mechanically efficiency** is based on the relationship of the power developed within the engine \checkmark and the actual brake power delivered at the fly wheel. \checkmark

(2)

7.6 **Brake Power** is the useable power \checkmark developed at the flywheel. \checkmark

(2)

[32]

QUESTION 8: MAINTENANCE (Specific)

8.1 **Radiator cap pressure test:**

- Install the cap on the cooling system pressure tester. \checkmark
- Pump up the tester while watching the pressure gauge. \checkmark
- The pressure cap should release air at the rated pressure stamped on the cap. \checkmark
- The cap should hold the pressure for at least one minute. \checkmark
- If not install new cap. \checkmark

(5)

8.2 **Causes and correction for pressure drop:**

Causes:

- Leaks between components of the cooling system. \checkmark
- Leaks at water hose. \checkmark
- Blown cylinder head gasket. \checkmark
- Leaks at water pump. \checkmark
- Leaks at radiator. \checkmark
- Leaks at corroded welsh or core plug. \checkmark
- Leaks at interior heater radiator. \checkmark
- Leaks at heater tap. \checkmark

(Any 2 x 1)

Corrections:

- Renew the gaskets and seals. ✓
- Renew faulty hoses and secure clamps. ✓
- Skim the cylinder head and replace cylinder head gasket. ✓
- Renew water pump. ✓
- Renew the radiator. ✓
- Renew welsh or core plugs. ✓
- Renew interior radiator. ✓
- Renew radiator tap. ✓

(Any 2 x 1) (4)

8.3 Specification to conduct cooling system pressure test, check for:

- Water and anti-freeze ratio. ✓
- Pressure allowed in the radiator. ✓
- Pressure of radiator cap. ✓
- Reading of the cooling system pressure tester. ✓

(Any 2 x 1) (2)

8.4 Safety: Compression test:

- Ensure that tester can handle the pressure you want it test. ✓
- Clean spark plug area to prevent dirt entering when you remove spark plug. ✓
- Ensure rubber hoses on tester are in good order. ✓
- Ensure release valve on the tester is working. ✓
- Ensure using the right spark plug adaptor. ✓
- Disconnect high tension leads. ✓
- Disconnect the fuel feed. ✓
- Make sure the tester is at zero mark. ✓
- Ensure that the air filter is clean. ✓

(Any 4 x 1). (4)

8.5 Gas analyser results:**8.5.1 High carbon monoxide (CO) reading:****Causes:**

- Too rich mixture. ✓
- Ignition misfire. ✓
- Dirty or restricted air filter. ✓
- Improper operation of the fuel delivery system. ✓
- Faulty thermostat or coolant sensor. ✓
- Non-functioning PCV valve system. ✓
- Faulty catalytic converter. ✓

(Any 1 x 1) (1)

- 8.5.2 **Corrective measures:**
- Reset fuel mixture. ✓
 - Check for misfire and repair. ✓
 - Replace air filter. ✓
 - Check and correct fuel delivery system. ✓
 - Check and repair coolant sensor. ✓
 - Check and repair PCV valve. ✓
 - Check and repair or replace catalytic converter. ✓
- (Any 1 x 1) (1)**
- 8.5.3 **Low carbon dioxide (CO₂) reading:**
Causes:
- Fuel mixture too rich or lean. ✓
 - Exhaust system leaks. ✓
 - Ignition misfire. ✓
 - Dirty or restricted air filter. ✓
 - Improper operation of the fuel delivery system. ✓
 - Faulty thermostat or coolant sensor. ✓
 - Non-functioning PCV valve system. ✓
 - Faulty catalytic converter. ✓
- (Any 1 x 1) (1)**
- 8.5.4 **Corrective measures:**
- Reset fuel mixture. ✓
 - Repair or replace exhaust system. ✓
 - Check for misfire and repair. ✓
 - Replace air filter. ✓
 - Check and correct fuel delivery system. ✓
 - Check and repair coolant sensor. ✓
 - Check and repair PCV valve. ✓
 - Check and repair or replace catalytic converter. ✓
- (Any 1 x 1) (1)**
- 8.5.5 **High hydrocarbon (HC) reading:**
Causes:
- Excessive unburned fuel by incomplete combustion. ✓
 - Improper timing. ✓
 - Vacuum leak. (Low fuel pressure) ✓
 - Leaking fuel injector. ✓
 - Defective cold start valve. ✓
 - Faulty air management system. ✓
- (Any 1 x 1) (1)**

8.5.6 **Corrective measures:**

- Reset fuel mixture. ✓
- Check and reset ignition system. ✓
- Check and repair vacuum leaks. ✓
- Check and repair/replace fuel injector. ✓
- Check and repair/replace cold start valve. ✓
- Check and repair air management system. ✓

(Any 1 x 1) (1)

8.6 **Specification to conduct fuel pressure test, check for:**

- Fuel pressure before the carburettor. ✓
- Fuel pressure before and after the injector pump. ✓
- Fuel pressure when engine is idling. ✓
- Fuel pressure on high revolutions. ✓

(Any 2 x 1) (2)

[23]

QUESTION 9: SYSTEMS AND CONTROL (Automatic gearbox) (Specific)9.1 **Purpose of an automatic gearbox:**

- To relieve ✓ the driver of clutch and gearshift operation. ✓
- To promote ✓ smoother and easier ✓ driving of the vehicle.

(Any 1 x 2) (2)

9.2 **Advantages of vehicle fitted with an automatic gearbox:**

- It reduces driver fatigue. ✓
- It reduces wheel spin under bad road conditions. ✓
- The vehicle can be stopped suddenly without the engine stalling. ✓
- The system dampens all engine torsional vibrations. ✓
- It is easier to drive. (e.g. Disabled persons) ✓

(Any 2 x 1) (2)

9.3 **Disadvantages of vehicle fitted with an automatic gearbox:**

- Automatic gearbox is more expensive to manufacture/maintain. ✓
- If a car with automatic gearbox has to be towed for along distance the propeller shaft must be removed. ✓
- Automatic gearbox makes the vehicle heavier that with a manual gearbox. ✓

(Any 2 x 1) (2)

9.4 **Torque converter:**9.4.1 **Labels:**

- A – Ring gear/flex plate ✓
- B – Casing ✓
- C – Stator ✓
- D – Impeller/Pump ✓
- E – Transmission/Shaft/Spigot ✓
- F – Fluid path/Impeller/Pump ✓
- G – Vanes ✓
- H – Turbine ✓

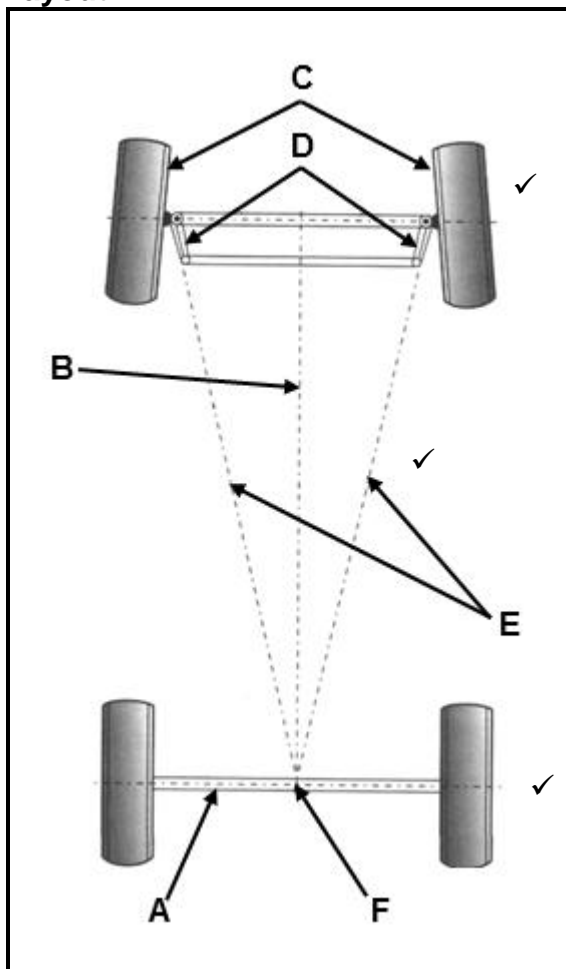
(8)

- 9.4.2 **Advantages of torque converter:**
- Torque increases automatically. ✓
 - Torque is transferred smoothly to reduce shocks on the gearbox, chassis and wheels. ✓
 - Minimum servicing is required. ✓
 - Disconnects at low revolutions. ✓
- (Any 2 x 1) (2)**
- 9.4.3 **Increasing torque converter speed:**
Torque multiplication tapers off ✓ (reduce/decrease) gradually. ✓
- (2)**
[18]

QUESTION 10: SYSTEMS AND CONTROL (Axles, steering geometry and electronics) (Specific)

- 10.1 **Tyre wear:**
- 10.1.1 **Feathering:**
- Toe-in or toe-out wear ✓
 - Worn out king pin ✓
- (Any 1 x 1) (1)**
- 10.1.2 **One side of the thread worn:**
- Camber wear ✓
 - Worn out king pin ✓
 - Incorrect wheel alignment ✓
- (Any 1 x 1) (1)**
- 10.2 **Requirements of well-designed steering mechanism:**
- Light and easy to control. ✓
 - Free from vibration and road shocks. ✓
 - As direct as possible without needing too much driver attention or effort. ✓
 - Self centring. ✓
 - Able to operate without being affected by the action of the suspension or braking system. ✓
- (Any 2 x 1) (2)**
- 10.3 **King pin inclination:**
- 10.3.1 **Label:**
- A – Offset/Scrub radius/pivot angle radius ✓
 - B – 90° - Perpendicular ✓
 - C – Wheel centre line ✓
 - D – King pin inclination angle ✓
 - E – Steering axis centre line/King-pin centre line ✓
- (5)**
- 10.3.2 King pin inclination is the inward tilt ✓ of the top of the king pin viewed from the front. ✓
- (2)**

10.4 Ackerman angle layout:



(3)

Labels:

- A – Rear axle ✓
- B – Longitudinal axis ✓
- C – Front wheels ✓
- D – Steering arms ✓
- E – Extended centre lines from steering arms ✓
- F – Intersection/Centre point ✓

(Any 3 x 1)

(3)

10.5 Purpose of Toe-out on turns:

The toe-out effect in a turn, gives a true rolling motion ✓ to the front wheels in a corner without scuffing. ✓

(2)

10.6 Wheel balancing pre-checks:

- The tyres for bruises, cracks and damaged side walls. ✓
- The wheel rims for damaged beads. ✓
- For foreign matter on rim and tyres. ✓
- Tyre pressure. ✓
- Tyre thread wear. ✓

(Any 2 x 1)

(2)

10.7 **Purpose of catalytic convertor:**
The catalytic convertor converts the pollutants ✓ in the exhaust gases of the engine into non – toxic substances making it environmentally friendly. ✓ (2)

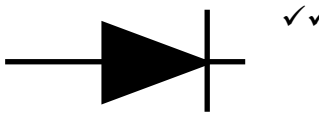
10.8 **Adaptive speed control:**

- Maintain a speed as set by the driver. ✓
- Adapt this speed and maintain a safe distance from the vehicle in front. ✓
- Provide a warning if there is a risk of a collision. ✓
- Prevent driver fatigue. ✓
- To control the set speed. ✓
- Improve fuel economy. ✓
- A constant controlled speed setting prevents speeding fines. ✓

(Any 3 x 1) (3)

10.9 **Function of slip-ring and brush assembly:**
Provide a moveable connection ✓ in order to allow current flow. ✓ (2)

10.10 **Diode symbol:**



(2)

10.11 **Advantages of electric fuel pump:**

- Immediate supply of fuel when the ignition switch is turned on. ✓
- Low operation noise. ✓
- Less discharge pulsation of fuel. ✓
- Compact and lighter design. ✓
- Characterised to prevent fuel leak and vapour lock. ✓
- Delivers fuel at higher pressures. ✓
- Can be placed anywhere in the fuel line. ✓

(Any 2 x 1) (2)
[32]

TOTAL: [200]