



Province of the
EASTERN CAPE
EDUCATION

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

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**MECHANICAL TECHNOLOGY: AUTOMOTIVE
MARKING GUIDELINE**

MARKS: 200

This marking guideline consists of 11 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

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

QUESTION 2: SAFETY (GENERIC)

- 2.1 **Reason for wearing a helmet:**
Protects your eyes from ultra violet rays and infra-red rays. ✓✓ (2)
- 2.2 **Angle grinder safety:**
- Safety guard must be in place before grinding. ✓
 - Protective shields must be placed around the object being ground to protect passers-by. ✓
 - Use the correct grinding disc for the job.
 - Do not use excessive force while grinding and cutting.
 - Make sure there are no excessive force while grinding and cutting.
 - Make sure there are no cracks on the disc before you start a job.
 - Protective clothing and eye protection are essential. (Any 2) (2)
- 2.3 **Maximum gap – bench grinder:**
3 mm ✓ (1)
- 2.4 **Band saw safety:**
- Wear safety glasses or a face shield. ✓
 - Wear protective footwear when required. ✓
 - Make sure all guards are in place. ✓
 - Check for correct tension on the blade.
 - Use blades that are sharp, properly set and suitable for the job.
 - Keep the floor clean and free of obstructions or clutter. (Any 3) (3)
- 2.5 **Gas cylinder safety precautions:**
- Always store and use gas cylinders in an upright position. ✓
 - Never stack cylinders on top of one another. ✓
 - Do not bang or work on the cylinders.
 - Never allow cylinders to fall.
 - No oil and grease should come into contact with gas cylinders or fittings.
 - Keep the caps on the cylinders for protection. (Any 2) (2)
- [10]**

QUESTION 3: MATERIALS (GENERIC)**3.1 Quenching:**

- Quenching means to cool the heated material rapidly. ✓
- Cooling the material to room temperature. ✓
- Water is normally used for low and medium carbon steels. ✓
- Oil is used on high carbon and alloy steel.
- Extreme cooling brine is used.

(Any 3) (3)

3.2 Difference between brine and salt water:

Brine hardens steels better than fresh water, salt inhibits the water from dissolving into atmospheric gas. ✓

Salt water does not vaporise as quickly as fresh water. ✓

(2)

3.3 Purpose of case-hardening:

- It hardens the surface. ✓
- It provides a wear resistant surface. ✓
- Strengthens core to withstand applied loads. ✓

(3)

3.4 Methods of case-hardening:

Mild steel can be surface hardened by heating to its critical range and immersing in case hardening compound. Carbon is absorbed into surface layer of steel. ✓✓

Mild steel can be heated in an atmosphere of nitrogen called Nitriding. ✓✓

(Any 1 x 2) (2)

3.5 Difference between annealing and normalising:

Annealing requires steel to cool down over an extended period thus resulting in an internal structural change in the steel, making it softer. ✓✓

Normalising merely removes work-related stresses. ✓✓

(4)

[14]**QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)**

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

(14 x 1) **[14]**

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

- 5.1 5.1.1 Periscope optical alignment gauge ✓ **OR** (1)
Dunlop gauge optical alignment ✓
- 5.1.2 1 – Contact ✓
2 – Mirror gauge ✓
3 – Periscope ✓
4 – Periscope gauge ✓
5 – Height slot/Height bar ✓
6 – Toe gauge ✓
7 – Calculator ✓
8 – Stand ✓ (8)
- 5.1.3 To check the toe-in and toe-out of a vehicle. ✓ (1)
- 5.2 **Safety rules when using emission gas analyser:**
- The inlet hose must not be constricted in anyway. ✓
 - The hose connection must be airtight and the condenser valve closed. ✓
 - There must be no leaks on the exhaust. ✓
 - The condensate must be blown out of the hose regularly. ✓
 - The hoses must be disconnected from the analyser so that the pump will not be damaged. ✓
 - The condenser must be drained after each use. ✓
 - The paper filter must be changed when turned light grey. ✓
 - The fuel filter on the condenser must be changed regularly. ✓ (Any 4 x 1) (4)
- 5.3 **Set-up procedure for card type compressor tester:**
- Remove the spark plug ✓
 - Put a new card in the tester ✓
 - Depress the throttle valve and crank the engine for at least four revolutions ✓
 - Activate the tester and move to cylinder 2 ✓
 - Do the same for all cylinders ✓
 - Remove the card and compare with specification ✓ (6)
- 5.4 **The main purpose of the following automotive workshop tools:**
- 5.4.1 Gas analyser: To analyse the gas coming out of the exhaust of a motor vehicle. ✓ (1)
- 5.4.2 Wheel balancer: To balance the wheel of a vehicle for static and dynamic balance. ✓ (1)
- 5.4.3 Compression tester: To measure the pressure the piston will create during compression stroke. ✓ (1)

[23]

QUESTION 6: ENGINE (SPECIFIC)**6.1 Purpose of a vibration damper:**

Vibration dampers are fitted to the front of the crankshaft ✓ to smooth out the engine vibrations. ✓

(2)

6.2 Types of vibration dampers:

- Friction face-type ✓
- Combined rubber and friction disc ✓

(2)

6.3 Factors responsible for crankshaft vibration:

- Action of unbalance forces upon the shaft ✓
- Torsional effect of power stroke ✓

(2)

6.4 Factors that determine engine configuration:

- Number of cylinders ✓
- Position of the cylinders ✓
- Engine layout ✓
- Firing order ✓
- Position where the engine is located and how it is mounted ✓ (Any 3 x 1) (3)

6.5 Types of engine cylinder configurations:

- In-line engine ✓
- V-type engine ✓
- Horizontally opposed ✓
- W-engine ✓ (Any 3 x 1) (3)

6.6 Principle of operation of a working turbocharger:

The turbine is driven by the exhaust gases, ✓ the compressor forces more air into the inlet manifold ✓ while the centre hub assembly contains the bearing, lubrication, cooling and shaft that connect the turbine and the compressor ✓

(3)

6.7 Disadvantages of a turbocharger:

- Can have turbo lag problems ✓
- It tends to heat up the compressed air ✓
- Over revving must be controlled by waste gate ✓
- Shut-down procedure must be adhered to in-line with the product specification. ✓ (Any 3 x 1) (3)

6.8 Difference between turbocharger and supercharger

Turbocharger is driven by exhaust gases ✓ while supercharger is driven by a belt and pulley system ✓

(2)

6.9 Types of supercharger

- Root supercharger ✓
- Twin-screw supercharger ✓
- Centrifugal supercharger ✓
- Eccentric / sliding vane supercharger ✓ (Any 3 x 1) (3)

- 6.10 A – Inlet ✓
 B – Casing ✓
 C – Rotor ✓
 D – Vane ✓
 E – Outlet ✓

(5)
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QUESTION 7: FORCES (SPECIFIC)

7.1 Definition of compression ratio:

It is the relationship between the total volume of a cylinder when the piston is at the BDC to the volume of the charge (*combustion chamber*) when the piston is at TDC. ✓✓

(2)

7.2 Swept volume = $\frac{\pi D^2}{4} \times L$ ✓

$$= \frac{\pi(10,5)^2}{4} \times 11,2 \quad \checkmark$$

$$= 969,81 \text{ cm}^3 \quad \checkmark$$

$$\text{Compression ratio} = \frac{SV + CV}{CV} \quad \checkmark$$

$$CR = \frac{969,81 + 98}{98} \quad \checkmark$$

$$CR = 10,9 : 1 \quad \checkmark$$

(6)

7.3 Swept volume = $\frac{\pi D^2}{4} \times L$

$$= \frac{\pi(11)^2}{4} \times 11,2 \quad \checkmark$$

$$= 1\,064,372 \text{ cm}^3 \quad \checkmark$$

$$\text{Compression ratio} = \frac{SV + CV}{CV}$$

$$CR = \frac{1\,064,372 + 98}{98} \quad \checkmark$$

$$CR = 11,9 : 1 \quad \checkmark$$

(4)

7.4 Indicated power (IP):

It is a measure to determine the power developed by the burning fuel within the cylinder of an engine. ✓✓

(2)

7.5 Brake power testing tools:

7.5.1 Electric dynamometer is an electric current generating mechanism fitted to the engine. As the engine drives the generator and by measuring the amount of electricity produced, it determines the engine brake power in the process. ✓✓✓

(3)

7.5.2 Chassis dynamometer is a measuring tool used at the drive wheels of a vehicle. It consists of two rollers loaded in-line with the specifications of increasing resistance in order to determine the brake power of an engine. ✓✓✓

(3)

7.6.1 $P = 1600\ 000\ \text{Pa}$ ✓

$$L = \frac{92}{1\ 000}$$

$= 0,092\ \text{m}$ ✓

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

$$= \frac{\pi 0,099^2}{4}$$
 ✓

$= 7,70 \times 10^{-3}\ \text{m}^2$ ✓

$$N = \frac{4\ 600}{60 \times 2}$$

$= 38,33\ \text{r/s}$

$n = 4\ \text{cylinders}$ ✓

Indicated power = $PLANn$

$$= (1600000) \times (0,092) \times (7,7 \times 10^{-3}) \times (38,33) \times (4) \checkmark$$

$$= 173\ 779,02\ \text{W}$$

$= 173,78\ \text{Kw}$ ✓

(7)

7.6.2 Brake power = $2\pi \times N \times T$ ✓

$= 2\pi 70 \times 280\ \text{W}$ ✓

$= 123\ 150,43\ \text{W}$

$= 123,15\ \text{Kw}$ ✓

(3)

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

$$= \frac{123,15}{173,78} \times 100\% \checkmark$$

$= 70,87\%$ ✓

(2)

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QUESTION 8: MAINTENANCE (SPECIFIC)**8.1 8.1.1 Causes of high hydrocarbon (HC) reading:**

- Excessive unburned fuel by incomplete combustion ✓
- Improper timing ✓
- Vacuum leak ✓
- Faulty air management system ✓

(Any 3 x 1) (3)

8.1.2 Corrective measures:

- Reset fuel mixture ✓
- Check and reset ignition system ✓
- Check and repair vacuum leaks ✓
- Check and repair faulty air management system ✓

(Any 3 x 1) (3)

8.1.3 Exhaust gases that are analysed:

- Carbon monoxide ✓
- Carbon dioxide ✓
- Nitrogen oxide ✓
- Sulphur dioxide ✓
- Oxygen ✓

(Any 2 x 1) (2)

8.2 Carry out wet test on the cylinder ✓

(1)

8.3 Cylinder leakage test procedure:

- Ensure the vehicle is at normal operating temperature ✓
- Remove the air filter, high tension cables, oil cap, radiator cap, dip stick ✓
- Unscrew the spark plug ✓
- Turn the engine until both valves are close on cylinder 1 and keep the crankshaft pulley locked ✓
- Screw in the cylinder leakage tester to the sparkplug hole ✓
- Open the relief valve slowly and check the leakage reading ✓
- Repeat the process on the other cylinders and compare readings with specifications ✓

(7)

Faults	Possible causes	Corrective measures
Hissing sound in inlet manifold ✓	Worn out inlet valve ✓	Replace or lap the inlet valve ✓
Hissing sound in exhaust manifold ✓	Worn out exhaust valve ✓	Replace or lap the exhaust valve ✓
Hissing sound at dip stick or oil filler cap ✓	Piston rings are worn out ✓	Overhaul the engine and fit in new bigger piston and rings ✓
Bubble in radiator water ✓	Blown gasket or cracked cylinder head ✓	Skim the cylinder head and replace gasket ✓

(Any 2 x 3) (6)

8.5 Reason for conducting radiator cap pressure testing:

In order to determine the relief pressure of the radiator cap and compare with specifications ✓

(1)

[23]

QUESTION 9: SYSTEMS AND CONTROL (AUTOMATIC GEARBOX) (SPECIFIC)**9.1 Principle of operation of a torque converter:**

The pump spins, ✓ throwing oil outwards into the curved vanes of the turbine. ✓ The stator intercepts the oil ✓ and redirects the path of the oil to enter the pump smoothly. ✓ The torque produced by the redirected oil is increased when it leaves the pump again to enter the turbine. ✓

(5)

9.2 Function of the following components of an automatic transmission system:

9.2.1 Torque converter multiplies the engine torque automatically according to the road and engine speed. ✓✓

(2)

9.2.2 Brake bands are placed around the annulus to enable the annulus to come stationary position in order to change to another gear. ✓✓

(2)

9.2.3 Hydraulic pistons control the brake bands or the multidisc clutches which allow the change of gear. ✓✓

(2)

9.2.4 Oil pumps are built into the transmission in order to control the brake bands and the multidisc clutches. ✓✓

(2)

9.3 States of torque converter speed:

9.3.1 Stall speed is the point when the pump has reached the highest velocity but the turbine is still at rest. ✓

(1)

9.3.2 Increasing speed is at the point where the turbine begins to turn and the vehicle starts moving. ✓

(1)

9.4 Type of oil used in automatic transmission:

Automatic transmission fluid (ATF) ✓

(1)

9.5 Methods of cooling oil in automatic transmission system:

- The use of special oil cooler alongside the engine cooling radiator ✓
- Oil circulates through a tank built into the bottom of a radiator tank. ✓

(2)

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QUESTION 10: SYSTEMS AND CONTROL (AXLES, STEERING GEOMETRY AND ELECTRONICS) (SPECIFIC)**10.1 Purpose of the following alignment applications in vehicle:**

- 10.1.1 To overcome the tendency of wheels with positive camber to point outwards. ✓✓ (2)
- 10.1.2 To overcome the tendency of wheels with negative camber to point outwards. ✓✓ (2)
- 10.1.3 To enable a vehicle to navigate a circle/curve effectively without skidding. ✓✓

10.2 Camber ✓ (1)**10.3 Functions of the following steering angles:**

- 10.3.1 Camber angle brings the contact point of tyre directly on the road in order to achieve less steering effort. ✓✓ (2)
- 10.3.2 Caster angle gives self-steering action to the steering and keeps the wheel in the straight-ahead position. ✓✓ (2)
- 10.3.3 Kingpin inclination is designed to bring the front wheel back to the straight-ahead position after rounding a corner without any driver effort. ✓✓ (2)

10.4 Factors to be considered before wheel alignment is checked or adjusted:

- Kerb mass must be checked against the manufacturer's specifications ✓
 - Uneven wear on the tyres ✓
 - Tyre pressure ✓
 - Check wheel nuts with torque wrench ✓
 - Correct preload on the hub (wheel bearings) with torque wrench ✓
 - Check kingpin and bushes ✓
 - Suspension ball joints ✓
 - Check suspension bushes for excessive movement ✓
 - Steering box play whether secure on chassis ✓
 - Check the tie-rod ends ✓
 - Sagged springs ✓
 - Check shock absorbers ✓
- (Any 4 x 1) (4)

10.5 Types of wheel imbalance:

Dynamic ✓ and static imbalance ✓ (2)

10.6 Function of electric fuel pump:

To pump fuel from the tank to the ejector at a specified pressure ✓✓ (2)

10.7 Types of electric fuel pump:

- External fuel pump ✓
- In-tank/submerged fuel pump ✓ (2)

10.8 Advantages of an electric fuel pump:

- Low operation noise ✓
- Less discharge pulsation of fuel ✓
- Compact and light design ✓
- They have the ability to prevent fuel leak and vapour lock ✓
- Immediate supply of fuel as the ignition is switched on ✓ (Any 3 x 1) (3)

10.9 Factors that determine injection quantity:

- The pressure ✓
- Injection time ✓
- Injector orifice ✓ (3)

10.10 Advantages of an alternator:

- Higher output to mass ratio ✓
- High output at low engine speed ✓
- Highly reliable ✓
- Small current through brushes and slip rings ✓
- It has current regulation characteristics ✓
- Maximum operation speed can be achieved ✓ (Any 3 x 1) (3)

[32]**TOTAL: 200**