basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE/ NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: AUTOMOTIVE

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MARKING GUIDELINE

MARKS: 200

These marking guideline consist of 19 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 A ✓ (1)

1.2 D ✓ (1)

1.3 A ✓ (1)

1.4 C ✓ (1)

1.5 B ✓ (1)

1.6 B ✓ (1)
[6]

QUESTION 2: SAFETY (GENERIC)

2.1 **Work procedures on machine:**
Switch off machine. ✓ (1)

2.2 **The horizontal band saw:**
- No adjustments to machine or work piece. ✓
- Ensure sufficient coolant on work piece and blade. ✓
- Do not leave machine unattended while in operation. ✓
- Do not lean on machine. ✓
- Keep hands clear from blade. ✓

(Any 2 x 1) (2)

2.3 **Surgical gloves:**
- Prevent contamination of wound ✓
- To prevent transmission of HIV/AIDS or any blood related diseases to the first aid helper. ✓ (2)

2.4 **Personal protective equipment (PPE) during arc welding:**
- Welding helmet / Helmet ✓
- Safety goggles / Face shield ✓
- Leather apron / Apron ✓
- Leather gloves / Gloves ✓
- Leather spat / Spats ✓
- Safety boots / Safety shoes ✓
- Over-all ✓
- Skull cap ✓
- Neck protection ✓
- Ear plugs / Ear muffs. ✓
- Respirator ✓

(Any 2 x 1) (2)

2.5 **Responsibility of the employer regarding the health and safety:**
- Sufficient lighting ✓✓
- Sufficient ventilation ✓✓
- Provide first-aid equipment ✓✓
- Provide a safe / clean working environment ✓✓
- Provide personal protective equipment (PPE) ✓✓
- Provide safety training to employees ✓✓

(Any 1 x 2) (2)

2.6 **Responsible for administering first aid:**
A qualified / trained first aid person ✓ (1)
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QUESTION 3: MATERIALS (GENERIC)

3.1 **Tests to identify various metals:**

3.1.1 **Sound test:**

- Tapping the metal with a hammer (any metal object) ✓ and identify the sound. ✓
- Dropping the metal on the floor ✓ and identify the sound. ✓

(Any 1 x 2) (2)

3.1.2 **File test:**

File the metal and pay attention to the bite of the file into the metal. ✓ The bigger the bite the softer the metal. **OR** The smaller the bite the harder the metal. ✓ (2)

3.2 **Purpose of heat treatment of steel:**

- To change ✓ the properties ✓ of steel.
- To change ✓ the grain structure ✓ of steel.

(Any 1 x 2) (2)

3.3 **Purpose of case hardening on steel:**

To create a hard / wear resistance surface / case ✓ with a tough core. ✓ (2)

3.4 **The tempering process for steel:**

- Heat the steel to a temperature (temper colour) below the critical temperature. ✓
- Soak it at that temperature for a period. ✓
- Quench / cool in an appropriate quenching agent. ✓ (water, brine, or oil) (3)

3.5 **THREE factors for heat treatment of steel:**

- Heating temperature / Carbon content ✓
- Soaking (Time period at temperature) / Work piece size ✓
- Cooling rate / Quenching rate (Quenching medium) ✓ (3)

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QUESTION 4: MULTIPLE-CHOICE (SPECIFIC)

4.1 C ✓ (1)

4.2 B ✓ (1)

4.3 D ✓ (1)

4.4 C ✓ (1)

4.5 A ✓ (1)

4.6 B ✓ (1)

4.7 D ✓ (1)

4.8 D ✓ (1)

4.9 C ✓ (1)

4.10 A ✓ (1)

4.11 D ✓ (1)

4.12 B ✓ (1)

4.13 C ✓ (1)

4.14 C ✓ (1)

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QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

5.1 **Periscope optical alignment gauge:**

5.1.1 **Labels:**

A. Height bar ✓
B. Contact bars ✓
C. Mirror gauge ✓
D. Periscope gauge ✓
E. Toe gauge ✓
F. Calculator ✓
G. Stand ✓ (7)

5.1.2 **Function of optical alignment:**

To check the toe-in and toe-out (wheel alignment) of the vehicle. ✓ (1)

5.1.3 **Set-up procedure:**

- Adjust the contact bars of the periscope gauge as close to the centre height of the rim as possible. ✓
- Adjust the contact bars to the width of the rim. ✓
- Place the mirror gauge next to the periscope gauge and adjust the mirror gauge contact bars to mesh the bars of the periscope. ✓
- Look through the periscope and align the vertical line with the triangle by moving the pointer arm. ✓
- Loosen the wing nut and adjust the toe gauge to “zero”. ✓ (5)

5.2 **Static imbalance:**

A small mass or weight is applied to the wheel rim ✓ diametrically opposite the heavy spot. ✓ (2)

5.3 **Diagnostic scanner engine parameters:**

- Speed / Power ✓
- Temperature ✓
- Voltage ✓
- Timing ✓
- Fuel injected ✓
- Manifold pressure ✓
- Air flow ✓
- Ignition control ✓
- Idle speed control (ISC) ✓
- Engine and emission control ✓
- Failure management ✓
- Self-diagnosis ✓

(Any 3 x 1) (3)

5.4 **Gas analyser result:**

- The analyser will give a lean reading. ✓✓
- The analyser will give an incorrect reading. ✓✓

(Any 1 x 2) (2)

5.5 **Compression test:**

A compression test indicates whether the cylinder pressure ✓ is correct ✓ or incorrect, ✓ according to the manufacturers specifications. (3)

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QUESTION 6: ENGINES (SPECIFIC)

6.1 **Crankshaft:**

6.1.1 **Main function of a crankshaft:**
To convert the reciprocating motion of the piston ✓ into rotary motion. ✓ (2)

6.1.2 **Labels:**
A. Crank pulley mounting / Vibrational damper mounting / Crank nose. ✓
B. Main journal oil way ✓
C. Main journal ✓
D. Main journal oil hole ✓
E. Flywheel mounting / Crank shaft flange ✓
F. Counterweights / Balance weight / Balancing mass ✓
G. Crankpin (big-end) journal ✓ (7)

6.1.3 **Firing orders:**
- 1 – 3 – 4 – 2 ✓
- 1 – 2 – 4 – 3 ✓ (2)

6.2 **Turbocharger:**

6.2.1 A turbo-charger ✓ (1)

6.2.2 **Labels:**
A. Exhaust gas inlet ✓
B. Impeller air outlet / Compressed air outlet / Air outlet ✓
C. Impeller housing / Compressor housing / casing ✓
D. Turbine / Turbine housing / Turbine casing / Rotor casing ✓
E. Exhaust gas outlet ✓ (5)

6.2.3 **Function:**
To increase volumetric efficiency (More air) of the engine. ✓ (1)

6.3 **Engine layouts:**
A. Inline engine / Straight engine ✓
B. V-engine ✓
C. W-engine / Double V ✓ (3)

6.4 **Advantages of a supercharger and turbocharger:**
- Outstanding fuel economy. ✓
- Reduced lag at low revolutions. ✓
- Increased power and torque across the entire power band. ✓
- Reduced power required (sapping effect) by the supercharger pulley from the engine. ✓

(Any 3 x 1) (3)

6.5 **Disadvantages of a supercharger and turbocharger:**

- Decreased power because of energy used for driving the mechanical drive system of the super charger. ✓
- Twin-charging is complex extra valves and clutches are required to switch between the two compressors. ✓
- Expensive electronic / maintenance and / or mechanical controls must be used. ✓

(Any 2 x 1) (2)

6.6 **Connecting rods and pistons:**

- To reduce ✓ reciprocating mass or force. ✓
- Reduce ✓ engine power loss. ✓
- To have a more powerful ✓ engine. ✓
- Less ✓ engine vibration. ✓
- Decrease ✓ engine mass. ✓

(Any 1 x 2) (2)
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QUESTION 7: FORCES (SPECIFIC)

7.1 **Indicated power:**

- Is the theoretical power that can be generated by the engine ✓ without considering any mechanical or other power losses. ✓
- Is a measure to determine the power ✓ developed by burning fuel within the cylinder of engine. ✓

(Any 1 x 2) (2)

7.2 **Lower compression ratio:**

- Fit piston with suitable lower crowns. ✓
- Fit thicker gasket between cylinder block and cylinder head. ✓
- Fit crankshaft with shorter stroke, with suitable connecting rod. ✓

(Any 2 x 1) (2)

7.3 **Types of dynamometer:**

- Electric dynamometer ✓
- Chassis dynamometer ✓
- Inertia ✓
- Water-brake (hydraulic) ✓
- Electric (motoring) ✓
- Eddy Current ✓
- Magnetic Powder ✓
- Hysteresis ✓

(Any 2 x 1) (2)

7.4 **Compression ratio:**

7.4.1 **Swept volume:**

$$\text{Swept Volume} = \frac{\pi D^2}{4} \times L$$

✓

$$= \frac{\pi\ (7{,}0)^2}{4} \times 9{,}0 \quad ✓$$

$$= 346{,}36\ \text{cm}^3 \quad ✓$$

(3)

7.4.2 **Original clearance volume:**

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

$$CV = \frac{SV}{CR - 1}$$

$$= \frac{346{,}36}{7{,}5 - 1} \quad ✓ \quad ✓$$

$$= \frac{346{,}36}{6{,}5}$$

$$= 53{,}29\ \text{cm}^3 \quad ✓$$

(3)

7.4.3 **New bore diameter:**

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

$$9{,}5 = \frac{SV}{53{,}29} + 1 \quad ✓$$

$$SV = 53{,}29 + (9{,}5 - 1)$$

$$SV = 53{,}29 \times 8{,}5 \quad ✓$$

$$= 452{,}965 \quad ✓$$

$$\frac{\pi D^2}{4} \times L = 452{,}965 \quad ✓$$

$$D^2 = \frac{452{,}965 \times 4}{\pi \times 9}$$

$$D = \sqrt{64{,}08} \quad ✓$$

$$= 8{,}005\ \text{cm}$$

$$= 80{,}05\ \text{mm} \quad ✓$$

(6)

7.5 **Power:**

7.5.1 **Torque:**
*** (Distance or Radius)**

$$\text{Torque} = \text{Mass} \times \text{Gravity} \times \text{Distance*}$$
$$= 50 \times 10 \times 1 \checkmark$$
$$= 500 \text{ N. m} \checkmark$$ (2)

7.5.2 **Brake Power:**

$$BP = 2\pi \times N \times T$$
$$\checkmark$$
$$= 2\pi \times \frac{4500}{60} \times 500$$
$$= 2\pi \times 75 \times 500 \checkmark$$
$$= 235\,619{,}45 \text{ W} \checkmark$$
$$= 235{,}62 \text{ kW} \checkmark$$ (4)

7.5.3 **Indicated Power:**

$$IP = P \times L \times A \times N \times n$$
$$P = 1450 \text{ kPa}$$
$$L = \frac{140}{1000}$$
$$= 0{,}14 \text{ m} \checkmark$$
$$A = \frac{\pi D^2}{4}$$
$$= \frac{\pi 0{,}11^2}{4}$$
$$= 9{,}5 \text{ x } 10^{-3} \text{ m}^2 \checkmark$$
$$N = \frac{4500}{60 \times 2}$$
$$= 37{,}5 \text{ power strokes per second} \checkmark$$
$$n = 4 \text{ cylinders}$$

$$IP = P \times L \times A \times N \times n$$
$$= \left(1450 \times 10^3\right) \times 0{,}14 \times \left(9{,}5 \times 10^{-3}\right) \times 37{,}5 \times 4 \checkmark$$
$$= 289\,275 \text{ W} \checkmark$$
$$= 289{,}28 \text{ kW} \checkmark$$ (6)

7.5.4 **Mechanical efficiency:**

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

$$= \frac{235,62}{289,28} \times 100 \quad ✓$$

$$= 81,45\,\% \quad ✓$$

(2)
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QUESTION 8: MAINTENANCE (Specific)

8.1 **Safety setting up gas analyser:**

- The vehicle being tested should have no leaks in the exhaust, manifolds or vacuum system. ✓
- The test must be done in a well-ventilated area. ✓
- Ensure proper battery connection of the gas analyser. ✓
- The tester must be placed in such a way as not to fall onto the engine or off the engine. ✓ (4)

8.2 **Safety setting-up fuel pressure tester:**

- Ensure that the tester can read the pressure of the engine. ✓
- Ensure that the place where you couple the tester is clean before you remove the sender unit. ✓
- Use the right adapter for the engine. ✓
- Ensure the rubber pipe is not perished on the tester. ✓
- Put the tester where it will be safe when cranking the engine. ✓
- Ensure that the pressure relief valve is working properly. ✓
- Check the pressure tightness of the couplings. ✓
- Place the bleed off hose in a container. ✓
- (Any other possible correct answer) ✓

(Any 3 x 1) (3)

8.3 **Compression and cylinder leakage test comparison:**

- The compression test indicates the compression status ✓ in the cylinder ✓ while cylinder leakage test will indicates where ✓ the compression pressure is lost ✓ in the engine cylinder.
- Compression test is done by cranking ✓ the engine ✓ while the cylinder leakage test is done by using ✓ compressed air. ✓

(Any 1 x 4) (4)

8.4 **Safety setting-up a compression tester:**

- Ensure that the tester can handle the pressure you want to test. ✓
- Clean the plug holes with compressed air from all dirt before you remove the spark plug. ✓
- Ensure that the rubber pipes are not perished. ✓
- Ensure that relief valve on the tester is working. ✓
- Ensure that you use the right adapter for the spark plug hole. ✓
- Disable the fuel supply. ✓
- Disconnect the, main wire to the coil and spark plug wires; remove spark plugs. ✓
- Do not let the compression tester fall during setup. ✓

(Any 4 x 1) (4)

8.5 **Oil pressure test faults, causes and corrective measures:**

Faults (Defects)	**Possible causes 8.5.1–8.5.2**	**Corrective measures 8.5.3–8.5.4**
Oil pressure too low	• Blocked oil pump sieve in sump. ✓	• Remove sump, check and clean the sieve ✓
	• Worn main, big-end and camshaft bearings. ✓	• Overhaul the engine, replace bearings ✓
	• Blocked or restricted oil filter ✓	• Replace the oil filter ✓
	• Dirty or contaminated oil ✓	• Change the oil ✓
	• Oil leaks ✓	• Replace defective gaskets ✓
	• Too little oil in the engine ✓	• Top-up oil level ✓
	• Incorrect grade of oil (too thin) ✓	• Use the correct grade of oil , according to manufacturer's specification ✓
	• Defective oil pressure relief valve ✓ **(Any 2 x 1)**	• Renew the relief valve ✓ **(Any 2 x 1)**
Oil pressure too high	**8.5.5–8.5.6**	**8.5.7–8.5.8**
	• Too little clearance on main, big-end and camshaft bearings ✓	• Overhaul the engine ✓
	• Too much oil in the engine ✓	• Change oil ✓
	• Incorrect grade of the oil (too thick) ✓	• Use the correct grade of oil , according to manufacturer's specification ✓
	• Defective pressure relief valve ✓	• Renew the relief valve. ✓
	• Blocked or restricted oil filter ✓ **(Any 2 x 1)**	• Replace oil filter ✓ **(Any 2 x 1)**

(8)
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QUESTION 9: SYSTEMS AND CONTROL (AUTOMATIC GEARBOX) (SPECIFIC)

9.1 **Functions of automatic gearbox:**

- Is to relieve the driver of clutch and gearshift operation. ✓
- Easier driving of the vehicle is promoted. ✓
- To Transmit the drive from the engine to the wheels. ✓
- To multiply engine torque according to load and engine speeds. ✓

(Any 2 x 1) (2)

9.2 **Function of brake bands:**

To enable the annulus to come to the stationary position to change to another gear ratio. ✓ (1)

9.3 **Disadvantages of an automatic gearbox:**

- It is expensive to manufacture. ✓
- If a car with automotive transmission has to be towed for a longer distance the propeller shaft must be removed. ✓
- Expensive to repair. ✓
- Automatic gearbox is heavier than a manual gearbox. ✓

(Any 2 x 1) (2)

9.4 **Advantages of transmission control unit:**

- Better fuel economy ✓
- Reduced engine emissions ✓
- Greater shift system reliability ✓
- Improved shift feel ✓
- Improved shift speed ✓
- Improved vehicle handling ✓

(Any 2 x 1) (2)

9.5 **Components in the epicyclic gear train to obtain different gear ratios:**

- Brake bands ✓
- Multi-disc clutches ✓ (2)

9.6 **Locking sequence of the epicyclic gear train:**

It is achieved by the pressure of the oil from the oil pump ✓ onto the hydraulic piston. ✓ (2)

9.7 **Purpose of "control valve body" in automatic gearbox:**

It directs the oil pressure to activate the hydraulic piston ✓ so that the correct ratio is selected to suit the load and speed. ✓ (2)

9.8 **Operation of the torque converter:**

- As the pump begins to spin oil is drawn outwards into the curved fins of the turbine (vortex action). ✓
- The oil circulates around through the turbine vanes. ✓
- The stator intercepts the oil thrown off by the turbine and redirects the path of the oil so it will enter the pump smoothly, and at the same time add the force of the pump. ✓
- The torque produced by the redirected oil is increased when it leaves the pump again to enter the turbine. ✓
- This allows the torque to multiply. ✓ (5)

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QUESTION 10: SYSTEMS AND CONTROL (AXLES, STEERING GEOMETRY AND ELECTRONIC) (SPECIFIC)

10.1 **Static balancing of a wheel and tyre assembly:**
The equal distribution of all weights ✓ around the axis of rotation ✓ in the rotational plane. (2)

10.2 **The wheel balancing process:**
- Uneven wear on the tyre. ✓
- Tyre pressure. ✓
- The tyres for bruises, cracks and damaged side walls. ✓
- The wheel rim for damaged beads. ✓
- For foreign matter on rim and tyre. ✓

(Any 3 x 1) (3)

10.3 **Alignment angle:**

10.3.1 Positive ✓ caster ✓ angle. (2)

10.3.2 **Positive caster labels:**
A. Point of wheel contact ✓
B. Kingpin ✓
C. Centre line of kingpin ✓
D. Positive caster angle ✓
E. Perpendicular line ✓
F. Front of vehicle / Direction / Wheel / Tyre ✓
G. Contact point of kingpin centre line ✓ (7)

10.3.3 **Definition of positive caster angle:**
Positive caster is the backward tilt ✓ of the king pin at the top, when viewed from the side. ✓ (2)

10.4 **Function of Ackermann principle:**
- To give variable toe-out to the front wheels on turns ✓ and automatically increases or decreases toe-out with the increased or decreased wheel turning angles. ✓
- In a turn it gives a true rolling motion ✓ to the front wheels in a corner without scuffing. ✓

(Any 1 x 2) (2)

10.5 **Purpose of catalytic converter:**
It converts the pollutants and exhaust gases of the engine into non-toxic substances. ✓ (environmentally friendly / less harmful gases.) (1)

10.6 **Requirements for catalytic converter:**

- The converter must be at the temperature of at least 250° ✓
- The temperature should be between 400° and 600° and not be more to prevent the ceramic monolith from damage. ✓
- Unleaded petrol must be used in a vehicle with a catalytic converter. ✓
- The ignition system must be accurately controlled for full effectiveness. ✓
- A persistent misfire will melt the ceramic monolith. ✓
- Burnt engine oil in the exhaust gases will also destroy the monolith. ✓
- The lambda probe exhaust gas sensor must function correctly. ✓

(Any 2 x 1) (2)

10.7 **Operation of lambda oxygen sensor:**

- The sensor is installed in the flow of exhaust gas and reaches the operating temperature quickly from the heat of the exhaust gases. ✓
- The sensor compares the oxygen content in the flow of exhaust gases with the oxygen content in the intake air. ✓
- It then supplies a signal relating current mixture composition to the electronic control unit. ✓
- The electronic control unit will then send signal to the manifold absolute pressure sensor and the air flow meters. ✓
- It will then adjust the air and fuel supply for a near perfect combustion. ✓ (5)

10.8 **Precautionary measures of alternator charging system:**

- Always connect the battery with the negative pole to the negative cable. ✓
- Always connect the booster battery in parallel. ✓
- Disconnect all battery cables before connecting a charger to a battery. ✓
- Do not try to polarise the alternator. ✓
- Never run an alternator on an open circuit. ✓
- Always disconnect the battery before working on alternator. ✓
- Use 12 volts when testing diodes. ✓
- Never tap on a diode. ✓
- Never drop a diode. ✓
- Adjust the fan belt to the correct tension before attempting a voltage test on an alternator. ✓

(Any 4x1) (4)

10.9 **Types of electric fuel pumps:**

- Diaphragm-type pump ✓
- Wesco-type pump ✓
- In-tank electric fuel pumps / Wet / Submerged fuel pump ✓
- External electric fuel pumps / Dry ✓

(Any 2 x 1) (2)

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GRAND TOTAL: 200