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 23 pages.

QUESTION 1: MULTIPLE-CHOICE (GENERIC)

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

QUESTION 2: SAFETY (GENERIC)

2.1 **Examination checks:**

- Severe bleeding ✓
- Internal bleeding ✓
- Head injuries ✓
- Neck injuries ✓
- Fractures ✓
- Vital signs ✓
- Physical abnormalities ✓

(Any 2 x 1) (2)

2.2 **Safety devices on the power-driven guillotine:**

- Finger protectors / Fixed guards / Blade guard ✓
- Rear view mirrors ✓
- Rear light curtains ✓
- Automatic sweep-away ✓
- Revolving warning lights ✓
- Two-hand / dual control device ✓
- Additional emergency buttons ✓
- Self-adjusting guards ✓
- Covered footswitch ✓

(Any 2 x 1) (2)

2.3 **Grinding wheel:**

- The wheel should be rated above the speed of the motor. ✓
- Check for cracks on the grinding wheel. ✓
- Check for chips on the grinding wheel. ✓
- Check that the arbor hole is the correct size. ✓
- Must not be contaminated by oil/fluids or grease. ✓
- Correct size of the wheel. ✓
- Correct type of wheel for the material. ✓

(Any 2 x 1) (2)

2.4 **Gas welding equipment – safety devices:**

- Valve guard ✓
- Flash back arrestor ✓
- Pressure regulator ✓
- C-clamps on hoses/Parallel hose clips ✓
- Acetylene spindle key must always be in place. ✓
- Cylinder valves. ✓

(Any 2 x 1) (2)

2.5 **Advantages of process layout of machines are:**

- High machine utilisation. ✓
- Better supervision. ✓
- Less interruption in the flow of work. ✓
- Lower equipment costs. ✓
- Better control of total manufacturing costs. ✓
- Greater flexibility. ✓

(Any 2 x 1) (2)
[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 **Colour code of metal:**

- To identify the type of metal. ✓
- To identify carbon content especially after the metal was stored. ✓
- To identify the profile/size of the metal. ✓

(Any 1 x 1) (1)

3.2 **Tests to determine properties of steel:**

3.2.1 **Sound test:**

- Hardness ✓
- Softness ✓

(Any 1 x 1) (1)

3.2.2 **Bending test:**

- Ductility ✓
- Bend strength ✓
- Fracture strength ✓
- Resistance to fracture
- Brittleness ✓
- Elasticity ✓
- Plasticity ✓
- Flexibility ✓

(Any 1 x 1) (1)

3.2.3 **Machining test:**

- Hardness ✓
- Strength ✓

(Any 1 x 1) (1)

3.3 **Reasons metal soaked during heat treatment:**

- To ensure uniform heat distribution ✓ throughout the metal. ✓
- To achieve a uniform grain structure ✓ after cooling the metal. ✓

(Any 1 x 2) (2)

3.4 **Case hardening:**

- Carburising ✓
- Nitriding ✓
- Cyaniding ✓

(Any 2 x 1) (2)

3.5 **Annealing process:**

Heating the steel slightly above AC_3, (upper critical temperature) ✓ soaking it for a required time/period ✓ and then slow cooling ✓ back to room temperature. (3)

3.6 **Rapid quenching mediums:**

- Brine/Salt water ✓
- Water ✓
- Nitrogen ✓
- Oil ✓

(Any 2 x 1) (2)

3.7 **Heat treatment process:**

Tempering ✓ (1)

[14]

QUESTION 4: MULTIPLE-CHOICE (SPECIFIC)

4.1	B ✓	(1)
4.2	B ✓	(1)
4.3	C ✓	(1)
4.4	B ✓	(1)
4.5	C ✓	(1)
4.6	B ✓	(1)
4.7	B ✓	(1)
4.8	A or D ✓	(1)
4.9	C ✓	(1)
4.10	C ✓	(1)
4.11	B ✓	(1)
4.12	D ✓	(1)
4.13	A ✓	(1)
4.14	A ✓	(1) **[14]**

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

5.1 **Compression tester:**

5.1.1 **Function of the compression tester:**

- It measures the pressure created ✓ when the piston is at top dead centre on the compression stroke. ✓
- It is used to determine the condition of the piston rings ✓ after a wet compression test. ✓

(Any 1 x 2) (2)

5.1.2 **Reasons for low compression:**

- Worn cylinders ✓
- Worn piston rings ✓
- Worn piston ✓
- Leaking inlet valve ✓
- Leaking exhaust valve ✓
- Leaking cylinder head gasket ✓
- Cracked cylinder head ✓
- Cracked piston / Damaged piston. ✓
- Piston ring groove worn out and not holding pressure. ✓
- Insufficient volumetric efficiency. ✓
- Cracked cylinder sleeve. ✓

(Any 1 x 1) (1)

5.1.3 **Card-type compression tester:**

- The compression tester automatically records ✓ the readings on the card in the tester. ✓
- To eliminate the human error ✓ that can be made when taking the readings, ✓ in terms of estimations.

(Any 1 x 2) (2)

5.2 **Cylinder leakage tester:**

5.2.1 **Function:**

- To check where the combustion chamber/cylinder leaks gases ✓ during compression stroke. ✓
- To determine the percentage ✓ pressure loss ✓ from the combustion chamber.

(Any 1 x 2) (2)

5.2.2 **Gauge A:**
Percentage leakage (%) / Pressure leakage gauge ✓ (1)

5.2.3 **Control valve:**

- Used to calibrate the cylinder leakage tester. ✓
- Regulates the air pressure entering the cylinder leakage tester. ✓

(Any 1 x 1) (1)

5.3 **Exhaust gas analysis unit of measure:**

5.3.1 **Carbon dioxide (CO_2):**
Percentage (%) ✓ (1)

5.3.2 **Hydrocarbon (HC):**
Parts per million (ppm) ✓ (1)

5.4 **Reason for removing pick-up hose:**

- For auto-zero on the analyser to start at zero. / Calibration of tester to zero. ✓
- For exhaust gases to get out of the hose. ✓ (2)

5.5 **OBD-II plug location:**

- At the glove compartment (cubby hole). ✓
- Under the dashboard by the driver. ✓
- Behind a trim panel. ✓
- Between the front seats. ✓
- By the ashtray. ✓
- The floor panel. ✓
- In the fuse box. ✓

(Any 2 x 1) (2)

5.6 **Information typed into the diagnostic scanner:**

- The vehicle identification number (VIN). ✓
- The make of the vehicle. ✓
- The model of the vehicle. ✓
- The engine type. ✓

(Any 3 x 1) (3)

5.7 **Wheel balancing:**
Static ✓ (1)

5.8 **Label the bubble gauge:**
Gauge 1 - Zero scale/level ✓
Gauge 2 - Castor ✓
Gauge 3 - King pin inclination ✓
Gauge 4 - Camber ✓ (4)
[23]

QUESTION 6: ENGINES (SPECIFIC)

6.1 **Crankshaft of a four-cylinder engine:**

6.1.1 **Label the crank shaft:**
A – Crank nose/vibration damper mounting ✓
B – Main journals ✓
C – Big-end journals / Crankpin journals ✓
D – Counterweight/Crank web ✓ (4)

6.1.2 **Correcting crank shaft imbalance:**
- By removing metal/weight from the crank webs. ✓
- By adding metal/weight to the crank webs. ✓ (2)

6.2 **Vibration dampers:**

6.2.1 **Label:**
A – Friction disc ✓
B – Crankshaft ✓
C – Secondary flywheel ✓
D – Rubber cushion ✓ (4)

6.2.2 **Location:**
Fitted to the front end/nose of the crankshaft. ✓ (1)

6.2.3 **Function:**
- To smooth out / absorb/ minimize the engine vibrations. ✓
- To counteract the torsion of the crankshaft. ✓

(Any 1 x 1) (1)

6.3 **Engine configurations:**
- Inline / Straight ✓
- V-engine ✓
- W-engine / Double V-engine ✓
- Horizontally opposed engine / Flat engine / Boxer engine ✓
- Radial engine ✓
- X-Engine ✓
- U-engine ✓
- Delta engine ✓
- K-engine ✓
- Opposed-piston engine ✓

(Any 2 x 1) (2)

6.4 **Power strokes per revolution:**

6.4.1 **Four-cylinder:**
2 ✓ (1)

6.4.2 **Six-cylinder:**
3 ✓ (1)

6.5 **Turbo-chargers:**

6.5.1 **Type:**
Variable geometry turbo-charger ✓ (1)

6.5.2 **Reason turbocharger boosts:**

- It increases ✓ volumetric efficiency ✓ of the cylinders.
- It increases ✓ the pressure of the air ✓ entering the cylinder.

(Any 1 x 2) (2)

6.5.3 **Influence on the lifespan:**

- The oil supply is clean. ✓
- Use of the correct grading/type of oil. ✓
- The exhaust gas does not become overheated. ✓
- Adopting the proper switch-off procedure. ✓
- Sufficient oil pressure. ✓

(Any 2 x 1) (2)

6.6 **Disadvantages of a turbo-charger:**

- It requires pressure lubrication for high-speed bearings. ✓
- It requires pressure lubrication to act as a coolant. ✓
- It suffers from lag. ✓
- It tends to heat the air, reducing its density. ✓
- It needs to be controlled from over-revving by the waste gate. ✓
- Some require a special shut-down procedure before the engine can be switched off. ✓

(Any 3 x 1) (3)

6.7 **Disadvantage of superchargers:**

6.7.1 **Roots supercharger:**

- The least efficient supercharger. ✓
- They add more weight to the vehicle. ✓
- Usually large/bonnet(hood) must be modified. ✓
- They move air in bursts. ✓

(Any 1 x 1) (1)

6.7.2 **Twin-screw supercharger:**

- They are expensive. ✓
- They require more precision manufacturing. ✓

(Any 1 x 1) (1)

6.8 **Reasons for a supercharger with a turbocharger on its engine:**

- To overcome lag at low rpm. ✓
- To increase power at all rpm. ✓
- Outstanding fuel economy. ✓
- To increase torque at all rpm. ✓
- Reduces the parasitic effect/power sapping on the engine. ✓

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

7.1

Indicated power:	Brake power
• Calculated using the volume and the indicated mean effective pressure. ✓	• Calculated using the torque developed. ✓
• Indicated power is the theoretical power. ✓	• Brake power is the actual power output of an engine. ✓
• Indicated power is calculated without considering any mechanical or other losses of the engine. ✓	• Calculated considering mechanical or other losses of the engine. ✓

(Any 1 x 2) (2)

7.2 **Calculations:**

7.2.1 **Swept volume:**

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

$$= \frac{\pi \times 7{,}5^2 ✓}{4} \times 8 ✓$$

$$= 353{,}43 \text{ cm}^3 ✓$$

(3)

7.2.2 **Original clearance volume:**

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

$$= \frac{353{,}43 ✓}{(10 - 1) ✓}$$

$$= 39{,}27 \text{ cm}^3 ✓$$

(3)

7.2.3 **Stroke length:**

$$SV = CV(CR - 1)$$
$$= 39{,}27(11 - 1) \checkmark$$
$$= 392{,}7\text{cm}^3 \checkmark$$

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

$$\text{Area} = \frac{\pi \times 7{,}5^2}{4}$$
$$= 44{,}18\ \text{cm}^2 \checkmark$$

$$L = \frac{SV}{\text{Area}} \checkmark$$
$$= \frac{392{,}70}{44{,}18} \checkmark$$
$$= 8{,}89\ \text{cm} \times 10$$
$$= 88{,}89\ \text{mm} \checkmark$$

(6)

7.3 **Methods to lower the compression:**

- Fit thicker gasket between cylinder block and cylinder head. ✓
- Fit a shim between cylinder block and cylinder head. ✓
- Fit piston with suitable lower crowns. ✓
- Fit crankshaft with shorter stroke (with suitable connecting rods). ✓
- Decrease bore diameter. ✓

(Any 2 x 1) (2)

7.4 **Prony brake test:**

7.4.1 **Torque:**

$$\text{Torque} = \text{Force} \times \text{radius}$$

$$\text{Torque} = (30 \overset{\checkmark}{\times} 10) \times \frac{400}{1000} \checkmark \qquad (g = 10\ \text{m/s}^2)$$
$$\checkmark$$
$$= 120\ \text{Nm} \checkmark$$

OR

$$\text{Torque} = (30 \overset{\checkmark}{\times} 9{,}81) \times \frac{400}{1000} \checkmark \qquad (g = 9,\ 81\ \text{m/s}^2)$$
$$\checkmark$$
$$= 117{,}72\ \text{Nm} \checkmark$$

(4)

7.4.2 **Brake power:**

$$BP = 2\pi NT$$
$$= 2 \times \pi \times \left(\frac{2000}{60}\right)^{\checkmark} \times 120 \checkmark \qquad (g = 10\ m/s^2)$$
$$= 25{,}13\ kW \checkmark$$

OR

$$BP = 2\pi NT$$
$$= 2 \times \pi \times \left(\frac{2000}{60}\right)^{\checkmark} \times 117{,}72 \checkmark \qquad (g = 9{,}\ 81\ m/s^2)$$
$$= 24{,}66\ kW \checkmark$$

(3)

7.4.3 **Indicated power:**

$$IP = PLANn$$

Where $P = 950 \times 10^3\ Pa$

$$L = \frac{85}{1000}$$
$$= 0{,}085\ m \checkmark$$

$$A = \left(\frac{\pi \times 0{,}09^2}{4}\right) \checkmark$$
$$= 6{,}36 \times 10^{-3}\ m^2 \checkmark$$

$$N = \frac{2000}{60 \times 2} \checkmark$$
$$= 16{,}67\ \text{power strokes per second} \checkmark$$

$$n = 4$$

$$IP = (950 \times 10^3) \times 0{,}085 \times (6{,}36 \times 10^{-3}) \times (16{,}67) \times 4 \checkmark$$
$$= 34{,}24\ kW \checkmark$$

(7)

7.4.4 **Mechanical efficiency:**

$$ME = \frac{BP}{IP} \times 100$$

$$= \frac{25,13}{34,24} ✓ \times 100 \qquad (g = 10 \text{ m/s}^2)$$

$$= 73,39\ \%\ ✓$$

OR

$$ME = \frac{BP}{IP} \times 100$$

$$= \frac{24,66}{34,24} ✓ \times 100 \qquad (g = 9,81 \text{ m/s}^2)$$

$$= 72,02\ \%\ ✓$$

(2)
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QUESTION 8: MAINTENANCE (SPECIFIC)

8.1 **Exhaust gas analysis:**

8.1.1 **Readings caused by a leak:**

- Incorrect ✓ readings ✓
- No ✓ readings at all ✓

(Any 1 x 2) (2)

8.1.2 **Ideal exhaust gas readings:**

- Low carbon monoxide ✓
- High carbon dioxide ✓
- Low Hydrocarbon ✓

(Any 2 x 1) (2)

8.2 **Compression tester:**

- Ensure that the tester can handle the pressure you want to test. ✓
- Ensure the rubber pipes are not perished. ✓
- Ensure the relief valve is working on the tester. / Zero the tester. ✓
- Ensure you use the correct adapter for the plug hole. ✓

(Any 2 x 1) (2)

8.3 **Cylinder leakage test:**

Fault	Possible cause
• Hissing noise at air intake. ✓	• Leaking inlet valve. ✓
• Hissing noise at exhaust. ✓	• Leaking exhaust valve. ✓
• Hissing noise at oil filler cap/dipstick. ✓	• Piston rings are worn. ✓
• Bubbles in the radiator. ✓	• Blown cylinder head gasket/Cracked cylinder head. ✓
• Hissing sound from adjacent spark plug hole ✓	• Blown cylinder head gasket between cylinders / crack between cylinders. ✓

(Any 3 x 2) (6)

8.4 **Oil pressure test:**

- Oil pressure when engine is idling. ✓
- Oil pressure when engine is cold. ✓
- Oil pressure when engine is hot. ✓
- Oil pressure on high revolutions. ✓

(Any 3 x 1) (3)

8.5 **Fuel pressure:**

- Faulty fuel pump ✓
- Blocked fuel filter ✓
- Cracked fuel line ✓
- Clogged pump strainer ✓
- Low voltage to the fuel pump ✓
- Faulty fuel pressure regulator ✓
- Empty fuel tank ✓
- Faulty fuel pump relay ✓
- Leaking fuel injectors ✓
- Blocked fuel line ✓

(Any 4 x 1) (4)

8.6 **Radiator cap pressure test:**

Step 1: Obtain the release pressure on the cap or from manufacturer's specifications. ✓
Step 2: Fit the radiator cap with the correct adaptor on the cooling system pressure tester. ✓
Step 3: Now pump the tester while watching the release pressure on the gauge. ✓
Step 4: Check that the cap holds the specified pressure. ✓ (4)

[23]

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

9.1 **Reasons for automatic gearbox preferred over manual gearbox:**

- There is no clutch pedal. (relieve the driver of clutch operation). ✓
- There is no need to change gears. (relieve the driver of gearshift operation). ✓
- Allows the driver to concentrate on driving. ✓
- Smoother and easier driving of the vehicle. ✓
- It reduces driving fatigue. ✓
- It ensures great reduction of wheel spin. ✓
- The vehicle can be stopped suddenly without the engine stalling. ✓
- The system dampens all engine torsional vibrations. ✓

(Any 4 x 1) (4)

9.2 **Towing vehicle with automatic gearbox:**

- The drive wheels ✓must be lifted off the ground. ✓
- The vehicle ✓ should be lifted on a flatbed tow truck. ✓
- The drive shaft/propeller ✓ shaft should be removed.

(Any 1 x 2) (2)

9.3 **Torque converter:**

9.3.1 **Functions:**

- It transfers the torque and power from the engine to the gearbox. ✓
- It drives the front pump of the gearbox. ✓
- It isolates the engine from the gearbox when the vehicle is stationary. ✓
- It multiplies the torque of the engine. ✓
- Reduction of engine vibrations transmitted to the gearbox. ✓
- Turn the engine during the idle strokes. (flywheel effect) ✓

(Any 3 x 1) (3)

9.3.2 **Component that prevents slip:**
Pressure plate/Clutch assembly ✓ (1)

9.4 **Brake band in automatic gearbox:**

9.4.1 **Label:**
A – Band adjuster ✓
B – Anchor ✓
C – Lever ✓
D – Brake band ✓ (4)

9.4.2 **Function of brake band:**
The brake band holds the drum/annulus in a stationary position. ✓ (1)

9.4.3 **Component controlling the brake band:**
Hydraulic piston ✓ (1)

9.5 **Double epicyclic gear train:**

9.5.1 First (1^{st}) gear / Gear reduction ✓ (1)

9.5.2 Second (2^{nd}) gear / Overdrive ✓ (1)
[18]

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

10.1 **Steering mechanism:**

The steering mechanism must enable the driver ✓ to be in control of the path taken by the vehicle at all times. ✓ (2)

10.2 **Signs of wheel imbalance:**

- Excessive tyre wear ✓
- A poor ride/tracking ✓
- Vibrations on the steering wheel ✓
- Wheel bounce/hop ✓
- Wheel shimmy/wobble ✓
- Vibrations on the brake pedal ✓
- Excessive wear on the suspension ✓

(Any 2 x 1) (2)

10.3 **Static wheel balance:**

- Mount the wheel so that it is free to turn on a spindle through its center. ✓
- The spindle must be approximately horizontal and the wheel turning slowly. ✓
- If the wheel is out of balance, it will always come to rest with one point, the 'heavy spot', at the bottom. ✓
- To correct static imbalance, a small mass (weight) is applied to the wheel rim, diametrically opposite the 'heavy spot'. The size and position of the weight to be fitted are found by trial and error. ✓ (4)

10.4 **Negative caster angle:**

A - Kingpin ✓
B - Perpendicular line ✓
C - Negative caster angle ✓
D - Centre line of kingpin ✓ (4)

10.5 **Electric fuel pump:**

- Immediate supply of fuel when the ignition switch is turned on. ✓
- Low operation noise. ✓
- Less discharge pulsation of fuel. ✓
- Compact and light design. ✓
- It helps to prevent fuel leak. ✓
- It reduces vapour lock. ✓
- Delivers fuel at a higher rate / pressure. ✓

(Any 2 x 1) (2)

10.6 **Fuel delivery system:**

10.6.1 **Pressure regulator:**

- It keeps the pressure in the rail at a specified value. ✓
- It regulates the pressure in the rail. ✓

(Any 1 x 1) (1)

10.6.2 **Fuel filter:**

- Prevents dirt from entering the fuel line. ✓
- Prevents damaging or clogging of the injectors. ✓
- Prevents damage to the pressure regulator. ✓

(Any 1 x 1) (1)

10.7 **Air induction system:**

10.7.1 **Label:**

A - MAF sensor ✓
B - Air filter/Air filter housing ✓
C - Throttle valve / Throttle body ✓
D - Intake valve ✓ (4)

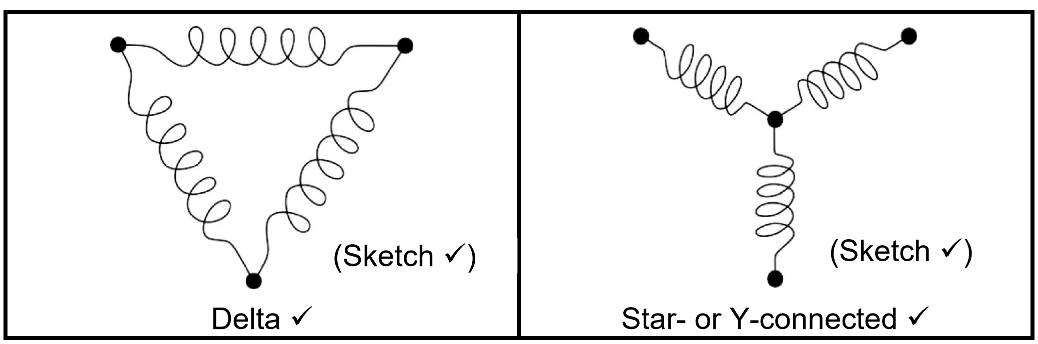
10.7.2 **Purpose:**

The air-induction system measures ✓ and controls the air required for the combustion. ✓ (2)

10.8 **Purpose of lambda sensor:**

The sensor measures the oxygen content in the flow of the exhaust gas ✓ and then sends a signal to the engine control unit. ✓ (2)

10.9 **Stator windings:**



(4)

10.10 **Increase the output frequency:**

- Increase the turns of wire/windings on the stationary coil/stator. ✓
- Increase the strength of the magnetic fields. ✓
- Increase the rotational frequency at which the magnets rotate. ✓

(Any 2 x 1) (2)

10.11 **Adaptive speed control:**

- To maintain a speed as set by the driver. ✓
- To adapt this speed and maintain a safe distance from the vehicle in front. ✓
- To provide a warning if there is a risk of a collision. ✓
- To provide a warning if the set speed is exceeded. ✓
- Reduces driver fatigue. ✓
- Improves fuel consumption. ✓

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

TOTAL: 200