



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MECHANICAL TECHNOLOGY: AUTOMOTIVE

MAY/JUNE 2025

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 20 pages.

Instructions to marker: Mechanical Technology – Automotive**1. General marking instructions:**

- 1.1 During the marking of multiple-choice questions, only ONE possible answer can be accepted. If the candidate indicated two or more responses, ONLY the first response will be recognised/acknowledged and marked according to the marking guidelines.
- 1.2 Where the number of responses of the candidate exceeds the required number stated in the question, ONLY the first number of responses will be accepted. For example, if the question states, 'Name THREE ...' and the candidate stated four different responses, ONLY the first three will be accepted and recognised.
- 1.3 If question numbering of sub questions is not correct according to the question paper sequence, the responses can be accepted if a sequence pattern can be identified.
- 1.4 Attention must be given to mark allocation in questions where two (2) marks were allocated for one response, e.g (**Any 1 x 2**).
- 1.5 There must be ONE tick allocated for each mark awarded.
- 1.6 An unanswered question must be indicated with a cross (X).
- 1.7 All blank pages in an ANSWER BOOK must be crossed out to indicate that the pages have been seen by the marker.
- 1.8 Attention must be given to questions where the candidate did not complete the question and continued answer(s) on subsequent pages in the ANSWER BOOK. Continue marking such questions and award marks, if applicable.
- 1.9 During calculation marking, pay attention to the position of the tick mark(s).
- 1.10 If a candidate skipped a step where a tick mark is allocated in the marking guidelines and the final answer is correct, the total amount of tick marks must be indicated by the marker to indicate full marks awarded for the question correctly answered, so that the examination assistant can verify marks awarded.

- 1.11 If the unit required for calculations is specified in the question, the final answer can be considered correct without explicitly stating the unit, provided that the numerical value matches the unit specified or used in the question.
- 1.12 If an incorrect unit is stated in the candidate's answer during calculations, the answer will be marked incorrect even if the value itself is correct.
- 1.13 Attention must be given to calculation type questions when different methods are used by candidates to obtain the correct answer.
- 1.14 Attention must be given to special marking instructions to the marker which are stated for specific questions in the marking guidelines.
- 1.15 A red line must be drawn by the marker to indicate the end of each question.
- 1.16 Marks of sub question totals must be indicated on the outside margins of the ANSWER BOOK pages and NOT on the inside margins.
- 1.17 Marks of sub question totals, when indicated on the outside margins, must be in line with the sub questions and must NOT be circled.
- 1.18 Total marks of a question must be indicated on the red line drawn by the marker and circled as to indicate marks for particular questions.
- 1.19 The marker must transfer the marks to the cover page and ensure the correctness of the transfer.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

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

QUESTION 2: SAFETY (GENERIC)**2.1 Manual guillotine:**

- Care must therefore be taken to never bring the operator's hands near the shearing blade. ✓
- Blade guard or back of the machine to catch the cut material must be fitted. ✓
- Cut material must be allowed to fall to the floor to be collected when safe to do so. ✓
- The guillotine must never be adjusted during operation. ✓
- The guillotine must never be lubricated during operation. ✓
- The guillotine must never be serviced during operation. ✓
- Care must be taken not to cut material that is thicker than the specified limit or harder materials. ✓
- Do not lean on the machine while operating. ✓

(Any 3 x 1) (3)**2.2 Examination procedures for First Aid:**

- Environmental observation ✓
- Visible signs ✓
- Visible symptoms ✓
- Indicators to diagnosis ✓
- Vital functions ✓

(Any 3 x 1) (3)**2.3 Acetylene cylinders key:**

So that the valve can be quickly closed./In case of an emergency. ✓ **(1)**

2.4 Product layout or a process layout:

2.4.1 Process layout ✓ **(1)**

2.4.2 Process layout ✓ **(1)**

2.4.3 Product layout ✓ **(1)**

[10]

QUESTION 3: MATERIALS (GENERIC)**3.1 Heat treatment:**

- Work piece size ✓
- Quenching rate ✓
- Carbon content ✓

(3)

3.2 Machining test:

3.2.1 Easy to cut ✓

(1)

3.2.2 Hard/Difficult to cut ✓

(1)

3.2.3 Easy to cut ✓

(1)

3.3 Annealing:

- To relieve internal stresses of the steel ✓
- Soften steel to allow for easy machining ✓
- Make steel ductile ✓
- Refine grain structure ✓
- Reduce brittleness ✓

(Any 1 x 1)

(1)

3.4 Normalising:

3.4.1 above ✓

(1)

3.4.2 soaking ✓

(1)

3.4.3 cooling ✓

(1)

3.4.4 room ✓

(1)

3.5 Rapid cooling:

- To increase the hardness of the metal. ✓
- To produce fine grain structure. ✓
- To maximise tensile strength. ✓
- To minimise ductility. ✓

(Any 1 x 1)

(1)

3.6 Processes which cause internal stress:

- Machining ✓
- Forging ✓
- Welding ✓
- Bending/Rolling ✓
- Twisting ✓
- Extreme/rapid heating ✓
- Flame/plasma cutting ✓
- Hardening ✓
- Rapid/uneven cooling ✓

(Any 2 x 1)

(2)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

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

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)**5.1 Engine faults detected on cylinder leakage test only but not compression test:**

- Leaking exhaust valves ✓
- Leaking inlet valves ✓
- Cracked cylinder head ✓
- Blown head gasket ✓
- Worn/broken piston rings (dry test only) ✓

(Any 3 x 1) (3)**5.2 Conduct compression test:****5.2.1 Place connected:**

Spark plug hole ✓

(1)

5.2.2 Unit of measure:

Bar/kPa ✓

(1)

5.2.3 Reason spark plugs removed:

To allow engine to crank (swing) with minimal resistance. ✓

(1)

5.3 Setup of cylinder leakage test:**5.3.1 Precaution before spark plug removed:**

Blow dirt away from around the spark plug. ✓

(1)

5.3.2 Reasons piston is at TDC:

- To ensure both/all valves are closed. ✓
- To test for leakages in the combustion chamber. ✓

(2)

5.4 Difference between static and dynamic wheel balancing:

STATIC BALANCING	DYNAMIC BALANCING
• Check where the wheel stops. ✓	• Done while wheel rotates. ✓
• Corrects wheel bounce (hop). ✓	• Corrects wheel (shimmy) wobble. ✓
• Balancing is done by trial and error. ✓	• Placement of weight is determined by wheel balancer. ✓
(Any 1 x 1)	(Any 1 x 1)

(2)

5.5 Functions of the wheel-weight hammer:

- Remove balancing weights. ✓
- Fit balancing weights ✓
- To cut weight if one cannot get correct weight. ✓
- Clean foreign matter from treads ✓

(Any 2 x 1) (2)

5.6 Wheel alignment tool:**5.6.1 Identify tool:**

Bubble gauge ✓

(1)

5.6.2 Angles measured with bubble gauge:

- Camber ✓
- Caster ✓
- King pin inclination (KPI) ✓

(3)

5.7 Functions of the turn-tables:

- It allows the front wheels to turn inward or outward. ✓
- It indicates the angles that the wheel turns. ✓

(2)

5.8 OBD scanners connected to a laptop or computer:

- Wi-Fi ✓
- Bluetooth ✓
- Cable ✓

(3)

5.9 Pre-check on exhaust system:

Ensure there are no exhaust gas leaks. ✓

(1)

[23]

QUESTION 6: ENGINES (SPECIFIC)**6.1 Importance of correct firing order for crankshaft:**

- Reduced torsional stress ✓
- Reduced vibrations/improve smooth running ✓
- Reduced chance of over twisting ✓
- To distribute the force of power strokes evenly. ✓
- It reduces wear. ✓

(Any 3 x 1) (3)**6.2 Engine terms:****6.2.1 Rotating mass:**

The crankpin ✓ and the lower two-thirds of the connecting rod. ✓

(2)**6.2.2 Reciprocating mass:**

The pistons ✓ and the upper third of the connecting rod. ✓

(2)**6.3 Types of vibration dampers:**

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

(Any 2 x 1) (2)**6.4 Balancing the crankshaft dynamically:**

- Drill holes (remove mass) in crank webs ✓
- Add mass pieces to crank webs ✓

(2)**6.5 Engine layout:****6.5.1 Engine cylinder layout:**

V-engine ✓

(1)**6.5.2 Advantages of this engine cylinder layout:**

- Shorter overall length ✓
- Can fit into smaller engine compartment ✓
- Lighter mass ✓
- Improved power-weight ratio ✓
- Improved fuel efficiency ✓

(Any 2 x 1) (2)**6.6 Power strokes:****6.6.1 One-cylinder, two-stroke engine:**

One ✓

(1)**6.6.2 Eight-cylinder, four-stroke engine:**

Four ✓

(1)

6.7 Turbo-charger:**6.7.1 Labels:**

- A. Compressor impeller/wheel/blade / Compressor ✓
- B. Compressor/Impeller housing/casing ✓
- C. Turbine housing/casing ✓
- D. Turbine blade/wheel / Turbine ✓

(4)

6.7.2 Turbo-charger drive:

Exhaust gases ✓

(1)

6.8 Limiting boost pressure:

- Waste gate ✓
- Vanes ✓
- Dump valve ✓

(Any 2 x 1)

(2)

6.9 Twin-charging system:**6.9.1 Labels:**

- A. Supercharger ✓
- B. Intercooler ✓
- C. Turbo-charger/Turbine ✓

(3)

6.9.2 Advantages twin-charging over super-charging:

- Outstanding fuel economy. ✓
- Increased power across the entire power band. ✓
- High torque available throughout the engine speed range. ✓
- Reduced power-sapping effect of the supercharger on the engine. ✓

(Any 2 x 1)

(2)

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QUESTION 7: FORCES (SPECIFIC)**7.1 Definitions:****7.1.1 Swept volume:**

- Total volume ✓ when the piston moves from bottom dead centre to top dead centre. ✓
- Total volume ✓ displaced during a stroke. ✓

(Any 1 x 2) (2)**7.1.2 Mechanical efficiency:**

The relationship between the theoretical power (IP) ✓ and actual power (BP) ✓ developed by the engine.

(2)**7.2 Methods to lower the compression ratio:**

- 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 shorter connecting rod. ✓
- Fit crankshaft with shorter stroke. ✓
- Re-sleeve the bore/cylinder. ✓

(Any 3 x 1) (3)**7.3 Calculations:****7.3.1 Swept volume:**

$$\begin{aligned}SV &= \frac{\pi \times D^2}{4} \times L \\&= \frac{\pi \times 9,2^2}{4} \times 8,5 \checkmark \\&= 565,05 \text{ cm}^3 \checkmark\end{aligned}$$

(3)**7.3.2 Clearance volume:**

$$\begin{aligned}CV &= \frac{SV}{CR - 1} \\&= \frac{565,05 \checkmark}{11 - 1 \checkmark} \\&= 56,51 \text{ cm}^3 \checkmark\end{aligned}$$

(3)

7.3.3 New bore diameter:

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

$$\begin{aligned} SV &= CV (CR-1) \checkmark \\ &= 56,51(12-1) \checkmark \\ &= 621,61 \text{ cm}^3 \checkmark \end{aligned}$$

$$SV = \frac{\pi \times D^2}{4} \times L$$

$$D = \sqrt{\frac{SV \times 4}{\pi \times L}} \checkmark$$

$$\begin{aligned} &= \sqrt{\frac{621,61 \times 4}{\pi \times 8,5}} \checkmark \\ &= 9,649 \text{ cm} \checkmark \end{aligned}$$

OR

$$\begin{aligned} &= \sqrt{\frac{621,61 \times 10^3 \times 4}{\pi \times 85}} \checkmark \\ &= 96,50 \text{ mm} \checkmark \end{aligned}$$

(6)

7.4 Engine calculations:**7.4.1 Torque:**

$$BP = 2\pi NT$$

$$\text{where } N = \frac{3000}{60} = 50 \text{ r/s} \checkmark$$

$$T = \frac{BP}{2\pi N} \checkmark$$

$$\begin{aligned} &= \frac{(16 \times 1000)}{2 \times \pi \times 50} \checkmark \\ &= 50,93 \text{ Nm} \checkmark \end{aligned}$$

(4)

7.4.2 Indicated power in kW:

$$P = 450 \times 10^3 \text{ Pa}$$

$$L = \frac{80}{1000}$$
$$= 0,08 \text{ m} \quad \checkmark$$

$$\text{Area} = \frac{\pi \times 0,083^2}{4} \quad \checkmark$$
$$= 0,00541 \text{ m}^2 \quad \text{OR} \quad 5,41 \times 10^{-3} \text{ m}^2 \quad \checkmark$$

$$N = \frac{3000}{60 \times 1} \quad \checkmark$$
$$= 50 \text{ firing strokes/sec} \quad \checkmark$$

$$n = 2$$

$$\text{IP} = \text{PLAN}n$$
$$= (450 \times 10^3) \times (0,08) \times (0,00541) \times (50) \times (2) \quad \checkmark$$
$$= 19,48 \text{ kW} \quad \checkmark \quad (7)$$

7.4.3 Mechanical efficiency:

$$\text{ME} = \frac{\text{BP}}{\text{IP}} \times 100$$
$$= \frac{16}{19,48} \times 100 \quad \checkmark$$
$$= 82,14 \% \quad \checkmark$$

(2)
[32]

QUESTION 8: MAINTENANCE (SPECIFIC)**8.1 Gas Analysis:**

FAULTS (DEFECTS)	POSSIBLE CAUSES	CORRECTIVE MEASURES
	8.1.1	8.1.2
High hydrocarbon (HC) reading	Excessive unburned fuel. ✓	Reset fuel mixture. ✓
	Improper timing. ✓	Check and reset ignition system. ✓
	Vacuum leak. ✓	Repair vacuum leaks. ✓
	Faulty air management system. ✓	Check and repair the air management system. ✓
	(Any 1 x 1)	(Any 1 x 1)
	8.1.3	8.1.4
High oxygen (O ₂) reading	Too lean air-fuel ratio. ✓	Reset fuel mixture. ✓
	Ignition problems. ✓	Check and reset ignition system. ✓
	Vacuum leaks. ✓	Repair vacuum leaks. ✓
	Catalytic converter not working. ✓	Check and repair the catalytic converter. ✓
	(Any 1 x 1)	(Any 1 x 1)

(4)

8.2 Perform wet compression test:

- Squirt oil into cylinder onto piston. ✓
- Fit compression tester. ✓
- Open throttle valve fully. ✓
- Crank engine 4 to 10 times. ✓
- Record the reading. ✓

(5)

8.3 Cylinder leakage test faults:**8.3.1 Bubbles in radiator:**

- Repair/Replace cylinder head. ✓
- Replace cylinder head gasket. ✓
- Repair/Replace cylinder block. ✓
- Replace cylinder sleeves. ✓

(Any 1 x 1) (1)**8.3.2 Hissing sound at the exhaust pipe:**

- Replace exhaust valve. ✓
- Re-seat exhaust valve. ✓
- Repair/Replace valve seats. ✓

(Any 1 x 1) (1)

8.3.3 Hissing sound at the dipstick:

- Replace piston rings. ✓
- Re-sleeve cylinders. ✓
- Re-bore cylinders. ✓
- Replace damaged piston. ✓

(Any 1 x 1) (1)**8.4 Oil pressure test:****8.4.1 Change the oil:**

- Oil is dirty/contaminated. ✓
- Incorrect oil viscosity/Oil is too thick/Oil too thin. ✓

(Any 1 x 1) (1)**8.4.2 Clean the oil pick up screen:**

Blocked oil pump screen in sump. ✓

(1)**8.4.3 Replace the oil pump:**

Worn/broken oil pump. ✓

(1)**8.4.4 Replace oil filter:**

Oil filter is dirty/contaminated. ✓

(1)**8.5 Manufacturer's specification:**

- Fuel pressure after the injector pump or fuel pump. ✓
- Fuel pressure when the engine is idling. ✓
- Fuel pressure on high revolutions. ✓

(3)**8.6 Precautions for cooling system pressure test:**

- Top up the water level. ✓
- Do not put more pressure in the system than indicated by the manufacturer's specifications. ✓
- Do not open the radiator cap when the engine is hot. ✓
- Do not drop the pump, as you may damage it. ✓
- Select the correct adapter for the vehicle's cooling system. ✓
- Ensure the pressure tester is calibrated. ✓

(Any 4 x 1) (4)
[23]

QUESTION 9: SYSTEMS AND CONTROL (AUTOMATIC GEARBOX) (SPECIFIC)**9.1 Difference between gearboxes:****9.1.1 Type of clutch:**

- The manual gearbox has a dry clutch. ✓
- The automatic gearbox has wet clutches. ✓ (2)

9.1.2 Type of gear system:

- The automatic gearbox uses an epicyclic gear system. ✓
- The manual gearbox uses compound gear trains. ✓ (2)

9.2 Torque converter:

Lock-up clutch torque converter ✓ (1)

9.3 Components of the torque converter:

9.3.1 Pump/Impeller ✓ (1)

9.3.2 Turbine ✓ (1)

9.4 Epicyclic gear system:**9.4.1 Labels:**

- A. Sun gear ✓
- B. Planetary gear ✓
- C. Annulus/ring gear ✓
- D. Planet carrier ✓
- E. Output shaft ✓ (5)

9.4.2 Advantages of epicyclic gear trains:

- Provides a variation in torque./Higher reduction ratio is achieved. ✓
- Changes the direction of rotation. ✓
- It's compact in design. ✓
- Gears are in constant mesh. ✓
- Reduced vibration. ✓
- The efficiency of transmission is higher. ✓

(Any 2 x 1) (2)

9.5 Function of automatic gearbox components:**9.5.1 Valve body:**

- To direct oil to components. ✓
- To automatically select gears. ✓ (2)

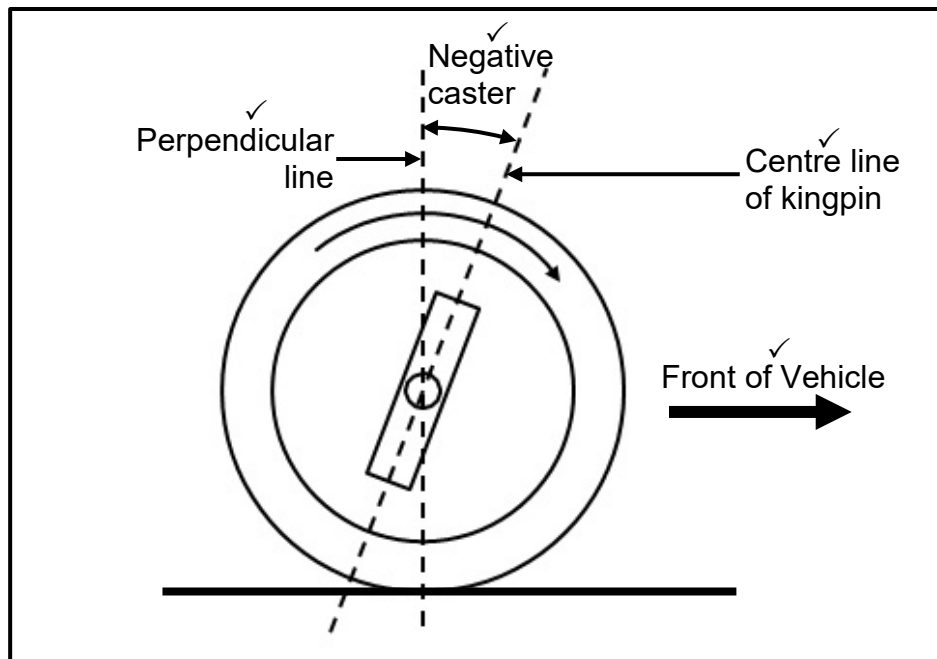
9.5.2 Oil pump:

- Circulates/Pumps the oil. ✓
- Pressurises the oil. ✓ (2)

[18]

QUESTION 10: SYSTEMS AND CONTROL (AXLES, STEERING GEOMETRY AND ELECTRONIC) (SPECIFIC)**10.1 Wheel alignment pre-checks:**

- Kerb mass against the manufacturer's specifications ✓
- Kerb height (riding height) ✓
- Tyre pressures ✓
- Tyre wear ✓
- Tyre sizes ✓
- Run-out on the wheels/tyres ✓
- Correct preload on the wheel (hub) bearings ✓
- Kingpins and kingpin bushes for wear ✓
- Suspension bushes for excessive free movement ✓
- Conditions of upper and lower control arm ball joints ✓
- Conditions of idler arm ball joints ✓
- Conditions of tie-rod ends ✓
- Steering box play ✓
- Worn or broken suspension springs ✓
- Ineffective shock absorbers. ✓
- Spring U-bolts and spring mountings ✓
- Condition of chassis ✓
- Loose cross-members ✓
- Even wheelbase at front and rear ✓

(Any 4 x 1) (4)**10.2 Negative caster:****(4 x 1 labels) (4)**

10.3 Sensors:

10.3.1 **Manifold absolute pressure sensor (MAP):**
Air intake system ✓ (1)

10.3.2 **Camshaft position sensor (CMP):**
Cylinder head ✓ (1)

10.3.3 **Lambda (oxygen) sensor:**
Exhaust system ✓ (1)

10.4 Basic functions of sensors:

- Detect engine operating conditions. ✓
- Sends the information to the ECU. ✓ (2)

10.5 Coil on plug (COP) ignition:

10.5.1 **Labels:**
A. Spark plug ✓
B. Control module ✓
C. Ignition switch ✓
D. Crank position sensor (CPS) ✓ (4)

10.5.2 **Conventional ignition:**
• Common coil ✓
• HT leads ✓
• Distributor ✓
(Any 2 x 1) (2)

10.6 Environmentally friendly gases:

- Water vapour/mist/steam (H₂O) ✓
- Nitrogen (N₂) ✓
- Carbon dioxide (CO₂) ✓
(Any 2 x 1) (2)

10.7 Advantages of the adaptive speed control system:

- Adapt the vehicle speed. ✓
- Maintain a safe distance from the vehicle in front. ✓
- Provide a warning if there is a risk of a collision. ✓
- It can take control of the brakes. ✓
- It can take control the vehicle's transmission. ✓
(Any 2 x 1) (2)

10.8 Rotor:**10.8.1 Labels:**

- A. Slip ring ✓
- B. Brushes ✓
- C. Pole pieces ✓

(3)**10.8.2 Function:**

- To provide an electromagnet. ✓✓
- Induces current into the stator. ✓✓

(Any 1 x 2) (2)**10.9 Advantages of an electric fuel pump:**

- Immediate supply of fuel when the ignition switch is turned on. ✓
- Low operation noise. ✓
- Less discharge pulsation of fuel. ✓
- Compact design. ✓
- Light in design. ✓
- Prevent fuel leak ✓
- Prevent vapour lock. ✓

(Any 2 x 1) (2)**10.10 Functions of a check (one-way) valve:**

- It maintains the pressure in the fuel line to prevent vapour lock. ✓
- It ensures better start ability. ✓
- Prevents back flow/Allows the fuel to flow in one direction. ✓

(Any 2 x 1) (2)**[32]****TOTAL: 200**