

Confidential



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

MECHANICAL TECHNOLOGY: AUTOMOTIVE

NOVEMBER 2025

MARKS: 200

TIME: 3 hours

This question paper consists of 16 pages and a 2-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. Write your centre number and examination number in the spaces provided on the ANSWER BOOK.
2. Read ALL the questions carefully.
3. Answer ALL the questions.
4. Number the answers correctly according to the numbering system used in this question paper.
5. Start EACH question on a NEW page.
6. Show ALL calculations and units. Round off final answers to TWO decimal places.
7. Candidates may use non-programmable scientific calculators and drawing instruments.
8. The value of gravitational acceleration should be taken as $9,81 \text{ m/s}^2$ or 10 m/s^2 .
9. ALL dimensions are in millimetres, unless stated otherwise in the question.
10. Write neatly and legibly.
11. A formula sheet is attached at the end of the question paper.
12. Use the criteria below to assist you in managing your time.

QUESTION	CONTENT	MARKS	TIME IN MINUTES
	GENERIC		
1	Multiple-choice Questions	6	6
2	Safety	10	10
3	Materials	14	14
	SPECIFIC		
4	Multiple-choice Questions	14	10
5	Tools and Equipment	23	20
6	Engines	28	25
7	Forces	32	25
8	Maintenance	23	20
9	Systems and Control (Automatic Gearbox)	18	20
10	Systems and Control (Axles, Steering Geometry and Electronics)	32	30
	TOTAL	200	180

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.6) in the ANSWER BOOK, e.g. 1.7 E.

- 1.1 Which ONE of the following refers to the code of good practice on HIV/Aids and employment? (1)
- A Employers can simply dismiss a person who has HIV/Aids.
 - B It does not elaborate on how everybody has the right to fair labour practices regarding HIV/Aids.
 - C It contains the daily working hours of employees.
 - D It contains common guidelines on how employers, employees and trade unions should respond to HIV/Aids in the workplace.
- 1.2 Who is responsible for the provision of PPE in the workshop? (1)
- A Employee
 - B Cleaning staff
 - C Foreman
 - D Employer
- 1.3 The function of the finger protector in the power-driven guillotine is to prevent the operators from ... (1)
- A reaching below the hold-down guards.
 - B touching revolving parts.
 - C getting their clothes caught in the machine.
 - D bending the work piece.
- 1.4 FIGURE 1.4 below shows a spark test being conducted. Identify the type of material with reference to the spark pattern. (1)

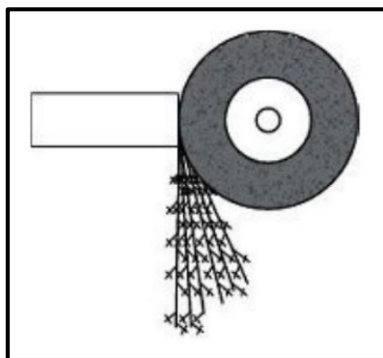


FIGURE 1.4

- A Copper
 - B Brass
 - C High-carbon steel
 - D Aluminium alloy
- (1)

- 1.5 The hardening temperature depends on the ... of the steel.
- A carbon content
 - B malleability
 - C size
 - D weight
- (1)
- 1.6 What determines the properties of steel during heat treatment?
- A The melting point
 - B Type of grain structure
 - C The water content of the metal
 - D The molten state of the metal
- (1)
[6]

QUESTION 2: SAFETY (GENERIC)

- 2.1 State TWO visible signs on an injured person that a first-aider must take note of before treatment. (2)
- 2.2 State TWO safety measures to be considered BEFORE arc welding can be performed. (2)
- 2.3 State TWO safety rules that must be adhered to BEFORE switching on a portable angle grinder. (2)
- (NOTE: All PPE has already been taken care of.) (2)
- 2.4 State TWO safety rules when handling oxy-acetylene gas cylinders. (2)
- 2.5 State ONE disadvantage of the product layout. (1)
- 2.6 State ONE general duty every employee must adhere to in the workplace according to the Occupational Health and Safety Act (OHSA), 1993 (Act 85 of 1993). (1)
[10]

QUESTION 3: MATERIALS (GENERIC)

- 3.1 What will be the effect on the following materials when conducting a bend test?
- 3.1.1 Mild steel (1)
 - 3.1.2 High-carbon steel (1)
- 3.2 What is the purpose of heat treatment of metals? (1)
- 3.3 State THREE quenching media used in the heat treatment of steel. (3)

- 3.4 Which TWO methods are used to conduct a sound test to identify metals? (2)
- 3.5 What is the purpose of case hardening of steel during heat treatment? (2)
- 3.6 Name TWO common methods of case hardening. (2)
- 3.7 Explain the reason for normalising steel during heat treatment. (2)
- [14]**

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

Various options are provided as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (4.1 to 4.14) in the ANSWER BOOK, e.g. 4.15 E.

4.1 Identify the test that is conducted in FIGURE 4.1 below.

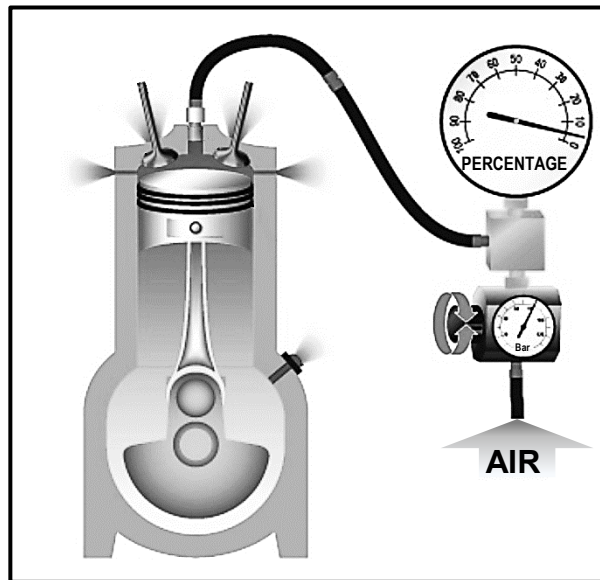


FIGURE 4.1

- A Compression test
 B Cylinder leakage test
 C Exhaust gas analysis test
 D Fuel pressure test (1)

4.2 The exhaust gas analyser should be set up correctly to ensure ...

- A proper ventilation.
 B accurate readings.
 C colour change of the filter.
 D hose blockage. (1)

4.3 The firing order commonly used on six-cylinder, four-stroke engines is ...

- A 1; 7; 3; 5; 8; 2; 6; 4.
 B 1; 4; 2; 3; 5.
 C 1; 5; 3; 6; 2; 4.
 D 1; 3; 4; 2. (1)

4.4 Why should an engine fitted with a turbocharger idle for a while before turning off the engine?

- A To save fuel
 B To allow the turbocharger to cool down
 C To stop the exhaust gases from entering the turbocharger
 D To give the turbocharger a nice sound (1)

- 4.5 The definition of power is ...
- A the rate at which work is done.
 - B a force that causes movement.
 - C the rate at which an object is falling.
 - D the strength of the engine. (1)
- 4.6 The volume that is displaced by the piston when it moves from BDC to TDC is known as the ...
- A clearance volume.
 - B compression volume.
 - C piston volume.
 - D swept volume. (1)
- 4.7 Which ONE of the following methods raises the compression ratio of an engine?
- A Fit a thicker gasket between the cylinder block and the cylinder head
 - B Fit pistons with suitable lower crowns
 - C Fit shorter connecting rods
 - D Increase the bore size of the cylinders (1)
- 4.8 What is the reason for a high hydrocarbon (HC) reading during an exhaust gas analysis?
- A Vacuum leak
 - B Slightly lean air/fuel ratio
 - C Dirty or clogged air filter
 - D Blocked injectors (1)
- 4.9 What is the reason for compression loss in an internal combustion engine?
- A Blocked cylinder head gasket
 - B Leaking inlet valve
 - C Faulty radiator cap
 - D Leaking exhaust pipe (1)
- 4.10 Which gearshift position in an automatic gearbox engages a lock that prevents the car from rolling?
- A Drive (D)
 - B Reverse (R)
 - C Neutral (N)
 - D Park (P) (1)
- 4.11 What is the function of the stator in the torque converter?
- A Pumps the oil through the gearbox
 - B Converts torque into power
 - C Increases the torque produced by the engine
 - D Brings the torque converter to a stop (1)

4.12 Identify the wheel alignment angle 'X' as shown in FIGURE 4.12 below.

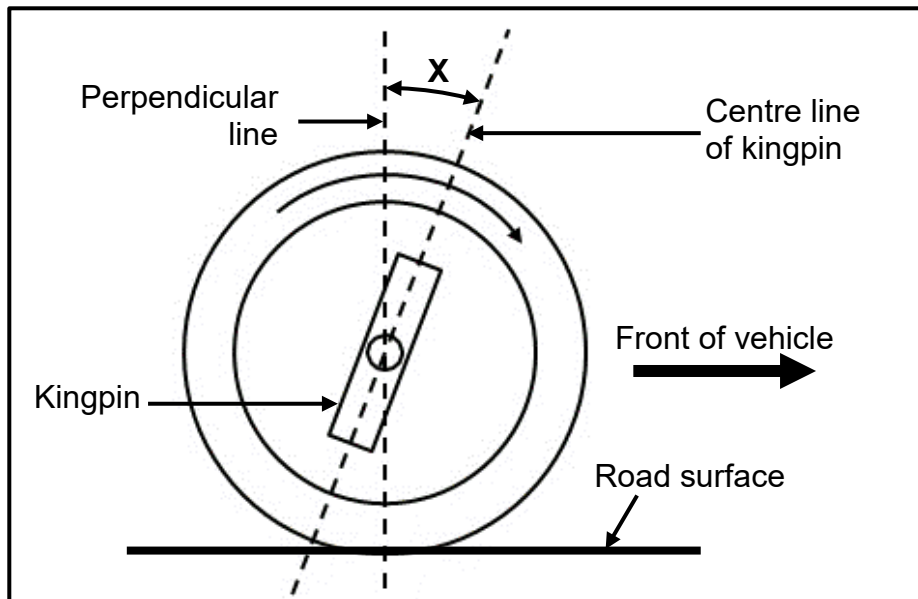


FIGURE 4.12

- A Positive caster
 - B Negative caster
 - C Negative camber
 - D Positive camber
- (1)

4.13 A function of the adaptive speed control is to ...

- A keep the vehicle at a constant speed.
 - B ensure that the wheels keep spinning.
 - C ensure that the driver stays awake.
 - D improve traction control.
- (1)

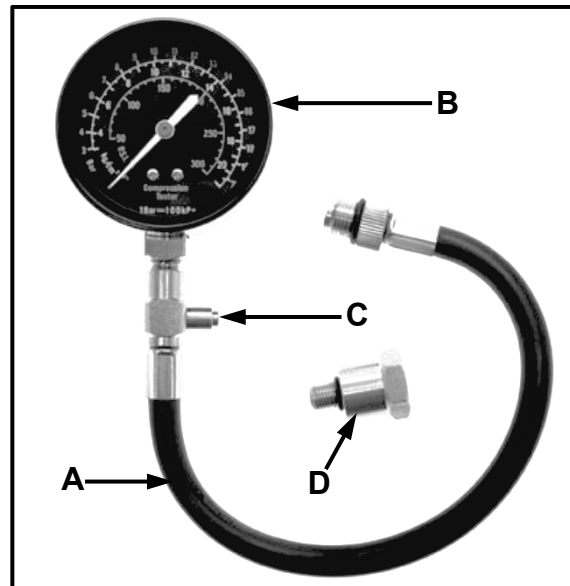
4.14 The function of the crankshaft positioning sensor (CKP) is to ...

- A advance the ignition spark.
 - B signal the crankshaft position to the ECU.
 - C keep the crankshaft in its position.
 - D sense the position of the car.
- (1)

[14]

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

5.1 FIGURE 5.1 below shows a compression tester. Label **A–D**.

**FIGURE 5.1**

(4)

5.2 Give reasons why EACH of the following precautions should be observed before performing a compression test:

5.2.1 Check if the engine is at operating temperature (2)

5.2.2 Clean around the spark plugs before removing them (2)

5.3 State the function of the cylinder leakage test. (2)

5.4 Explain how to set up the exhaust gas analyser on a vehicle. (4)

5.5 State THREE functions of an on-board diagnostics (OBD) scanner. (3)

5.6 State THREE pre-checks that are performed on a tyre before the wheel is balanced. (3)

5.7 An optical alignment gauge is used to check wheel alignment on a vehicle. Answer the questions that follow.

5.7.1 Name the part of the optical alignment gauge that shows the toe angle. (1)

5.7.2 State TWO precautions regarding the placement of the contact bars against the wheel. (2)

[23]

QUESTION 6: ENGINES (SPECIFIC)

6.1 FIGURE 6.1 below shows the crankshaft of a four-cylinder engine. Answer the questions that follow.

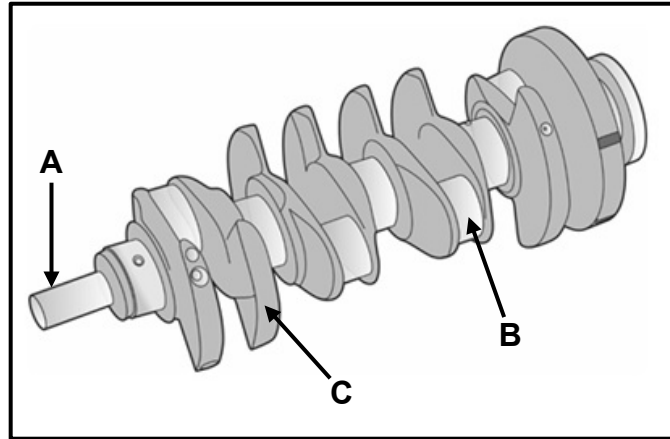


FIGURE 6.1

6.1.1 Label **A–C**. (3)

6.1.2 What is the main function of the crankshaft? (2)

6.2 FIGURE 6.2 below shows a part that is fitted to the front of the crankshaft in an internal combustion engine. Answer the questions that follow.

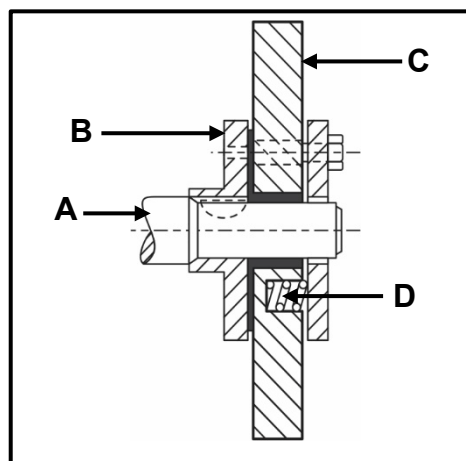


FIGURE 6.2

6.2.1 Label **A–D**. (4)

6.2.2 Identify the part shown. (1)

6.3 State TWO causes of torsional vibrations on a crankshaft. (2)

6.4 State the TWO firing orders that are used on a four-cylinder in-line engine. (2)

- 6.5 Identify the type of cylinder layout with EACH of the following features:
- 6.5.1 Cylinders that are all arranged next to each other in a row (1)
 - 6.5.2 Cylinders that are arranged in two banks on either side of the crankshaft (1)
- 6.6 How many power strokes per engine revolution are there for EACH of the following four-stroke engines?
- 6.6.1 V4 (1)
 - 6.6.2 V6 (1)
- 6.7 FIGURE 6.7 below shows how a turbocharger is connected to an internal combustion engine. Answer the questions that follow.

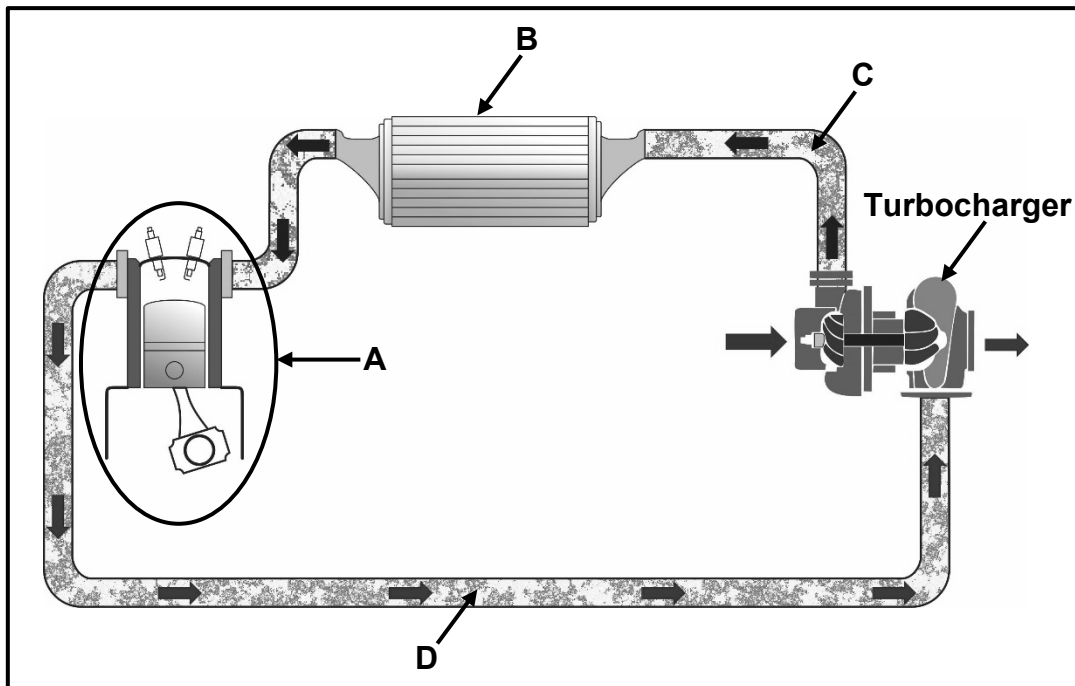


FIGURE 6.7

- 6.7.1 Label A–D. (4)
- 6.7.2 State THREE advantages of a turbocharged engine when compared to a naturally aspirated engine. (3)

6.8 FIGURE 6.8 below shows a vane-type supercharger. Label **A–C**.

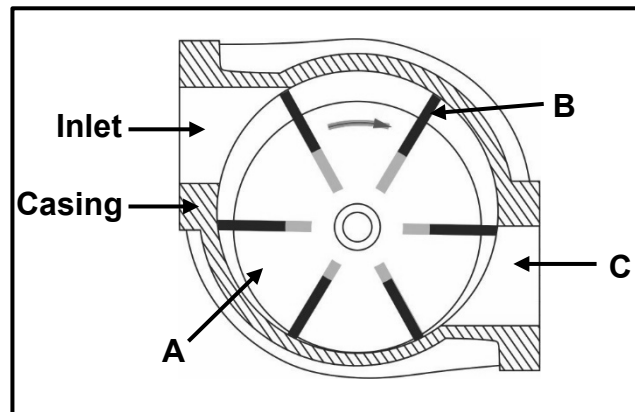


FIGURE 6.8

(3)
[28]

QUESTION 7: FORCES (SPECIFIC)

- 7.1 Explain the following terms with regard to an internal combustion engine:
- 7.1.1 Indicated power (2)
 - 7.1.2 Compression ratio (2)
- 7.2 The bore of an engine is 70 mm and the stroke length is 80 mm. The compression ratio is 9 : 1.
- Calculate the following:
- 7.2.1 The swept volume in cm^3 (3)
 - 7.2.2 The clearance volume in cm^3 (3)
 - 7.2.3 The new swept volume if the compression ratio is increased to 10 : 1 (3)
 - 7.2.4 The new diameter of the bore in **mm** if the clearance volume remains unchanged (4)
- 7.3 The following data was recorded during a test carried out on a four-stroke, four-cylinder petrol engine:
- | | |
|---------------------------|-------------|
| Mean effective pressure: | 1 800 kPa |
| Bore diameter: | 110 mm |
| Stroke length: | 150 mm |
| Brake arm length: | 840 mm |
| Scale reading: | 75 kg |
| Engine speed during test: | 1 200 r/min |
- Calculate the following:
- 7.3.1 Torque in Nm (3)
 - 7.3.2 Indicated power in kW (7)
 - 7.3.3 Brake power in kW (3)
 - 7.3.4 Mechanical efficiency (2)
- [32]**

QUESTION 8: MAINTENANCE (SPECIFIC)

8.1 Apart from hydrocarbons (HC), name THREE other gases that can be analysed by an exhaust gas analyser. (3)

8.2 TABLE 8.2 below shows the results of a cylinder leakage test. Complete the table by writing only the question numbers (8.2.1 to 8.2.5) and the answers in the ANSWER BOOK.

FAULT	POSSIBLE CAUSE	CORRECTIVE MEASURE
Hissing sound at air intake	8.2.1	8.2.2
8.2.3	Leaking exhaust valve	8.2.4
8.2.5	Blown cylinder head gasket	Skim the cylinder head and replace cylinder head gasket

TABLE 8.2 (5)

8.3 After a compression test on an internal combustion engine, the results showed low compression pressure in one of the cylinders. Answer the questions that follow.

8.3.1 State THREE possible causes of the low compression pressure. (3)

8.3.2 Briefly explain how the wet compression test is conducted. (3)

8.4 State THREE manufacturer's specifications required when performing an oil pressure test on an engine. (3)

8.5 State a corrective measure for EACH of the following faults when performing a fuel pressure test:

8.5.1 Pressure leaving fuel pump is too low (1)

8.5.2 Too high fuel pressure in the common rail (1)

8.6 Name FOUR places where the coolant may leak when performing the cooling system pressure test. (4)

[23]

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

9.1 FIGURE 9.1 below shows an exploded view of a torque converter. Answer the questions that follow.

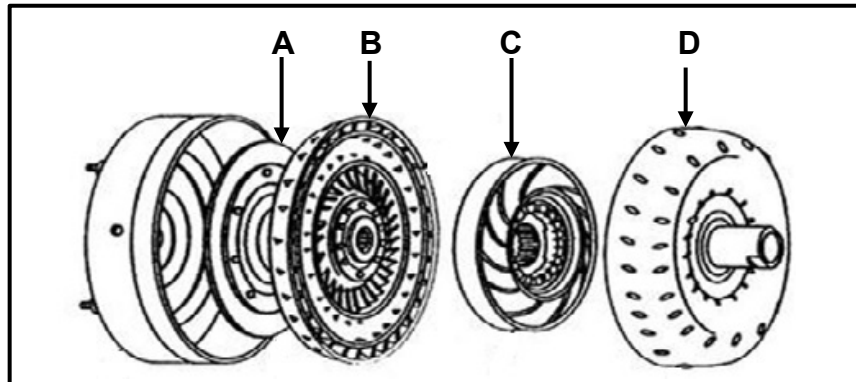


FIGURE 9.1

9.1.1 Label **A–D**. (4)

9.1.2 State **THREE** functions of the torque converter in an automatic gearbox. (3)

9.2 FIGURE 9.2 below shows a single epicyclic gear train. Answer the questions that follow.

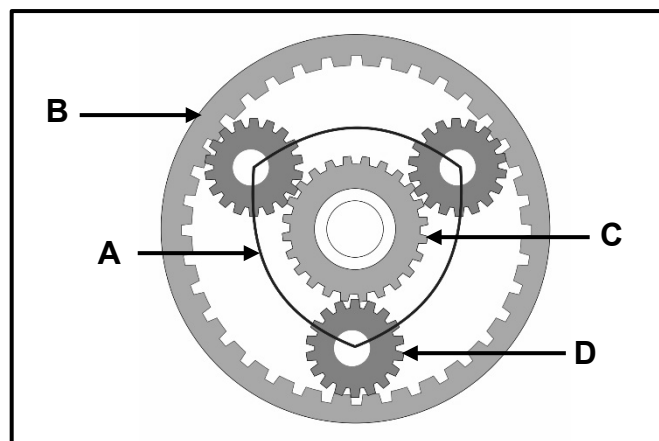


FIGURE 9.2

9.2.1 Label **A–D**. (4)

9.2.2 Explain how reverse gear is obtained in this gear train. (3)

9.3 Describe **TWO** methods of cooling the automatic transmission fluid. (2)

9.4 Which **TWO** of the following gearshift lever positions, P, R, N, D, 1, 2, allow an engine to be started? (2)

[18]

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

- 10.1 State THREE pre-checks done on the vehicle suspension before wheel alignment adjustments and checks can be done. Exclude the pre-checks on the wheels. (3)
- 10.2 Draw a neat, labelled sketch to explain toe-out on the front wheels. (4)
- 10.3 State the purpose of the following wheel alignment angles:
- 10.3.1 Negative camber (2)
- 10.3.2 Toe out on turns (2)
- 10.4 Explain the procedure to statically balance a wheel. (5)
- 10.5 State the function of the following systems that are controlled by the ECU:
- 10.5.1 Air-induction system (2)
- 10.5.2 Ignition system (2)
- 10.6 Name TWO elements that are used to coat the monolith in the catalytic convertor causing a chemical reaction with the exhaust gases. (2)
- 10.7 State the functions of the following components in the common rail direct injection (CRDI) system:
- 10.7.1 High-pressure pump (2)
- 10.7.2 Electronic control unit (ECU) (2)
- 10.7.3 Accelerator pedal sensor (2)
- 10.8 Answer the questions about the alternator that follow.
- 10.8.1 Draw a neat simple sketch of a diode symbol. (2)
- 10.8.2 State ONE function of the diode in the charging system. (2)

[32]**TOTAL: 200**

FORMULA SHEET FOR MECHANICAL TECHNOLOGY: AUTOMOTIVE

1. $F = m \times a$

Where:

$m = \text{Mass}$

$a = \text{Acceleration}$

2. $\text{Work done} = \text{Force} \times \text{Displacement}$ **OR** $W = F \times s$

3. $\text{Power} = \frac{\text{Force} \times \text{Displacement}}{\text{Time}}$ **OR** $P = \frac{F \times s}{t}$

4. $\text{Torque} = \text{Force} \times \text{Radius}$ **OR** $T = F \times r$

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

Where:

$IP = \text{Indicated power}$

$P = \text{Mean effective pressure}$

$L = \text{Stroke length}$

$A = \text{Area of piston crown}$

$N = \text{Number of power strokes per second}$

$n = \text{Number of cylinders}$

6. $BP = 2\pi NT$

Where:

$BP = \text{Brake power}$

$N = \text{Revolutions per second}$

$T = \text{Torque}$

7. $\text{Brake power with Pröny brake} = 2 \times \pi \times N \times F \times R$

Where:

$BP = \text{Brake power}$

$N = \text{Revolutions per second}$

$F = \text{Force}$

$R = \text{Brake arm length}$

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

$$9. \quad \text{Compression ratio} = \frac{SV + CV}{CV}$$

Where:

$$\begin{aligned} SV &= \text{Swept volume} \\ CV &= \text{Clearance volume} \end{aligned}$$

$$10. \quad SV = \frac{\pi D^2}{4} \times L$$

Where:

$$\begin{aligned} D &= \text{Bore diameter} \\ L &= \text{Stroke length} \end{aligned}$$

$$11. \quad CV = \frac{SV}{CR - 1}$$

$$12. \quad \text{Gear ratio} = \frac{\text{Product of teeth on driven gears}}{\text{Product of teeth on driver gears}}$$