basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MECHANICAL TECHNOLOGY: AUTOMOTIVE

MAY/JUNE 2026

MARKS: 200

TIME: 3 hours

This question paper consists of 18 pages and a 2-page formula sheet.

Copyright reserved

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 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 statement below is CORRECT in terms of a recommendation for the application of first aid?

A Remove anything that is stuck to the wound.
B Check the pulse of the patient.
C Pay no attention to loss of blood or breathing difficulties.
D Check the surroundings for safe objects. (1)

1.2 Which ONE of the following Acts states that employers must ensure that the workplace is safe?

A Occupational Health and Safety (OHS) Act, 1993 (Act 85 of 1993)
B Basic Conditions of Employment (BCE) Act, 1997 (Act 75 of 1997)
C Labour Relations (LR) Act, 1995 (Act 66 of 1995)
D Employment Equity (EE) Act, 1998 (Act 55 of 1998) (1)

1.3 Which ONE of the following is the cause of accidents while the surface grinder is being used?

A Overconfidence
B Correct wheel size
C Not forcing grinding
D Correct wheel design for the surface grinder (1)

1.4 Which ONE of the following types of steel will be least affected during the hardening process?

A High-carbon steel
B Medium carbon steel
C Low-carbon steel
D Stainless steel (1)

1.5 Which ONE of the following metals will be cut easily while the machinability test is being conducted?

A Spring steel
B Mild steel
C High-speed steel
D Cast steel (1)

1.6 Which ONE of the following heat treatment processes provides a material with a hard casing and a tough core?

A Tempering
B Cyaniding
C Annealing
D Normalising (1)
[6]

QUESTION 2: SAFETY (GENERIC)

2.1 Name ONE specific safety device that is fitted on EACH of the following machines to avoid injury:

2.1.1 Vertical band saw (1)

2.1.2 Power-driven guillotine (1)

2.1.3 Drill press (1)

2.1.4 Bench grinder (1)

2.2 State TWO safety rules for EACH of the following machines WHILE they are being operated:

NOTE: All PPE and environmental factors have been taken care of.

2.2.1 Horizontal band saw (2)

2.2.2 Arc-welding equipment (2)

2.3 Identify the following workshop layouts with reference to the following advantages:

2.3.1 Control over operations is easier (1)

2.3.2 Greater flexibility in manufacturing (1)
[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 TABLE 3.1 below shows the different metal tests and results. Complete the table by writing only the question numbers (3.1.1 to 3.1.4) and the answers in the ANSWER BOOK.

TYPE OF TEST	TYPE OF STEEL/IRON	TEST RESULTS
Sound test	3.1.1	Medium metallic sound
Bend test	Cast steel	3.1.2
Filing test	3.1.3	Very hard to file
Machining test	Cast iron	3.1.4

TABLE 3.1 (4)

3.2 FIGURE 3.2 below shows the iron-carbon equilibrium diagram. Label **A**–**D**.

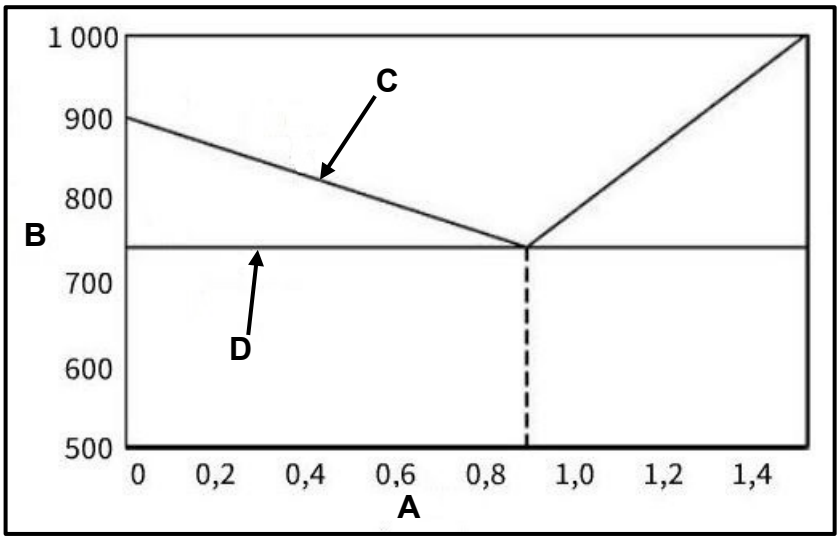


FIGURE 3.2 (4)

3.3 Which type of quenching medium is used in extreme cooling of heat-treated materials? (1)

3.4 Give TWO reasons why the lengths of metals are normally marked or colour coded at the ends. (2)

3.5 FIGURE 3.5 below shows the changes in metal structures during the annealing process. Label **A**–**C**.

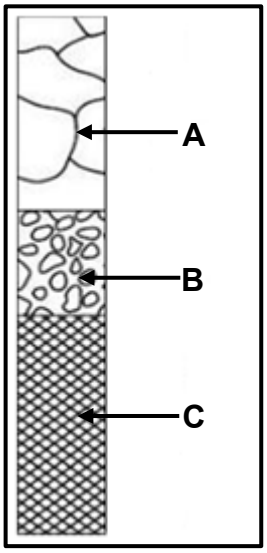


FIGURE 3.5

(3)
[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 Which equipment is used to measure toe angle?

A Toe adjustor
B Turntables
C Optical alignment gauge
D Wheel adaptor (1)

4.2 At what angle must the wheel be turned to set camber alignment with the bubble gauge?

A 20°
B 0°
C 30°
D 40° (1)

4.3 The function of a supercharger is to …

A drive the turbocharger.
B increase intake manifold pressure.
C charge the battery quickly.
D increase engine temperature rapidly. (1)

4.4 Which engine configuration is shown in FIGURE 4.4 below?

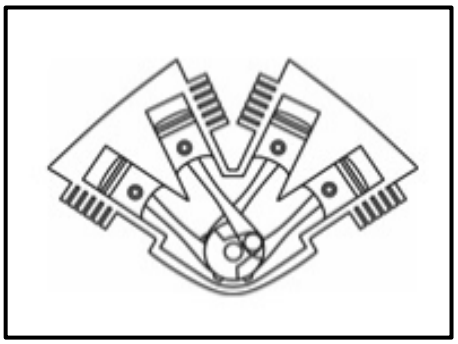


FIGURE 4.4

A In-line
B V4
C W
D Horizontally opposed (1)

4.5 What is the capacity, in millilitres, of a 150 cm^3 (cc) engine?

A 1,50 mℓ
B 1 500 mℓ
C 150 mℓ
D 15 mℓ (1)

4.6 What is the SI unit for work done?

A Joules
B Newtons
C Watts
D Pascals (1)

4.7 The electric dynamometer is used to measure …

A indicated power.
B brake power.
C torque output.
D swept volume. (1)

4.8 In a V6 engine the big-end journals are positioned at …

A 120°.
B 90°.
C 60°.
D 180°. (1)

4.9 Coolant used in the cooling system of an engine consists of …

A only water.
B water and soluble oil.
C water and anti-freeze.
D anti-freeze and soluble oil. (1)

4.10 What type of gear system is used in an automatic gearbox fitted with a torque converter?

A Helical gear system
B Planetary gear system
C Cluster gear system
D Cycloidal gear system (1)

4.11 What is the primary function of the torque converter in an automatic gearbox?

A To transmit power from the engine to the transmission
B To convert mechanical energy into hydraulic energy
C To provide smooth and gradual transition between gears
D To lock up the engine and transmission at high speeds (1)

4.12 What is the measuring unit for caster angle?

A Degrees
B Minutes
C Millimetres
D Cubic centimetres (1)

4.13 A well-balanced wheel will result in …

A wheel shimmy.
B reduced tyre tread wear.
C wheel tramp.
D uneven tyre wear. (1)

4.14 The function of the engine coolant temperature sensor is to … the engine coolant temperature.

A reduce
B increase
C remove
D measure (1)
[14]

QUESTION 5: TOOLS AND EQUIPMENT (SPECIFIC)

5.1 Answer the following questions regarding a compression test.

5.1.1 In THREE steps, describe how a wet compression test is performed on an internal combustion engine after a dry compression test. (3)

5.1.2 What is the function of a compression test? (2)

5.1.3 State ONE advantage of using the card-type compression tester. (1)

5.2 FIGURE 5.2 below shows a cylinder leakage tester. Answer the questions that follow.

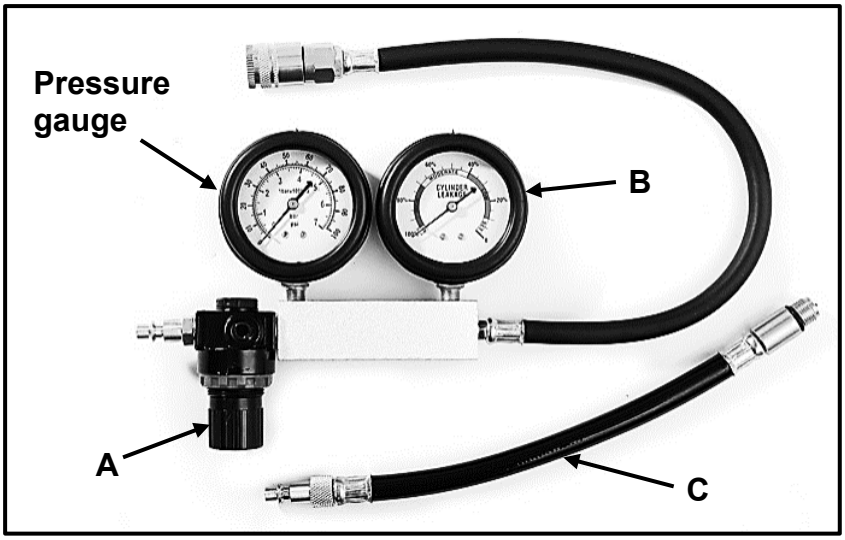


FIGURE 5.2

5.2.1 Label **A**–**C**. (3)

5.2.2 Why is the crankshaft locked when setting up the cylinder leakage test? (1)

5.2.3 State TWO differences between the *cylinder compression test* and the *cylinder leakage test*. (4)

5.3 What is determined by an exhaust gas analyser? (2)

5.4 Wheel alignment equipment is set up in the workshop. Answer the questions that follow.

5.4.1 Where is the bubble gauge placed to measure the wheel-alignment angles? (1)

5.4.2 Name TWO wheel-alignment angles that require a brake lock to be applied before setting up the bubble gauge. (2)

5.4.3 State TWO functions of the turn tables. (2)

5.5 State TWO manufacturer's specifications that must be entered or confirmed on an on-board diagnostics (OBD-II) scanner before a diagnostic test can be conducted. (2)

[23]

QUESTION 6: ENGINES (SPECIFIC)

6.1 The crankshaft is an essential part of the engine. Answer the questions that follow.

6.1.1 Name THREE engine parts that are directly driven by the crankshaft. (3)

6.1.2 What can be done to the pistons and connecting rods to improve engine balance? (2)

6.1.3 What is fitted to the crankshaft nose to improve crankshaft balance? (1)

6.1.4 Draw a neat, labelled sketch to illustrate the position of the crankpins in a four-cylinder in-line engine. (3)

6.1.5 Define *dynamic balancing* of the crankshaft. (2)

6.2 An engine is fitted with a turbocharger. Answer the questions that follow.

6.2.1 Name TWO types of turbochargers. (2)

6.2.2 Which part of the turbocharger is driven by exhaust gases? (1)

6.2.3 Explain why an engine fitted with a turbocharger should idle for a while before the engine is turned off. (2)

6.2.4 How does the turbocharger affect the flow of exhaust gases in the exhaust? (1)

6.3 Which TWO components control turbo-boost pressure? (2)

6.4 FIGURE 6.4 below shows a supercharger and a turbocharger fitted to the same engine. Answer the questions that follow.

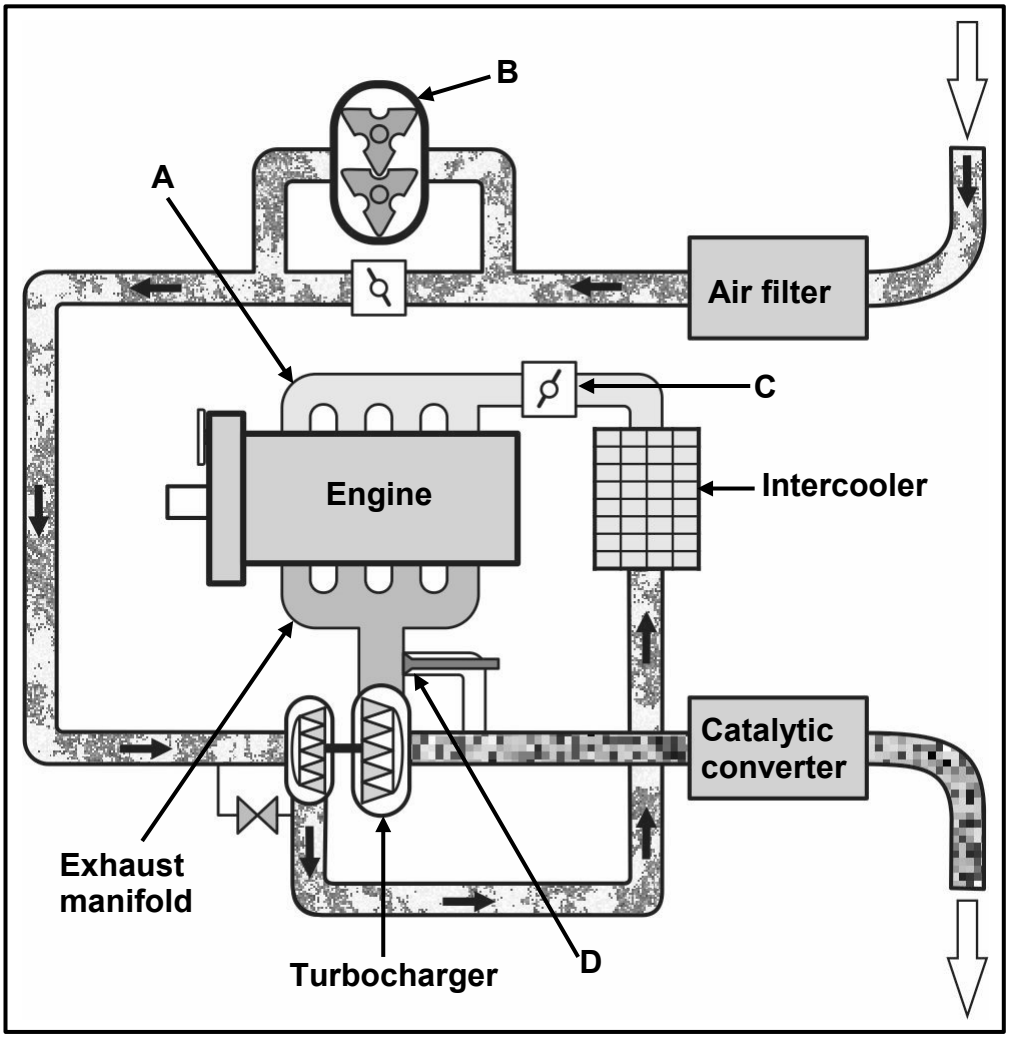


FIGURE 6.4

6.4.1 Label **A**–**D**. (4)

6.4.2 State TWO advantages of twin charging (i.e. both a supercharger and a turbocharger are fitted to a vehicle's engine). (2)

6.4.3 State TWO disadvantages of twin charging (i.e. both a supercharger and a turbocharger are fitted to a vehicle's engine). (2)

6.4.4 What is the purpose of the intercooler? (1)
[28]

QUESTION 7: FORCES (SPECIFIC)

7.1 Define the term *brake power*. (2)

7.2 The bore of a cylinder is 95 mm and the stroke length of the piston is 88 mm. The compression ratio is 16 **:** 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 required stroke length if the compression ratio is increased to 17 **:** 1. The clearance volume and bore remain unchanged. The answer must be in **mm**. (6)

7.3 State THREE methods to lower the compression ratio of an engine. (3)

7.4 The following data was recorded during a Pröny brake test on a four-stroke, four-cylinder engine.

Mean effective pressure:	4 300 kPa
Bore diameter:	80 mm
Stroke length:	55 mm
Brake arm length:	700 mm
Scale reading:	42 kg
Engine speed during test:	1 800 r/min

Calculate the following:

7.4.1 The torque in Nm (3)

7.4.2 Brake power in kW (3)

7.4.3 Indicated power in kW (7)

7.4.4 Mechanical efficiency (2)
[32]

QUESTION 8: MAINTENANCE (SPECIFIC)

8.1 State ONE possible cause and its corrective measure for a high nitrogen oxide (NO_X) reading in an exhaust gas analysis. (2)

8.2 State whether the ideal reading on an exhaust gas analyser should be either high or low for the following gases:

8.2.1 Hydrocarbon (HC) (1)

8.2.2 Carbon monoxide (CO) (1)

8.2.3 Carbon dioxide (CO_2) (1)

8.3 State THREE pre-checks that must be done on a compression tester to ensure accurate readings. (3)

8.4 TABLE 8.4 below gives a fault with its cause and corrective measure with regard to a dry compression test. Complete the table by writing only the question numbers (8.4.1 to 8.4.2) and the answer in the ANSWER BOOK.

FAULT	POSSIBLE CAUSE	CORRECTIVE MEASURE
Very low, but similar readings on two adjacent cylinders	8.4.1	8.4.2

TABLE 8.4 (2)

8.5 Explain why EACH of the following procedures are conducted during a cylinder leakage test on an internal combustion engine:

8.5.1 Listen for a hissing sound at the exhaust. (1)

8.5.2 Check for bubbles in the radiator. (1)

8.5.3 Connect the adaptor hose from the cylinder leakage tester into the engine spark-plug hole. (1)

8.6 How will the following oil defects affect oil pressure:

8.6.1 Too thick oil (1)

8.6.2 Oil pressure relief valve stuck in the open position (1)

8.6.3 Blocked oil filter (1)

8.7 Which THREE electrical faults on an internal combustion engine could cause low fuel pressure? (3)

8.8 Explain in FOUR steps how to conduct a pressure test on a radiator cap. (4)

[23]

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

9.1 FIGURE 9.1 below shows a torque converter with the lockup clutch engaged. Answer the questions that follow.

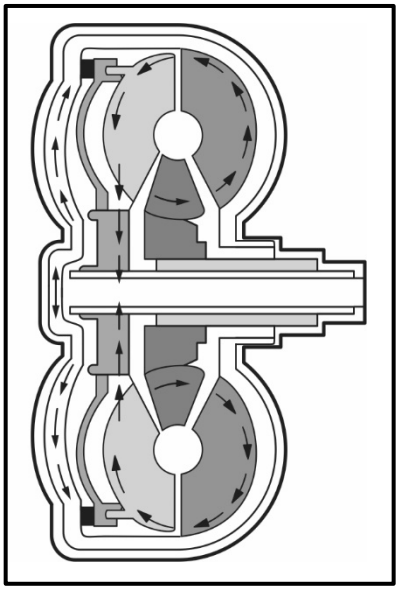


FIGURE 9.1

9.1.1 Describe how the lockup clutch is engaged. (4)

9.1.2 What is the function of the stator? (2)

9.1.3 State TWO advantages of using torque converters. (2)

9.2 FIGURE 9.2 below shows a brake band used in an automatic gearbox. Answer the questions that follow.

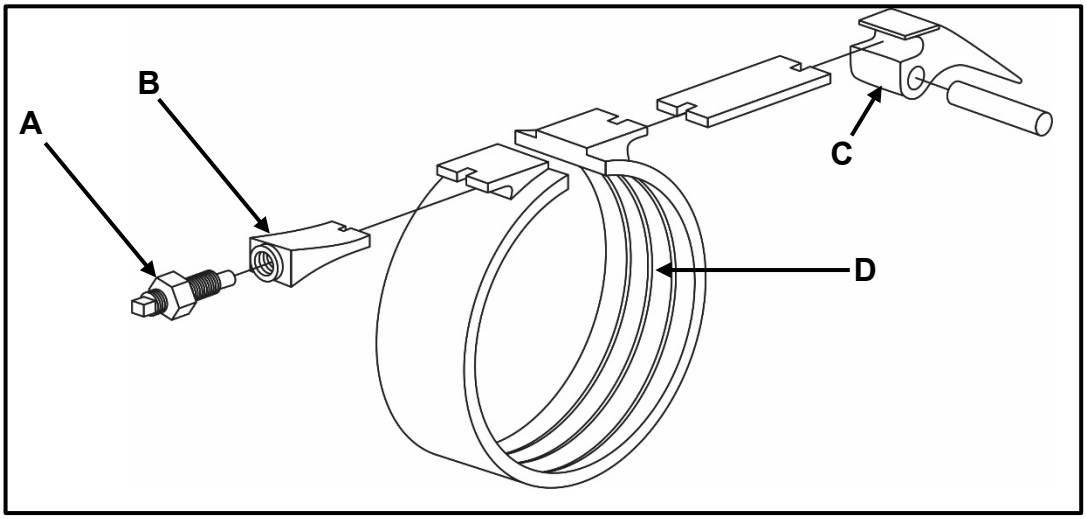


FIGURE 9.2

9.2.1 Label **A**–**D**. (4)

9.2.2 What is the purpose of the brake band? (2)

9.3 Explain how reduction-forward is obtained in the automatic gearbox. (3)

9.4 Why is the gear-selector lever moved to the P-position when parking a vehicle with an automatic gearbox? (1)
[18]

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

10.1 State TWO features of a well-designed steering system. (2)

10.2 State TWO negative effects of an imbalanced wheel. (2)

10.3 FIGURE 10.3 below shows the wheel geometry as seen from the front. Label **A**–**D**.

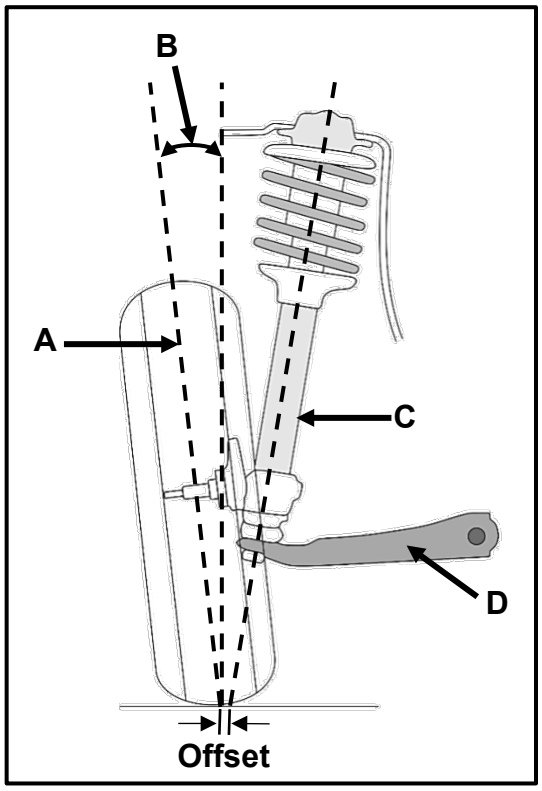


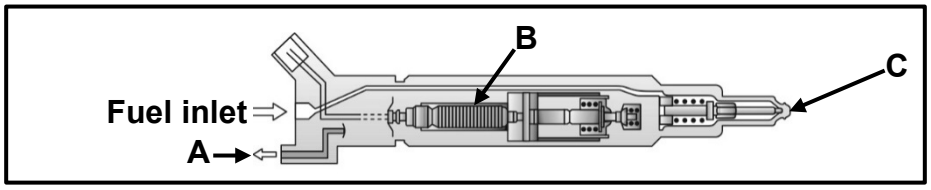
FIGURE 10.3 (4)

10.4 State the purpose of EACH of the following wheel-alignment angles:

10.4.1 Positive caster (2)

10.4.2 King-pin inclination (KPI) (2)

10.5 FIGURE 10.5 below shows a piezo injector. Answer the questions that follow.



FIGUUR 10.5

10.5.1 Label **A**–**C**. (3)

10.5.2 State TWO criteria that determine the efficiency of an injector in the fuel delivery system. (2)

10.6 FIGURE 10.6 below shows the air-induction system. Answer the questions that follow.

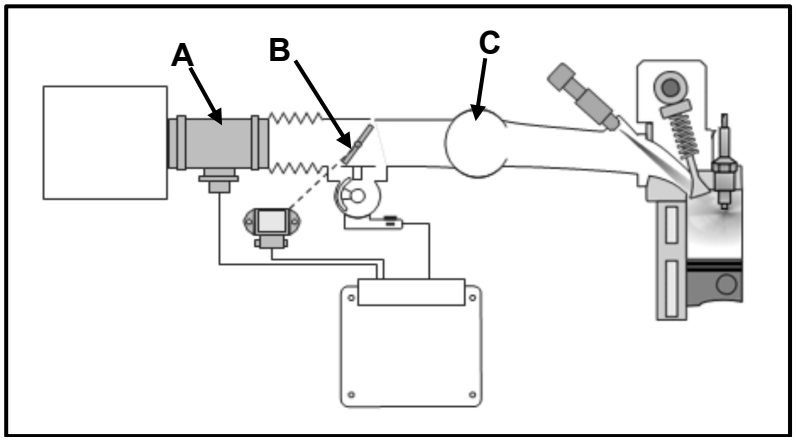


FIGURE 10.6

10.6.1 Label **A**–**C**. (3)

10.6.2 What is the purpose of the air-induction system fitted to an internal combustion engine? (2)

10.7 State the purpose of the diesel particulate filter (DPF) in the exhaust system. (2)

10.8 An alternator is part of the charging system. Answer the questions that follow.

10.8.1 Describe the function of the slip-ring and brush assembly on the rotor. (2)

10.8.2 State TWO methods to increase the output frequency of an alternator. (2)

10.8.3 Give TWO reasons why a fan belt must be tensioned correctly. (2)

10.9 Describe TWO methods to deactivate the speed-control system that is fitted to a vehicle. (2)
[32]

TOTAL: 200

Copyright reserved

FORMULA SHEET FOR MECHANICAL TECHNOLOGY: AUTOMOTIVE

1. $F = m \times a$

   Where:

   m = *Mass*
   a = *Acceleration*

2. *Work done = Force × Displacement* **OR** $W = F \times s$

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

4. *Torque = Force × Radius* **OR** $T = F \times r$

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

   Where:

   IP = *Indicated power*
   P = *Mean effective pressure*
   L = *Stroke length*
   A = *Area of piston crown*
   N = *Number of power strokes per second*
   n = *Number of cylinders*

6. $BP = 2\pi NT$

   Where:

   BP = *Brake power*
   N = *Revolutions per second*
   T = *Torque*

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

   Where:

   BP = *Brake power*
   N = *Revolutions per second*
   F = *Force*
   R = *Brake arm length*

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

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

Where:

SV = *Swept volume*
CV = *Clearance volume*

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

Where:

D = *Bore diameter*
L = *Stroke length*

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

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

Copyright reserved