



Province of the
EASTERN CAPE
EDUCATION

**NATIONAL
SENIOR CERTIFICATE**

GRADE 11

NOVEMBER 2019

MECHANICAL TECHNOLOGY: AUTOMOTIVE

MARKS: 200

TIME: 3 hours



This question paper consists of 18 pages, including a 1-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. Write your NAME 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. You may use a non-programmable scientific calculator and drawing instruments.
8. The value of gravitational force should be taken as 10 m.s^{-2}
9. All dimensions are in millimetres, unless stated otherwise in the question.
10. A formula sheet is attached to the question paper.
11. Write neatly and legibly.
12. Use the criteria below to assist you in managing your time.

QUESTION	CONTENT	MARKS	TIME in minutes
GENERIC			
1	Multiple-choice questions	20	18
2	Safety	24	22
3	Tools and Equipment	16	14
4	Maintenance	8	7
5	Materials	32	29
SPECIFIC			
6	Tools and Equipment	9	8
7	Engines	15	14
8	Systems and Control	27	24
9	Maintenance	11	10
10	Forces	30	27
11	Terminology	8	7
TOTAL:		200	180

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A–D) next to the question number (1.1–1.20) in your ANSWER BOOK, for example 1.21 A.

1.1 Which safety measure is applicable to guillotines in terms of the OHS Act?

- A Clamp the work piece securely to the table
 - B Do not leave the chuck key on the machine
 - C Machine must be fitted with fixed guards to prevent fingers from reaching through the point of operation
 - D Use the table of the machine as an anvil
- (1)

1.2 Which ONE of the following safety procedures is applicable to the press machine?

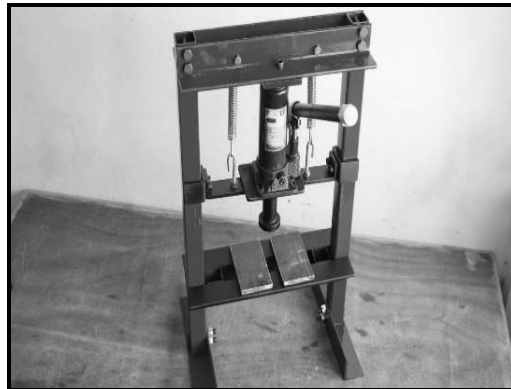


FIGURE 1.2

- A Hold the material firmly to prevent inaccurate cutting of material
 - B Make sure not to exceed pressure limit of the machine
 - C Use this machine only to cut sheet metal, not rods or angle iron
 - D Use this machine only to bend rods or angle iron
- (1)

1.3 Which ONE of the following welding or flame cutting operations may not be undertaken unless ...

- A an operator has been instructed on how to use the equipment safely.
 - B a work place is partitioned off.
 - C an operator uses protective equipment.
 - D All of the above.
- (1)

1.4 Which ONE of the following safety procedures is applicable to the operation of a hydraulic press?

- A Do not apply wrench to revolving work
 - B Guards could be removed when pressing soft material
 - C Pressure gauges must be tested regularly and adjusted or replaced if any malfunction occurs
 - D Use the machine table as an anvil
- (1)

- 1.5 What safety measure is applicable to the use of the bench grinder in terms of the Occupational Health and Safety Act?



FIGURE 1.5

- A The tool rest must not be more than 3 mm away from the grinding wheel surface
 B Remove guards before grinding
 C Grind on the sides of the grinding wheel
 D The grinding machine can be forced to grind thick material (1)
- 1.6 What is the purpose of cooling the blade of a band saw with cutting fluid?
- A To cause friction
 B To ensure clean cuts and remove metal waste
 C To sharpen the blade during the cutting process
 D To ensure straight cut (1)
- 1.7 What is the function of the extension bars of a guillotine?
- A To enlarge the size of the material
 B To support the guards
 C To support longer pieces of material
 D To activate the foot pedal of the machine (1)
- 1.8 Which ONE of the following is an incorrect function of an angle grinder?



FIGURE 1.8

- A Drilling
 B Grinding
 C Cutting
 D Polishing (1)

- 1.9 Which ONE of the following is a component of a pedestal drilling machine?
- A Pressure gauge
 - B Grinding wheel
 - C Chuck
 - D Tool rest
- (1)
- 1.10 Which ONE of the following tools is used for marking off?
- A Allen key
 - B Scriber
 - C Circlip plier
 - D Steel ruler
- (1)
- 1.11 What is the purpose of lubricating moving parts of machines?
- A To prevent moist
 - B To prevent rust
 - C To minimise overloading
 - D To prevent incorrect lubrication
- (1)
- 1.12 Maintenance of a power saw includes, amongst others, to check ...
- A guide alignment.
 - B belt tension.
 - C transmission oil level.
 - D All of the above.
- (1)
- 1.13 Overloading in pedestal grinders can result in machine malfunction due to ...



FIGURE 1.13

- A excessive load on the spindle bearing.
 - B friction.
 - C power loss.
 - D bearings.
- (1)

- 1.14 Which ONE of the following methods is used to reduce friction between two moving parts?
- A Use sufficient lubrication
 - B To increase the temperature between two metals
 - C To add abrasives to the contact area
 - D To increase the speed
- (1)
- 1.15 Lack of maintenance on a bench grinder will cause the following to happen:
- A Inaccurate grinding results
 - B Sharp edges on the work piece
 - C Insufficient lubrication of the grinding wheel
 - D High speed grinding
- (1)
- 1.16 What gets smelted in a blast furnace?

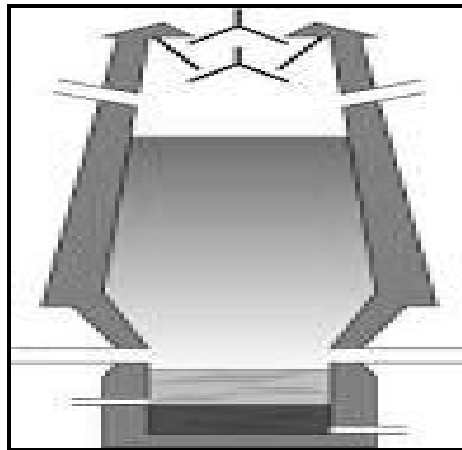


FIGURE 1.16

- A Rocks
 - B Iron ore
 - C Pig iron
 - D Carbon
- (1)
- 1.17 The unit for torque is ...
- A mm.
 - B Pa.
 - C N.
 - D Nm.
- (1)
- 1.18 Which of the following properties of material allows a material to return to its original shape when the load is removed?
- A Hardness
 - B Brittleness
 - C Elasticity
 - D Malleability
- (1)

1.19 The most common method of extracting iron from iron ore is called ...

- A tempering.
- B smelting.
- C elasticity.
- D charging.

(1)

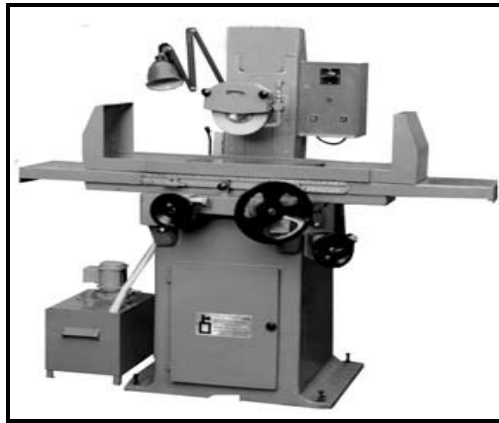
1.20 Which element is used to make coke in a blast furnace?

- A Limestone
- B Coal
- C Dolomite
- D Iron ore

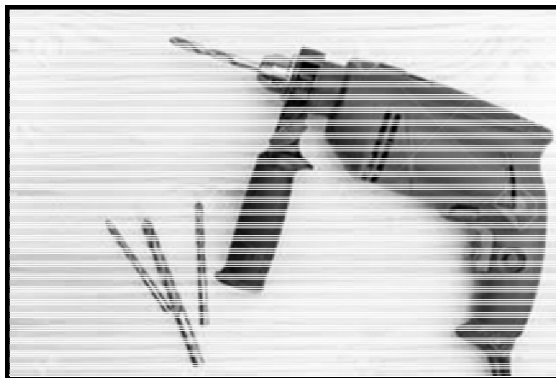
(1)
[20]

QUESTION 2: SAFETY (GENERIC)

- 2.1 Name any THREE pieces of personal safety equipment that you need to wear when using gas welding equipment. (3)
- 2.2 State THREE safety precautions you should observe before pressing a bearing from a shaft on a hydraulic press. (3)
- 2.3 Give THREE safety rules that must be followed while the surface grinder is in operation.

**FIGURE 2.3**

- (3)
- 2.4 When completing a task on any machine, what safety aspect must be considered before leaving the machine? (1)
- 2.5 State THREE safety measures to observe before switching on the bench grinder. (3)
- 2.6 What is the function of the Perspex shield of a pedestal grinder? (1)
- 2.7 State THREE safety rules to apply when using a portable hand drill machine.

**FIGURE 2.7**

- (3)
- 2.8 Give THREE safety rules to follow when handling gas cylinders. (3)
- 2.9 State THREE safety rules one must adhere to before switching on a band saw. (3)
- 2.10 Which safety precaution should be adhered to when drilling a hole on a small work piece on a drill press? (1)

[24]

QUESTION 3: TOOLS AND EQUIPMENT (GENERIC)

3.1 What is the function of the diagram shown in FIGURE 3.1 below?



FIGURE 3.1

(2)

3.2 Explain the purpose of the extension bars of a guillotine.

(2)

3.3 FIGURE 3.3 below shows a hand-operated hydraulic press. Label parts A–F.

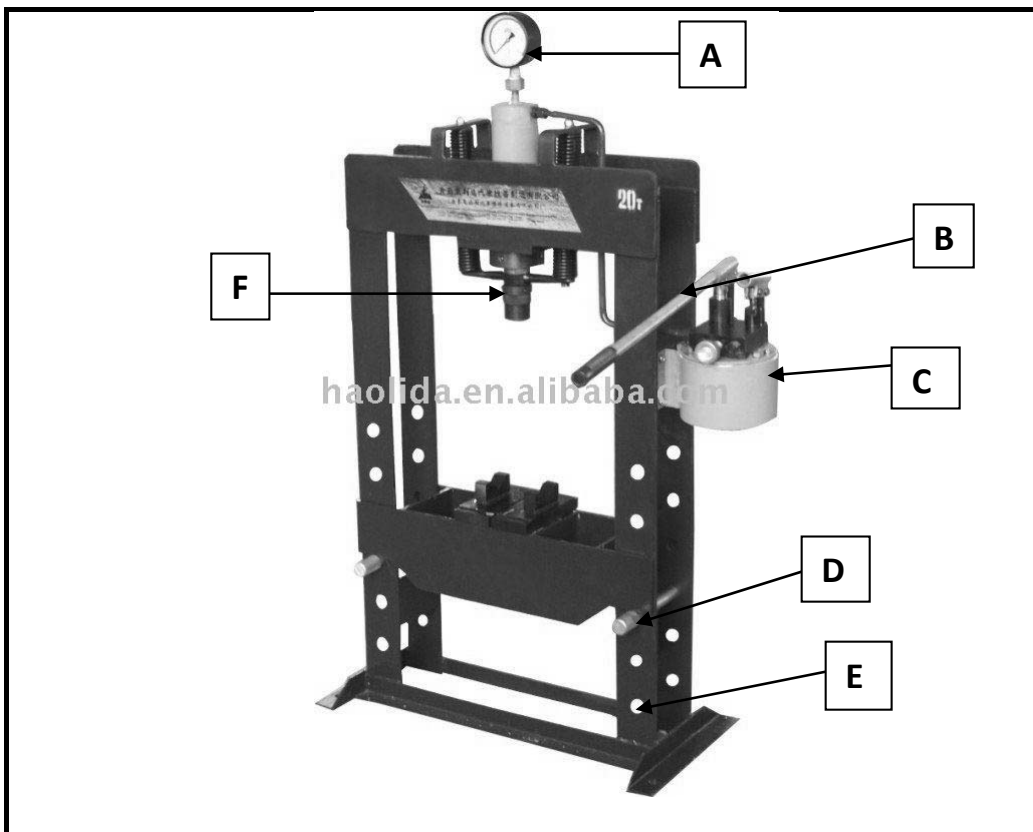


FIGURE 3.3: HAND-OPERATED HYDRAULIC PRESS

(6)

3.4 Describe the function of the following equipment:

3.4.1 Angle grinder

(2)

3.4.2 Rolling machine

(2)

3.4.3 Press machine

(2)

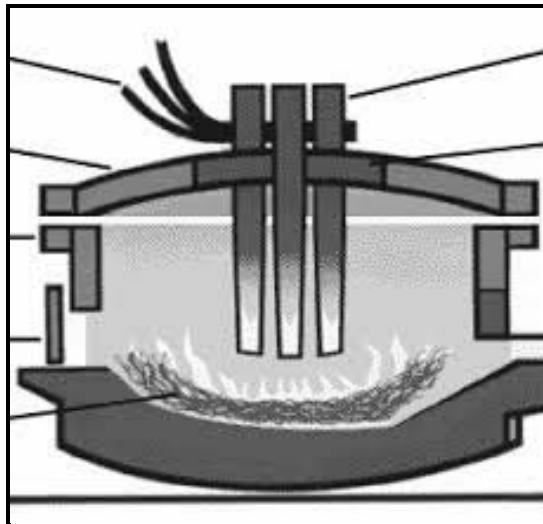
[16]

QUESTION 4: MAINTENANCE (GENERIC)

- 4.1 Explain the maintenance of a pedestal grinder with regard to the guards. (2)
- 4.2 How can friction be reduced when drilling holes? (2)
- 4.3 What do you understand by *overloading*? (2)
- 4.4 State the results of the lack of lubrication in a gear system. (2)

[8]**QUESTION 5: MATERIALS (GENERIC)**

- 5.1 Name THREE raw materials needed in the production of iron. (3)
- 5.2 What is the name of the product produced by the blast furnace? (1)
- 5.3 Describe the operation of an electric arc furnace. (3)

**FIGURE 5.3**

(3)

- 5.4 State the function of each of the following furnaces:

- 5.4.1 Blast furnace (2)
- 5.4.2 Bessemer converter furnace (2)
- 5.4.3 Open hearth furnace (2)

5.5 FIGURE 5.5 below shows the cross-sectional view of a furnace.

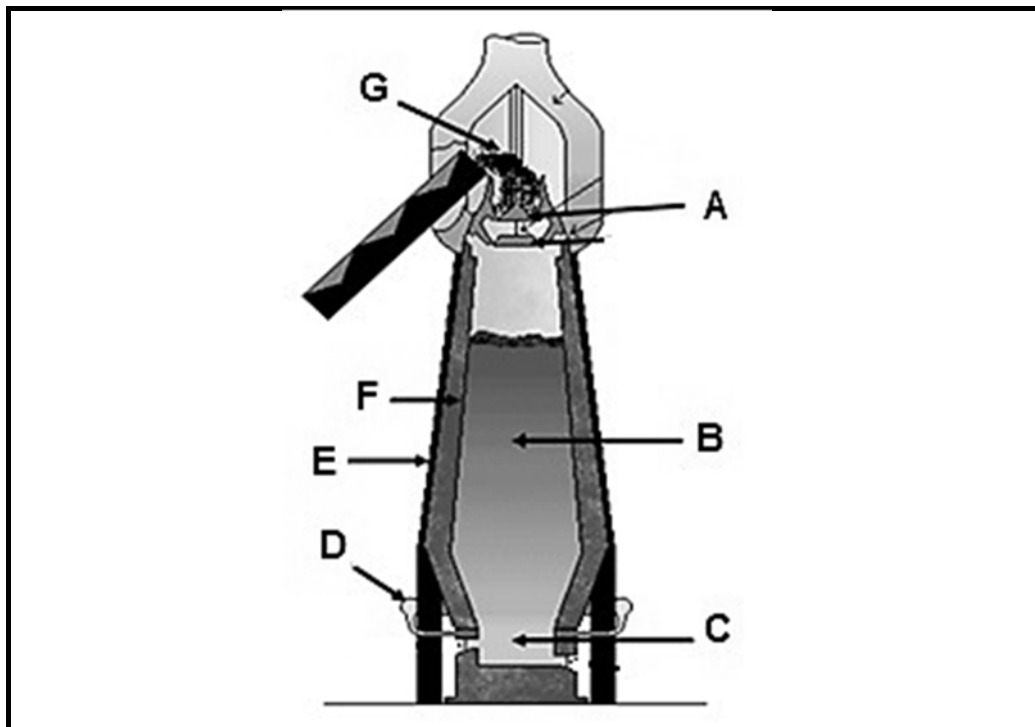


FIGURE 5.5

- 5.5.1 Identify the furnace in FIGURE 5.5 above. (1)
- 5.5.2 Label parts **A–G**. (7)
- 5.6 Melting in the rotor plant takes place in an atmosphere which, within limits, may be controlled. Name **THREE** advantages of this process. (3)
- 5.7 Describe the following terms which are used to identify the properties of metals:
- 5.7.1 Ductility (2)
- 5.7.2 Brittleness (2)
- 5.7.3 Plasticity (2)
- 5.7.4 Toughness (2)
- [32]**

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1

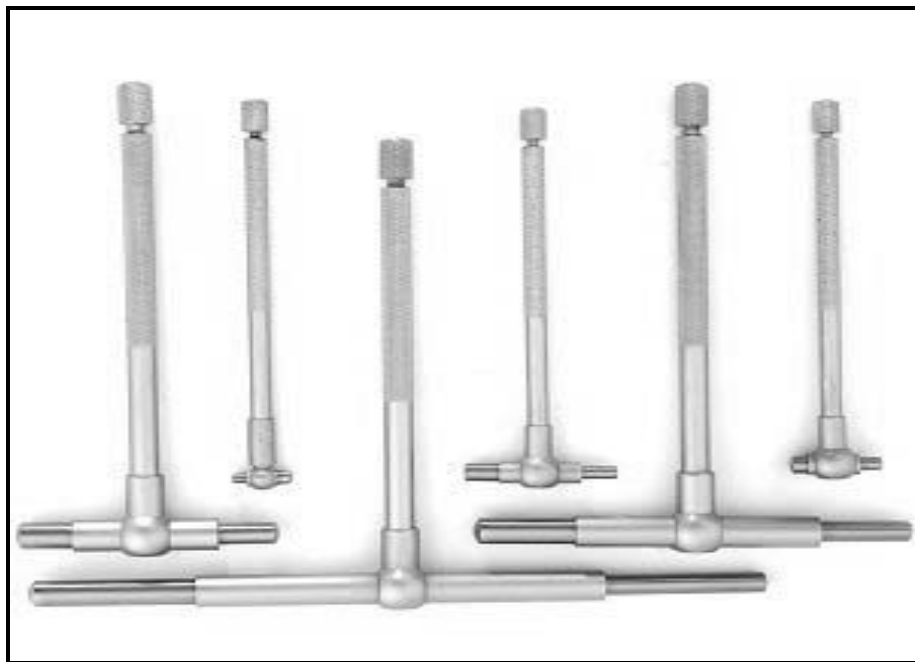


FIGURE 6.1

- 6.1.1 Identify the precision tool indicated in FIGURE 6.1 above. (1)
- 6.1.2 State the function of the tool. (1)
- 6.1.3 The tool in FIGURE 6.1 is not calibrated. How can you determine measurements while using it? (1)

6.2

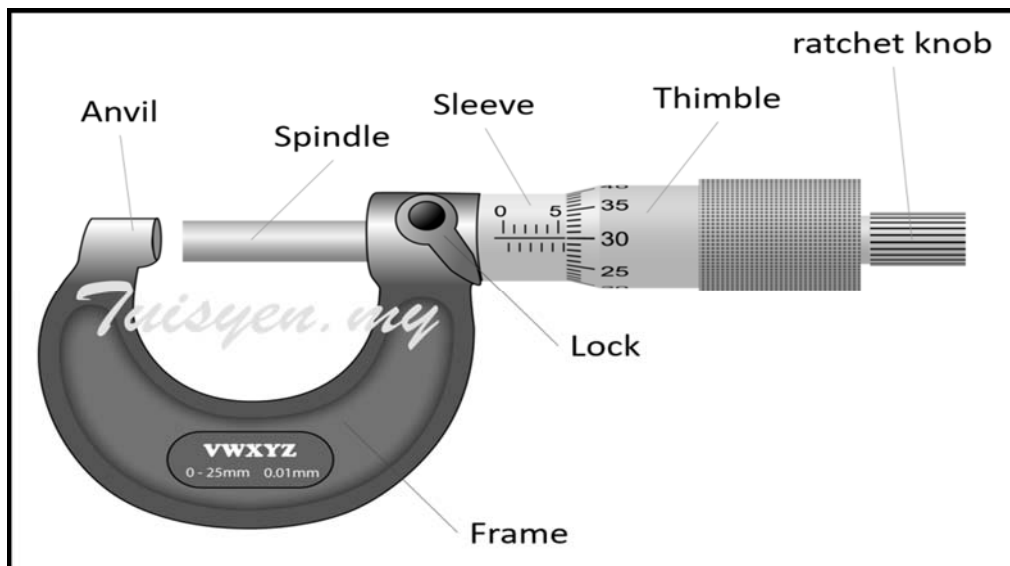


FIGURE 6.2

- 6.2.1 What is the name of the tool shown in FIGURE 6.2 above? (1)
- 6.2.2 Calculate the measurement displayed on FIGURE 6.2. (2)
- 6.3 Give THREE automotive applications where a torque wrench can be used. (3)

[9]

QUESTION 7: ENGINES (SPECIFIC)

- 7.1 What is the function of a glow plug in a compression ignition engine system? (3)
- 7.2 A four-stroke engine has the following valve timing information:
- | | |
|-----------------------|----------|
| Inlet valve opens: | 16° BTDC |
| Inlet valve closes: | 34° ABDC |
| Exhaust valve opens: | 36° BBDC |
| Exhaust valve closes: | 12° ATDC |
| Injection : | 16° ATDC |
- Draw a valve timing diagram for this engine. (3)
- 7.3 Use the diagram drawn in QUESTION 7.2 to calculate the following:
- 7.3.1 Inlet valve period (1)
- 7.3.2 Exhaust valve period (1)
- 7.3.3 Power period (1)
- 7.3.4 Valve overlap (1)
- 7.4 Briefly explain the following states of valve timing:
- 7.4.1 Valve lead (2)
- 7.4.2 Valve lag (2)
- 7.5 Give ONE disadvantage of excessive valve clearance. (1)

[15]

QUESTION 8: SYSTEMS AND CONTROL (SPECIFIC)**FIGURE 8.1**

- 8.1 What is the name of the final drive gear shown in FIGURE 8.1 above? (1)
- 8.2 Give TWO functions of final drives in a motor vehicle. (2)
- 8.3 Give THREE advantages of using hypoid gear assembly in final drive. (3)
- 8.4 Mention TWO functions of a differential in a motor vehicle. (2)

8.5

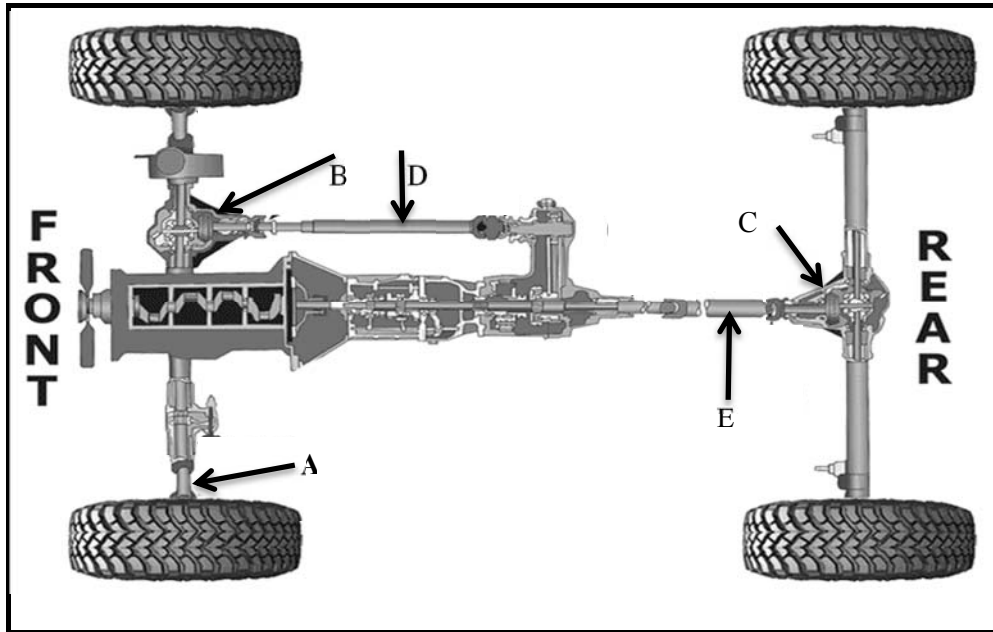


FIGURE 8.5

Study FIGURE 8.5 above and answer the following questions:

- 8.5.1 Identify the layout of the drive system shown in FIGURE 8.5 above. (1)
- 8.5.2 Label parts **A–E**. (5)
- 8.5.3 What is the purpose of the driver system shown in FIGURE 8.5? (2)

- 8.6 What is the function of the following brake components?
 - 8.6.1 Master cylinder (1)
 - 8.6.2 Vacuum servo unit (2)
- 8.7 Give ONE factor that determines the braking distance of a car. (1)
- 8.8 Briefly explain the working principles of a starter solenoid. (3)
- 8.9 Name TWO types of drive mechanisms for a starter solenoid. (2)
- 8.10 What is the difference between a *cold spark plug* and a *hot spark plug*? (2)

[27]

QUESTION 9: MAINTENANCE (SPECIFIC)

9.1 What is the purpose of using an oil pump in an SI/CI engine? (2)

9.2 FIGURE 9.2 below shows the oil pump for an internal combustion engine. Study the diagram and answer the questions that follow.

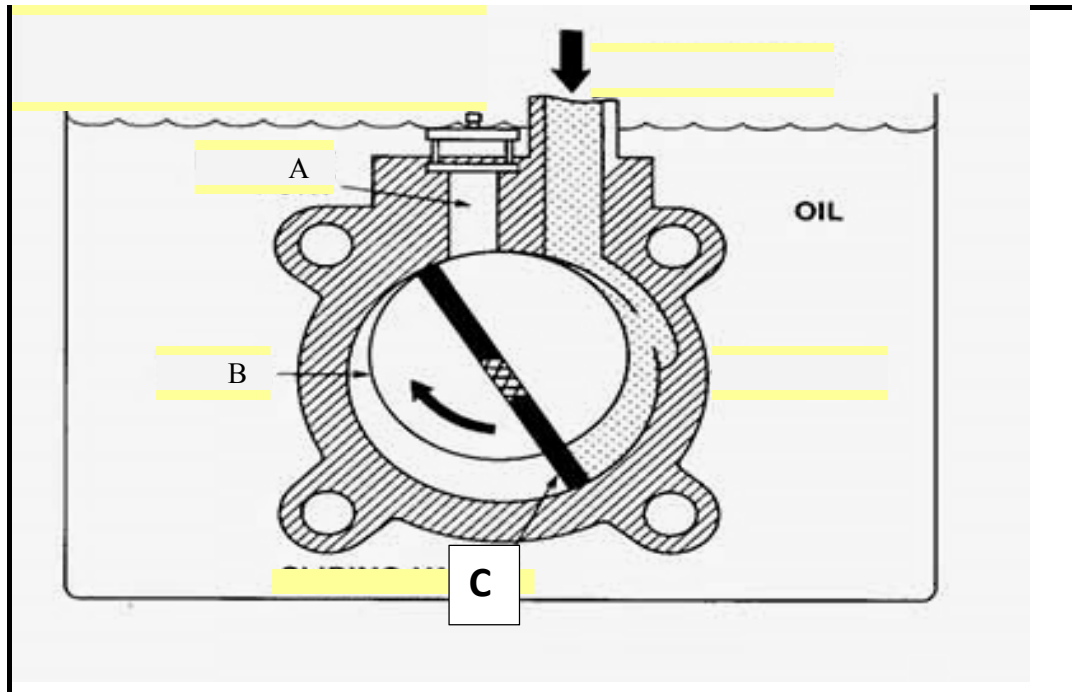


FIGURE 9.2

9.2.1 What type of oil pump is shown in FIGURE 9.2? (1)

9.2.2 Label parts **A–C**. (3)

9.2.3 Give TWO advantages of using this type of oil pump in an SI engine. (2)

9.3 What is the function of the following engine components?

9.3.1 Oil seal (1)

9.3.2 Gasket (2)

[11]

QUESTION 10: FORCES (SPECIFIC)

- 10.1 A spark ignition (SI) engine has a cylinder diameter of 96 mm, a stroke length of 72 mm and a clearance volume 74 cm³. Calculate the compression ratio of the engine (6)
- 10.2 What do you understand by the *mean effective pressure* (MEP) of an internal combustion engine? (2)
- 10.3 What are the TWO kinds of mean effective pressure (MEP) applicable in the automotive industry? (2)
- 10.4 Briefly explain what is meant by the term *indicated power*. (2)
- 10.5 The following data was recorded during a test carried out on a four-stroke, four-cylinder petrol engine:
- | | |
|--|-----------|
| Mean effective pressure on the piston: | 1 800 kPa |
| Length of stroke: | 80 mm |
| Cylinder bore: | 102 mm |
| Revolutions per minute: | 4 300 rpm |
| Number of cylinders: | 4 |
- Calculate the indicated power. (9)
- 10.6 Briefly explain the following:
- 10.6.1 Swept volume (2)
- 10.6.2 Clearance volume (2)
- 10.6.3 Torque (2)
- 10.7 Calculate the torque applied to a bolt by a torque wrench with a length of 450 mm from the point of grip, when a force of 395 N is applied. (3)
- [30]**

QUESTION 11: TERMINOLOGY (SPECIFIC)

- 11.1 Briefly explain the following terminology in relation to the set-up and operations of an automotive workshop:
- 11.1.1 Capital (2)
- 11.1.2 Tools and equipment (2)
- 11.1.3 Flow control (2)
- 11.1.4 Quality control (2)
- [8]**

TOTAL: 200

FORMULA SHEET FOR MECHANICAL TECHNOLOGY (AUTOMOTIVE)

$$\text{Force} = m \times a \quad \text{where } m = \text{mass}$$

$$a = \text{acceleration}$$

$$\text{Work} = \text{force} \times \text{distance} \quad (F \times d)$$

$$\text{Power} = \frac{\text{force} \times \text{distance}}{\text{time}}$$

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

$$\text{Indicated power} = P \times L \times A \times N \times n$$

where $P = \text{mean effective pressure}$

$L = \text{length of stroke}$

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

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

$n = \text{number of cylinders}$

$$\text{Brake power} = 2 \pi N \times T$$

where $N = \text{revolutions per second}$

$T = \text{torque}$

$$\text{Brake power (Prony brake)} = F \times 2 \times \pi \times R \times N$$

where $F = \text{force}$

$R = \text{length of brake arm}$

$N = \text{revolutions per second}$

$$\text{Mechanical efficiency} = \frac{\text{brake power}}{\text{indicated power}} \times 100$$

$$\text{Compression ratio} = \frac{\text{swept volume} + \text{clearance volume}}{\text{clearance volume}}$$

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

where $L = \text{length of stroke}$

$D = \text{diameter of bore}$

$$\text{Clearance volume} = \frac{\pi \times D^2}{4} \times l$$

where $D = \text{diameter of bore}$

$l = \text{clearance}$

$$\text{Gear ratio} = \frac{\text{product of the number of teeth of the driven gears}}{\text{product of the number of teeth of the driver gears}}$$