



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

**NATIONAL
SENIOR CERTIFICATE**

GRADE 10

MECHANICAL TECHNOLOGY

EXEMPLAR 2016

MARKS: 200

TIME: 3 hours

This question paper consists of 23 pages and a 2-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. Write your NAME on the ANSWER BOOK.
2. This question paper consists of FOUR sections:

SECTION A is COMPULSORY.

SECTION B: FITTING AND MACHINING

SECTION C: AUTOMOTIVE

SECTION D: WELDING AND METALWORK
3. Answer SECTION A (COMPULSORY) and then answer SECTION B or C or D, according to your choice of specialisation.
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. Write neatly and legibly.
11. A formula sheet is supplied at the end of the question paper.
12. Use the criteria below and on the next page to assist you in managing your time.

SECTION A (GENERIC)			
QUESTION	CONTENT	MARKS	TIME
1	Multiple-choice questions (Generic)	20	15 minutes
2	Safety (Generic)	10	10 minutes
3	Tools and Equipment (Generic)	12	10 minutes
4	Materials (Generic)	12	10 minutes
5	Joining Methods (Generic)	24	20 minutes
6	Forces (Generic)	27	25 minutes
7	Maintenance (Generic)	16	15 minutes
8	Engines (Generic)	19	20 minutes
TOTAL SECTION A:		140	125 minutes

FITTING AND MACHINING			
SECTION B (SPECIFIC)			
QUESTION	CONTENT	MARKS	TIME
9	Terminology (Specific)	33	30 minutes
10	Systems and Control (Specific)	27	25 minutes
TOTAL SECTION B:		60	55 minutes
GRAND TOTAL:		200	180 minutes

AUTOMOTIVE			
SECTION C (SPECIFIC)			
QUESTION	CONTENT	MARKS	TIME
11	Terminology (Specific)	20	20 minutes
12	Maintenance (Specific)	10	10 minutes
13	Systems and Control (Specific)	17	15 minutes
14	Engines (Specific)	13	10 minutes
TOTAL SECTION C:		60	55 minutes
GRAND TOTAL:		200	180 minutes

WELDING AND METALWORK			
SECTION D (SPECIFIC)			
QUESTION	CONTENT	MARKS	TIME
15	Welding terminology (Specific)	10	10 minutes
16	Arc welding (Specific)	10	10 minutes
17	Gas welding (Specific)	10	10 minutes
18	Welding symbols and Joints (Specific)	15	10 minutes
19	Development (Specific)	15	15 minutes
TOTAL SECTION D:		60	55 minutes
GRAND TOTAL:		200	180 minutes

SECTION A (GENERIC)**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 number (1.1–1.20) in the ANSWER BOOK, for example 1.21 A.

- 1.1 Which ONE of the following safety precautions is applicable when using hand tools?
- A Work at a very slow speed.
 - B Work with well-lubricated tools.
 - C Use tools only for the purpose for which they were made.
 - D Replace all tools after use. (1)
- 1.2 What is the maximum safe distance that a tool rest should be from a grinding wheel on a bench grinder?
- A 8 mm
 - B 10 mm
 - C 3 mm
 - D 6 mm (1)
- 1.3 Which ONE of the following tools is used for marking off?
- A Combination spanner
 - B Circlip pliers
 - C Allen key
 - D Scriber (1)
- 1.4 What is the included angle of a centre punch?
- A 45°
 - B 60°
 - C 90°
 - D 0° (1)
- 1.5 A smooth file is preferred to finish off ...
- A soft material.
 - B hard material.
 - C wood.
 - D plastic. (1)
- 1.6 Lead is a...
- A hard, grey-coloured metal.
 - B soft, bluish grey metal.
 - C Medium soft, light grey metal.
 - D very soft, white-grey metal. (1)

- 1.7 Which ONE of the following is a use of duralumin?
- A Roof trusses
 - B School desks
 - C Aircraft parts
 - D Garden furniture
- (1)
- 1.8 Why is tungsten one of the principal alloying elements for tool steel?
- A It increases the strength and toughness of the steel.
 - B It increases the malleability of the steel.
 - C It makes the steel lighter.
 - D It decreases the lifespan of the steel.
- (1)
- 1.9 Which ONE of the following statements describes the application of a split pin?
- A A metal ring fitted into a groove on a metal bar or in the bore of a boss to hold a component or object in position
 - B A metal pin passed through a hole and held in place by its bended ends
 - C A metal nut with slots on one end that gives it a castle-like appearance
 - D A metal strip to fit in a space
- (1)
- 1.10 Identify the item in FIGURE 1.10 below.

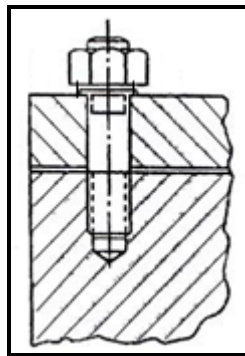


FIGURE 1.10

- A Stud bolt
 - B Hexagonal bolt
 - C Taper bolt
 - D Gib-head bolt
- (1)

1.11 Identify the type of key in FIGURE 1.11 below.

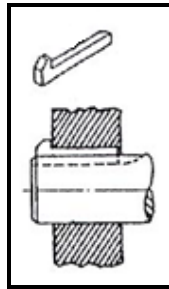


FIGURE 1.11

- A Woodruff key
- B Gib-head key
- C Taper key
- D Parallel key

(1)

1.12 What type of force is shown in FIGURE 1.12 below?

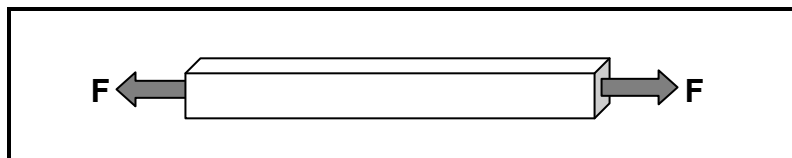


FIGURE 1.12

- A Tensile force
- B Compressive force
- C Rolling force
- D Shearing force

(1)

1.13 What class of lever is shown in FIGURE 1.13 below?

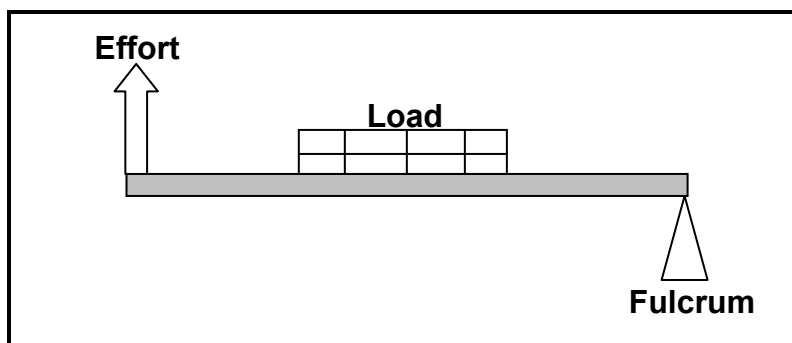


FIGURE 1.13

- A 1st class
- B 2nd class
- C 3rd class
- D 4th class

(1)

- 1.14 What do you understand by the term *stress* in materials?
- A The internal force in a material resisting a shearing load
 - B The internal force in a material resisting a pulling load
 - C The internal force in a material resisting a compressive load
 - D The internal force in a material resisting an external load
- (1)
- 1.15 Which ONE of the following is the main purpose of maintenance on machinery?
- A To ensure that machinery always operates at an optimal level
 - B To ensure that minor repairs on machinery are separated from major repairs
 - C To make sure that the well-being of workers is always taken care of
 - D To provide systematic inspection and resulting failure of workshop equipment
- (1)
- 1.16 Which ONE of the following is an advantage of using cutting fluid on a machine?
- A It keeps the cutting tool and work piece cool during the cutting process.
 - B It increases vibration on the machine parts.
 - C It causes the work piece to rust.
 - D It shortens the lifespan of the cutting tool.
- (1)
- 1.17 What is understood by the term *pour point*?
- A The lowest temperature at which a fluid will flow
 - B The highest temperature at which a fluid will flow
 - C The lowest pressure at which a fluid will flow
 - D The highest pressure at which a fluid will flow
- (1)
- 1.18 What type of fuel is used in a spark-ignition engine?
- A Diesel
 - B Oil
 - C Gas
 - D Petrol
- (1)
- 1.19 The correct stroke order of a four-stroke spark-ignition engine is as follows:
- A Compression stroke; power stroke; inlet stroke; exhaust stroke
 - B Inlet stroke; compression stroke; power stroke; exhaust stroke
 - C Power stroke; exhaust stroke; compression stroke; inlet stroke
 - D Inlet stroke; compression stroke; exhaust stroke; power stroke
- (1)

1.20 The crankshaft of a four-stroke engine rotates at 3 000 revolutions per minute. At how many revolutions per minute will the camshaft rotate?

- A 6 000 r/min
- B 4 500 r/min
- C 1 500 r/min
- D 3 000 r/min

(1)
[20]

QUESTION 2: SAFETY (GENERIC)

2.1 Name THREE personal protective items to worn while operating machinery in a workshop. (3)

2.2 Name TWO safety precautions to be observed before a drill press may be used. (2)

2.3 State THREE safety precautions to be adhered to while a milling machine is in operation. (3)

2.4 Which important safety procedure should be carried out after finishing the cutting process on a lathe? (1)

2.5 State the type of fire extinguisher used to extinguish flammable liquids. (1)
[10]

QUESTION 3: TOOLS AND EQUIPMENT (GENERIC)

3.1 State TWO file profiles. (2)

3.2 Describe the advantage of using an open-ended spanner over a ring spanner. (1)

3.3 Name TWO different types of pliers. (2)

3.4 Why are Phillips screwdrivers preferred to flat screwdrivers? (2)

3.5 State THREE uses of a combination set. (3)

3.6 State ONE use of each of the following punches:

3.6.1 Prick punch (1)

3.6.2 Centre punch (1)
[12]

QUESTION 4: MATERIALS (GENERIC)

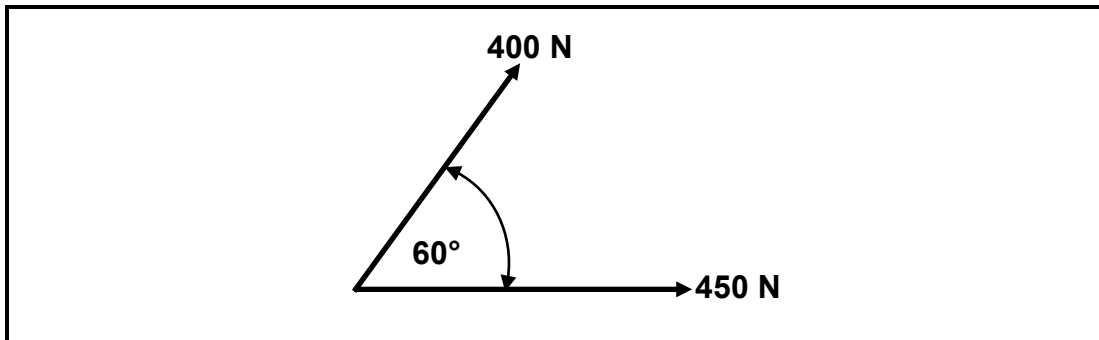
- 4.1 State the THREE groups of carbon steel. (3)
- 4.2 Cast iron is divided into white and grey cast iron. What determines the hardness of these two types of cast iron? (2)
- 4.3 State ONE use of each of the following non-ferrous elements:
- 4.3.1 Copper (1)
- 4.3.2 Tin (1)
- 4.3.3 Aluminium (1)
- 4.4 Name FOUR non-ferrous alloys. (4)
- [12]**

QUESTION 5: JOINING METHODS (GENERIC)

- 5.1 Name the sequence of the THREE taps used to cut internal screw threads. (3)
- 5.2 Give THREE reasons for inferior results during hand threading, by referring to accuracy and finishing of the screw thread. (3)
- 5.3 What is the purpose of a die during hand threading? (2)
- 5.4 A pulley needs to be fitted on a 42 mm diameter shaft. Calculate the following dimensions of the parallel key needed for this assembly:
- 5.4.1 The width of the parallel key (3)
- 5.4.2 The thickness of the parallel key (3)
- 5.4.3 The length of the parallel key (3)
- 5.5 A M16 x 2 V-thread needs to be tapped in a work piece. Calculate the diameter of the drill needed. (3)
- 5.6 Draw neat sketches of the following rivet heads:
- 5.6.1 Pan head (2)
- 5.6.2 Countersunk head (2)
- [24]**

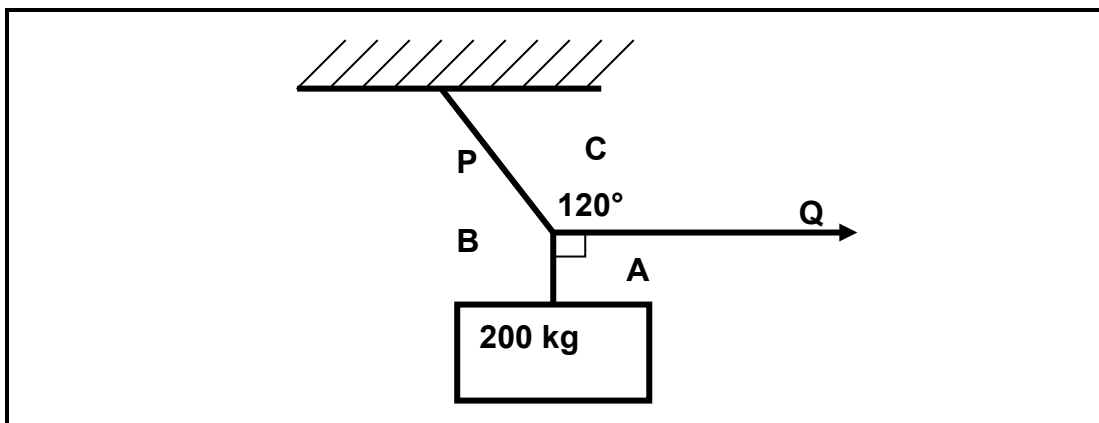
QUESTION 6: FORCES (GENERIC)

- 6.1 Use a parallelogram of forces and determine graphically the magnitude and direction of the resultant for the system of forces in FIGURE 6.1 below. (Use scale 1 mm = 5 N.)

**FIGURE 6.1**

(4)

- 6.2 The system of forces in FIGURE 6.2 below is in equilibrium. Use Bow's notation and determine graphically the magnitude and directions of the unknown forces **P** and **Q**. (Use scale 1 mm = 20 N.)

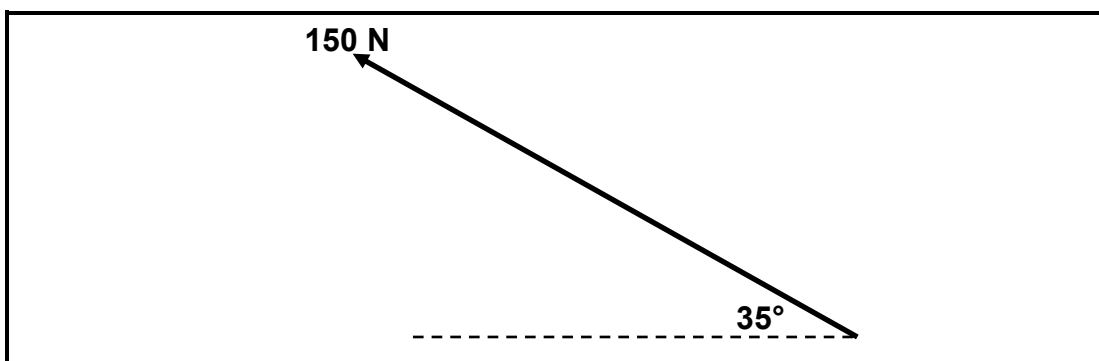
**FIGURE 6.2**

(5)

- 6.3 Define a *force*.

(5)

- 6.4 FIGURE 6.4 below shows a single force of 150 N acting in a direction 35° north from west. Calculate the magnitudes and directions of the horizontal and vertical components of this force.

**FIGURE 6.4**

(4)

6.5 A compressive force of 30 kN is exerted onto a round bar with a diameter of 15 mm. Calculate the stress in the material. (5)

6.6 FIGURE 6.6 below shows a uniform beam onto which two perpendicular forces are exerted. Calculate the total moment around point A caused by the forces.

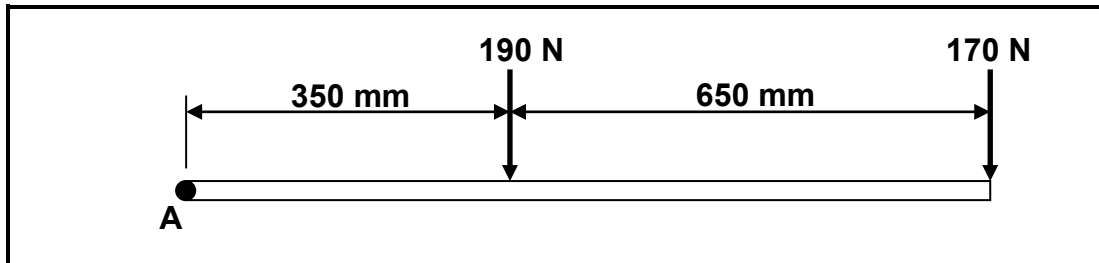


FIGURE 6.6

(4)
[27]

QUESTION 7: MAINTENANCE (GENERIC)

7.1 Name FOUR effects of a lack of maintenance on equipment. (4)

7.2 Briefly explain what the following types of maintenance entails and give an example of each:

7.2.1 Preventative ('routine') maintenance (2)

7.2.2 Predictive ('in-service') maintenance (2)

7.3 Different lubricants are used to extend machinery's reliability and maintenance. Explain the purpose of a lubricant on machine components. (3)

7.4 Define *viscosity* with reference to lubricants. (1)

7.5 Indicate the viscosity (high, medium or low) of each of the following types of lubricants and motivate each answer:

7.5.1 Engine oil (2)

7.5.2 Grease (2)

[16]

QUESTION 8: ENGINES (GENERIC)

8.1 Describe the following terms with reference to internal combustion engines:

8.1.1 Stroke (1)

8.1.2 Top dead centre (TDC) (1)

8.1.3 Cycle (1)

8.2 FIGURE 8.2 below shows a stroke of a two-stroke petrol engine. Answer the questions that follow.

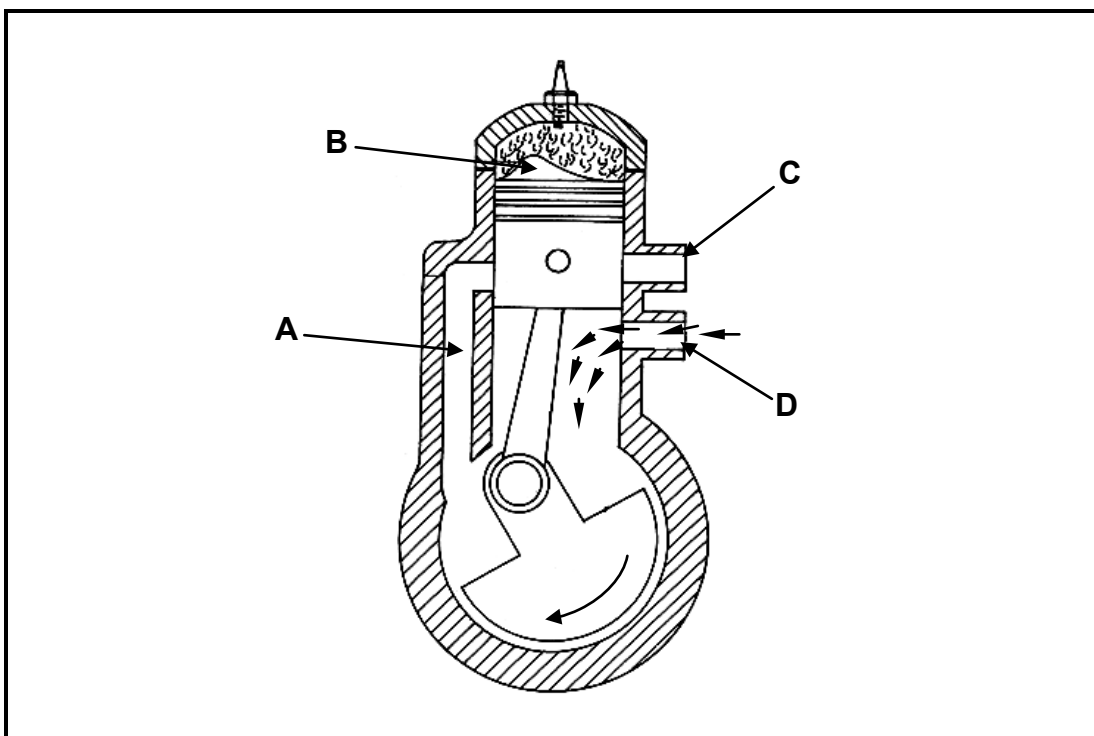


FIGURE 8.2

8.2.1 Label parts A–D. (4)

8.2.2 Identify and explain the operation of the stroke in FIGURE 8.2 above. (4)

8.3 FIGURE 8.3 below shows a stroke of a four-stroke petrol engine. Answer the questions that follow.

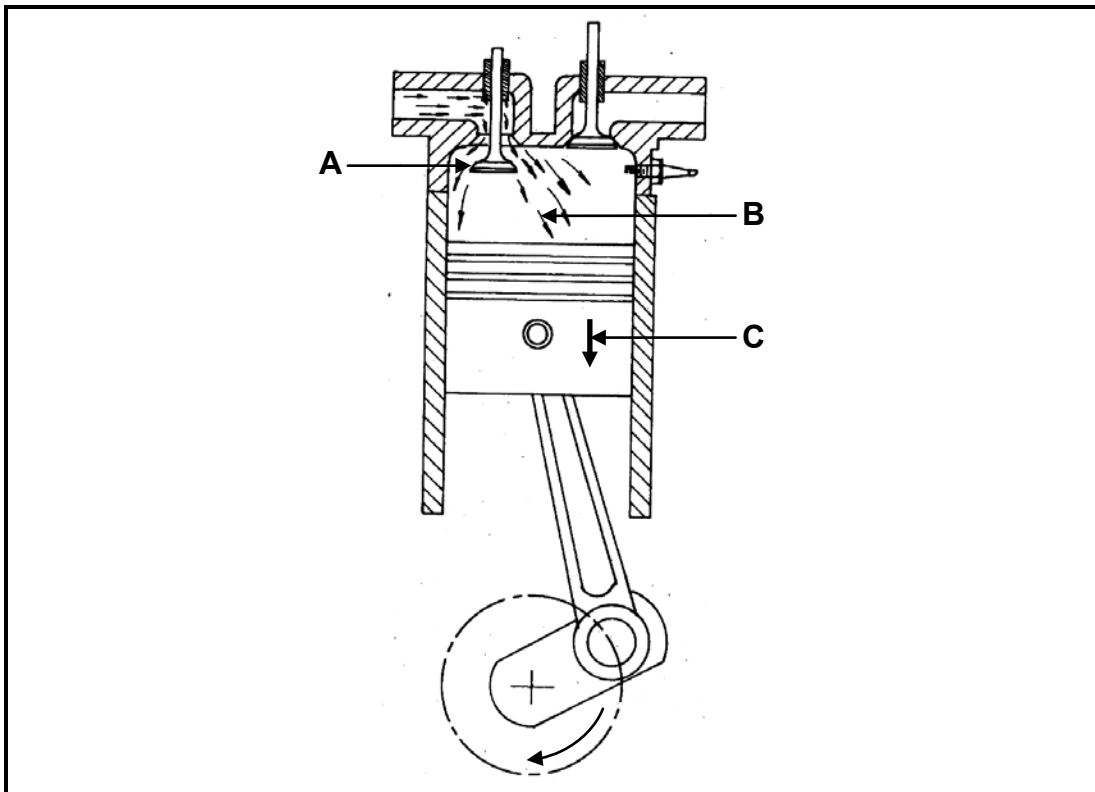


FIGURE 8.3

- 8.3.1 Identify the stroke in FIGURE 8.3 above. (1)
 - 8.3.2 Label parts A–C. (3)
 - 8.3.3 Explain the operation of the stroke in FIGURE 8.3 above. (4)
- [19]**

TOTAL SECTION A: 140

SECTION B: FITTING AND MACHINING (SPECIFIC)

QUESTION 9: TERMINOLOGY (SPECIFIC)

9.1 A vernier calliper is shown in FIGURE 9.1 below. Answer the questions that follow.

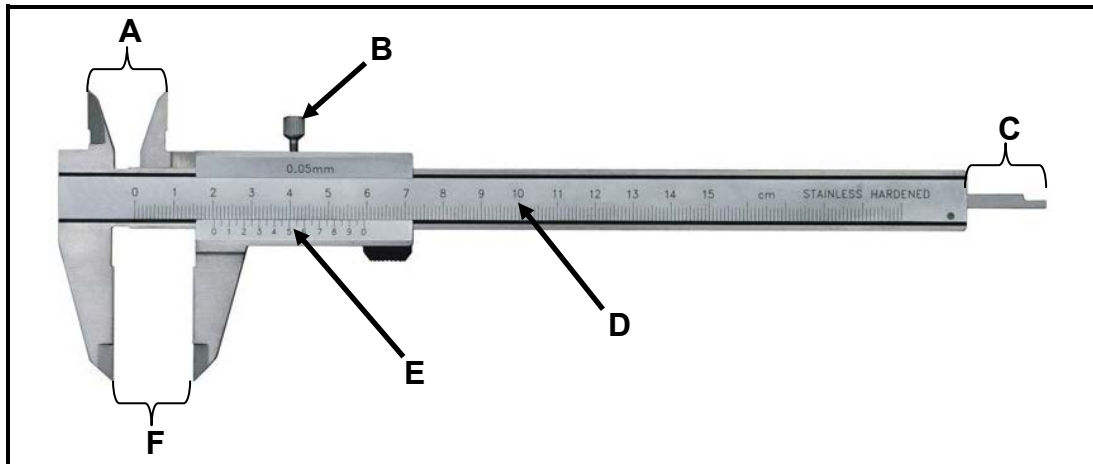


FIGURE 9.1

9.1.1 Label parts **B**, **D** and **E**. (3)

9.1.2 Which measurements are indicated by **A**, **C** and **F**? (3)

9.1.3 Draw a neat, diagrammatic representation of the reading on the calliper for 107,42 mm. (The accuracy of the calliper is 0,02 mm.) (5)

9.2 FIGURE 9.2 below shows a reading on an outside micrometer. What is the value of the reading?

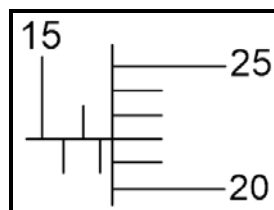


FIGURE 9.2

(4)

9.3 Name TWO types of centre lathe beds. (2)

9.4 What is the purpose of the four-jaw chuck on a centre lathe? (2)

9.5 Describe the function of the following centre lathe components:

9.5.1 Lead screw (2)

9.5.2 Tailstock (2)

- 9.6 FIGURE 9.6 below shows the angles on a centre lathe cutting tool. Label parts A–D.

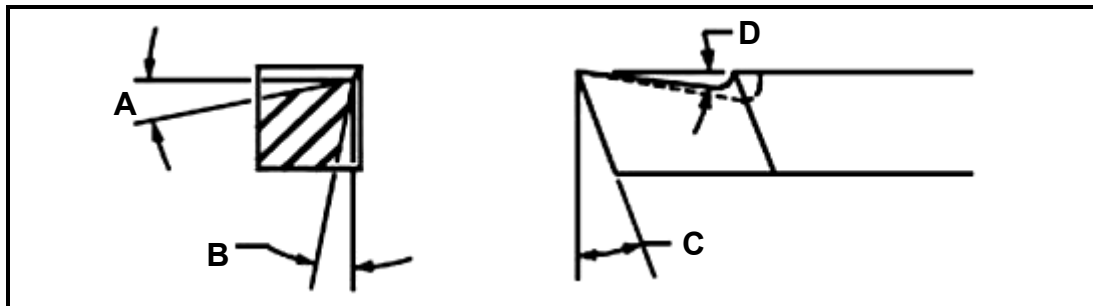


FIGURE 9.6

(4)

- 9.7 Give TWO reasons for using coolant when machining is done on a centre lathe. (2)
- 9.8 State TWO advantages of the compound slide method for taper cutting on a centre lathe. (2)
- 9.9 State TWO disadvantages of the compound slide method for taper cutting on a centre lathe. (2)

[33]

QUESTION 10: SYSTEMS AND CONTROL (SPECIFIC)

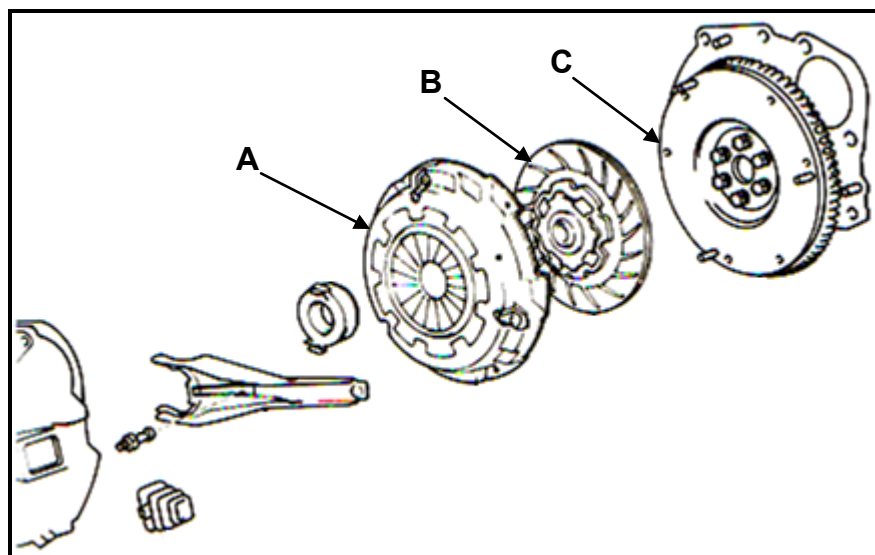
- 10.1 Draw neat, labelled sketches of the following screw threads to indicate the profile, pitch and included angle of each:
- 10.1.1 Metric V-screw thread (fine) (3)
- 10.1.2 Square screw thread (3)
- 10.1.3 Acme screw thread (3)
- 10.2 State ONE use of each of the following screw threads:
- 10.2.1 Metric V-screw thread (fine) (1)
- 10.2.2 Square screw thread (1)
- 10.3 A gear system used to drive a centrifugal pump consists of a driver gear with 60 teeth rotating at 120 r/min and a driven gear rotating at 60 r/min. Calculate the number of teeth on the driven gear. (4)
- 10.4 A flat belt pulley with a diameter of 460 mm rotates at 180 revolutions per minute. Calculate the belt speed of this system in metre per second. (4)

- | | | |
|------|--|-------------|
| 10.5 | State TWO advantages of V-belts. | (2) |
| 10.6 | State TWO disadvantages of flat belts. | (2) |
| 10.7 | State TWO advantages of gear drives. | (2) |
| 10.8 | State TWO disadvantages of chain drives. | (2) |
| | | [27] |

TOTAL SECTION B: 60

SECTION C: AUTOMOTIVE (SPECIFIC)**QUESTION 11: TERMINOLOGY (SPECIFIC)**

- 11.1 The clutch is a unit that engages and disengages the gearbox from the engine. Name TWO types of friction clutches normally used in the drive train of a motor vehicle. (2)
- 11.2 Name TWO important adjustments that may be made to a hydraulically operated clutch unit to ensure proper engagement. (2)
- 11.3 Name the TWO types of pressure plates that are used. (2)
- 11.4 Why must there be clearance between a pressure plate and a release bearing (thrust bearing)? (1)
- 11.5 FIGURE 11.5 below shows a single-plate clutch assembly. Label parts A–C. (3)

**FIGURE 11.5**

- 11.6 State ONE possible cause of each of the following clutch faults: (3)
- 11.6.1 Clutch slip (1)
- 11.6.2 Clutch shuddering (1)
- 11.7 Describe the function of the following joints: (1)
- 11.7.1 Slip joint (1)
- 11.7.2 Universal joint (1)

- 11.8 Name TWO types of gears used in the gearbox of a motor vehicle. (2)
- 11.9 Explain the function of the following components in a constant-mesh gearbox:
- 11.9.1 Synchroniser unit (2)
- 11.9.2 Selector mechanism (2)
- [20]**

QUESTION 12: MAINTENANCE (SPECIFIC)

- 12.1 What is the most important difference between a *pressure feed system* and a *full pressure feed system* with reference to the lubrication in an engine? (2)
- 12.2 What is a *crankcase ventilation system*? (1)
- 12.3 State ONE cause of excessive oil consumption by an engine. (1)
- 12.4 Why will an engine overheat even if there is enough water in the cooling system? (1)
- 12.5 How are harmful gases formed in a crankcase ventilation system? (1)
- 12.6 Describe the main difference between a *direct air-cooling system* and an *indirect air-cooling system* for engines. (2)
- 12.7 What is the function of the thermostat in the cooling system of an engine? (1)
- 12.8 What do you understand by *oil dilution*? (1)
- [10]**

QUESTION 13: SYSTEMS AND CONTROL (SPECIFIC)

- 13.1 State ONE function of the carburettor of a spark ignition engine. (1)
- 13.2 What is the function of the choke on a spark ignition engine? (2)
- 13.3 State TWO types of air filtering systems used in internal combustion engines. (2)
- 13.4 Why is brake fluid used in a hydraulic braking system? Give TWO reasons. (2)
- 13.5 Explain the operation of a hydraulic brake wheel cylinder. (4)
- 13.6 Define *Ohm's law*. (1)
- 13.7 What is *electric current*? (1)

13.8 What is measured by the following units?

13.8.1 Volt (1)

13.8.2 Ampere (1)

13.8.3 Ohm (1)

13.9 What is the function of the battery in the spark ignition system of a vehicle's engine? (1)

(1)
[17]

QUESTION 14: ENGINES (SPECIFIC)

14.1 Identify the engine component shown in FIGURE 14.1 below.

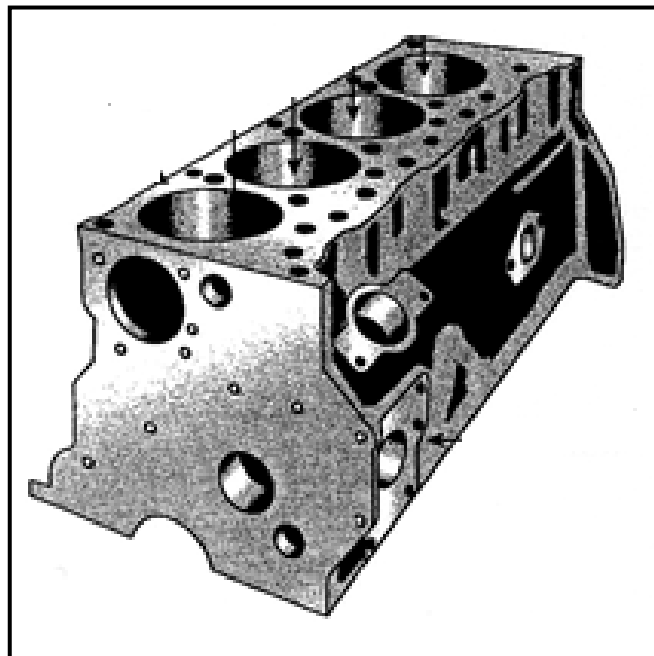


FIGURE 14.1

(1)

14.2 Describe the function of a crankshaft with reference to the connecting rod and piston. (2)

(2)

14.3 FIGURE 14.3 below shows a piston assembly. Label parts A–D.

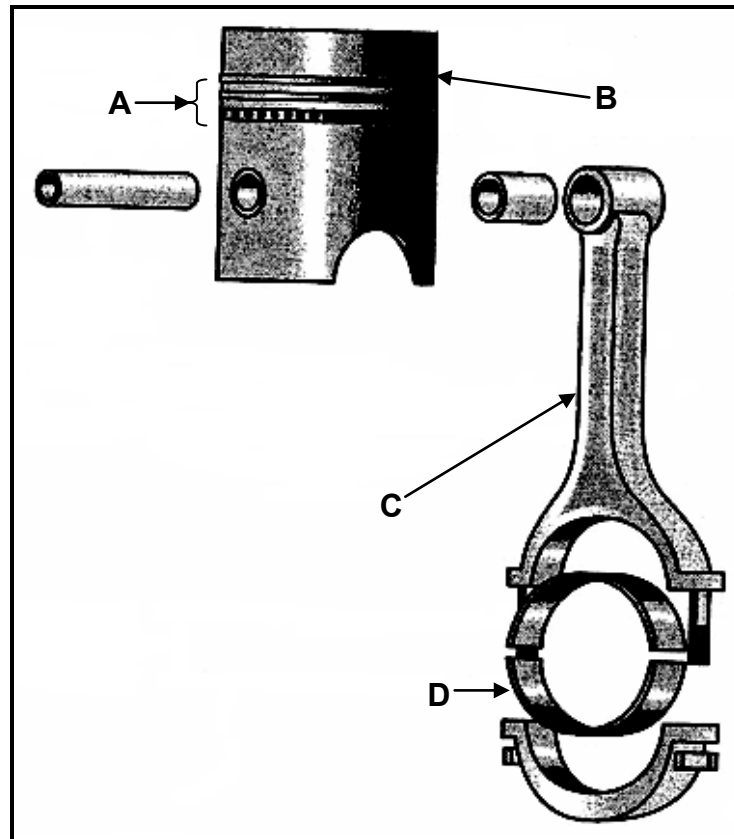


FIGURE 14.3

(4)

14.4 State ONE advantage of each of the following engine positioning layouts:

14.4.1 Engine in front with front-wheel drive (1)

14.4.2 Engine in front with rear-wheel drive (1)

14.4.3 Engine at the back with rear-wheel drive (1)

14.5 State ONE disadvantage of each of the following engine positioning layouts:

14.5.1 Engine in front with front-wheel drive (1)

14.5.2 Engine in front with rear-wheel drive (1)

14.5.3 Engine at the back with rear-wheel drive (1)

[13]

TOTAL SECTION C: 60

SECTION D: WELDING AND METALWORK (SPECIFIC)**QUESTION 15: WELDING TERMINOLOGY (SPECIFIC)**

- 15.1 Draw a neat, labelled sketch of a welded joint and show the root, root gap and the included angle. (4)
- 15.2 Name TWO materials that are used for template making. (2)
- 15.3 FIGURE 15.3 below shows triangle ABC.

Calculate the value of side **R** by applying the theorem of Pythagoras.

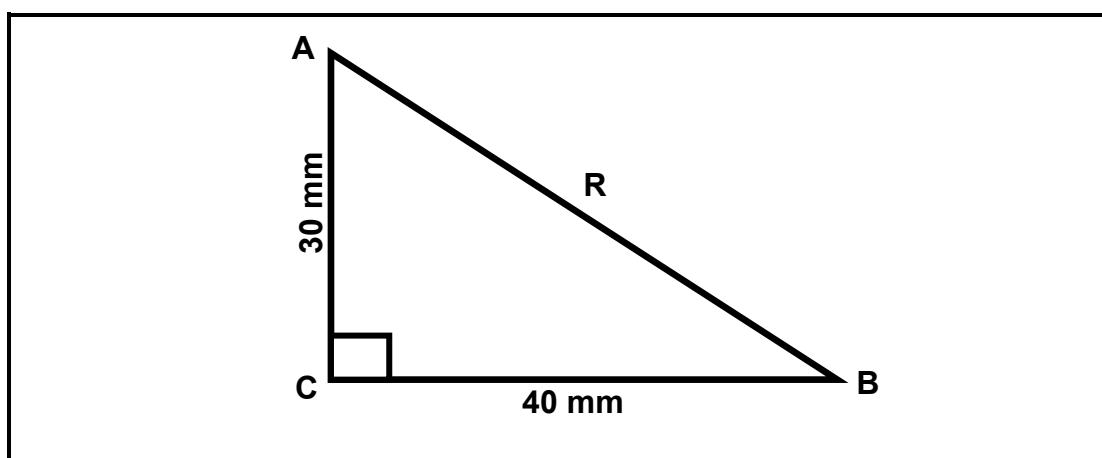


FIGURE 15.3

(4)
[10]

QUESTION 16: ARC WELDING (SPECIFIC)

- 16.1 Explain the arc welding process. (3)
- 16.2 State the function of each of the following welding accessories:
- 16.2.1 Electrode holder (1)
 - 16.2.2 Earth clamp (1)
 - 16.2.3 Transformer (1)
- 16.3 Briefly describe the operation of the following welding machines:
- 16.3.1 Direct current (DC) (2)
 - 16.3.2 Alternating current (AC) (2)

[10]

QUESTION 17: GAS WELDING (SPECIFIC)

- 17.1 Name the TWO different torches used with the oxy-acetylene system. (2)
- 17.2 State the purpose of the following gas welding components:
- 17.2.1 Regulator (1)
 - 17.2.2 Flashback arrestor (1)
 - 17.2.3 Torch (1)
- 17.3 What is the colour code for the following gas cylinders?
- 17.3.1 Acetylene (1)
 - 17.3.2 Oxygen (1)
- 17.4 Briefly explain the application of each of the following oxy-acetylene flames:
- 17.4.1 Oxidising flame (1)
 - 17.4.2 Carburising flame (1)
 - 17.4.3 Neutral flame (1)
- [10]**

QUESTION 18: WELDING SYMBOLS AND JOINTS (SPECIFIC)

- 18.1 Draw a neat, labelled sketch to show the FOUR elements of a welding symbol. (4)
- 18.2 Draw neat sketches of the following welding symbols:
- 18.2.1 Double U butt joint (1)
 - 18.2.2 J butt joint (1)
 - 18.2.3 V butt joint (1)
- 18.3 Draw neat sketches of the following welded joints:
- 18.3.1 Lap joint (2)
 - 18.3.2 Butt joint (2)
 - 18.3.3 Edge joint (2)
 - 18.3.4 Fillet joint (2)
- [15]**

QUESTION 19: DEVELOPMENT (SPECIFIC)

FIGURE 19.1 below shows a pipe elbow with one joint. Develop the pattern of pipe A **OR** pipe B. Use full scale (scale 1 : 1). Start at the right-hand side (shortest side).

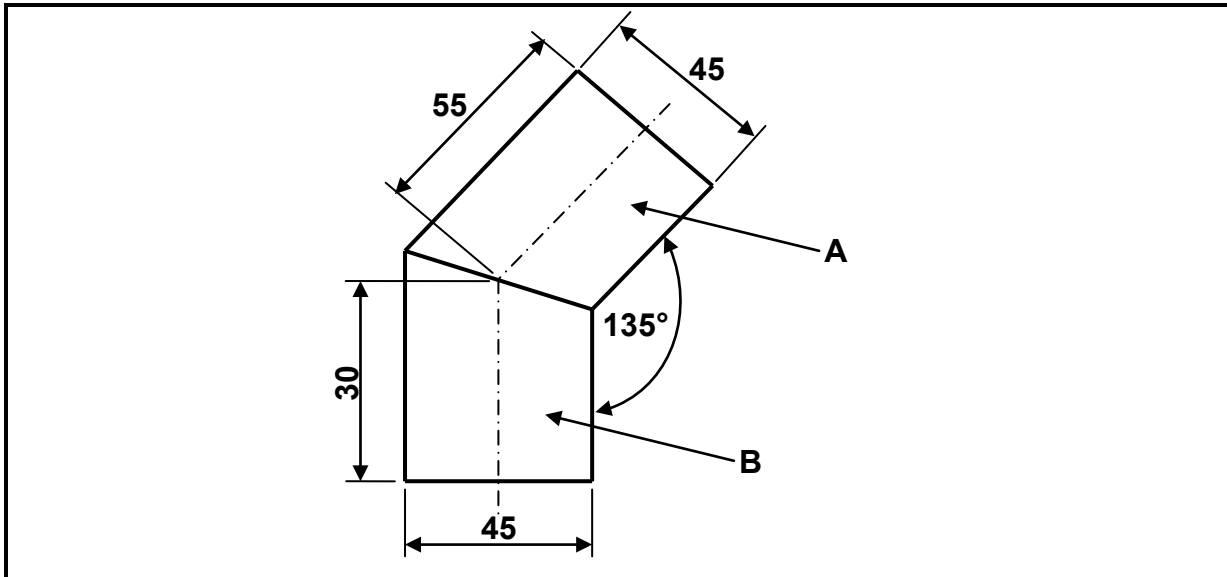


FIGURE 19.1

[15]

TOTAL SECTION D: 60
GRAND TOTAL: 200

FORMULA SHEET FOR MECHANICAL TECHNOLOGY – GRADE 10**1. BELT DRIVES**

1.1 $N_1 D_1 = N_2 D_2$ where N = rotational frequency
D = diameter of pulley

1.2 Belt speed = $\frac{\pi D N}{60}$

1.3 Speed ratio = $\frac{\text{diameter of driven pulley}}{\text{diameter of driver pulley}}$

1.4 Power (P) = $\frac{2\pi N T}{60}$ where T = torque

2. STRESS AND STRAIN

2.1 Stress = $\frac{\text{force}}{\text{area}}$ or $(\sigma = \frac{F}{A})$

2.2 $A_{\text{shaft}} = \frac{\pi d^2}{4}$

2.3 $A_{\text{pipe}} = \frac{\pi(D^2 - d^2)}{4}$

2.4 $A_{\text{square bar}} = \text{side} \times \text{side}$

3. KEYS

3.1 Width of key = $\frac{\text{diameter of shaft}}{4}$

3.2 Thickness of key = $\frac{\text{diameter of shaft}}{6}$

3.3 Length of key = 1,5 × diameter of shaft

3.4 Standard taper for taper key: 1 in 100 or 1 : 100

4. GEAR DRIVES

4.1 $N_1 T_1 = N_2 T_2$ where N = rotational frequency
T = number of teeth on gear

4.2 Power (P) = $\frac{2\pi NT}{60}$

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

4.4 $\frac{N_{\text{input}}}{N_{\text{output}}} = \frac{\text{product of number of teeth on driven gears}}{\text{product of number of teeth on driving gears}}$