



Province of the
EASTERN CAPE
EDUCATION

Iphondo leMpuma Kapa: Isobhe leMfundo
Provinsie van die Oos Kaap: Departement van Onderwys
Porafensie Ya Kapa Botjhabela: Lefapha la Thuto

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2024

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

MARKS: 200

TIME: 3 hours

This question paper consists of 20 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 questions 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	6	6
2	Safety	10	10
3	Materials	14	14
	SPECIFIC		
4	Multiple-choice questions	14	10
5	Terminology (Templates)	23	20
6	Tools and Equipment	18	15
7	Forces	45	40
8	Joining Methods (Inspection of weld)	23	20
9	Joining Methods (Stress and distortion)	18	20
10	Maintenance	8	10
11	Terminology (Development)	21	20
	TOTAL	200	180

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC) (COMPULSORY)

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, for example 1.7 A.

- 1.1 Which safety law state that all employers must ensure that the workplace is safe, and that the employees are not at risk of becoming infected with HIV at work?
- A The code of good practice on HIV/Aids and employment.
 - B Occupational Health and Safety Act (OHSA), 1993 (Act 85 of 1993)
 - C Employment Equity Act (EEA), 1998 (Act 55 of 1998)
 - D Basic Conditions of Employment Act (BCEA), 1997 (Act 75 of 1997) (1)
- 1.2 Checking breathing, heart rate, consciousness, pulse and loss of blood of an injured person, is called ...
- A vital functions.
 - B indicators to diagnosis.
 - C visible signs and symptoms.
 - D environmental observation. (1)
- 1.3 The safe working pressure must never be exceeded.
- At which of the following equipment is the safety precaution mentioned in the above statement applicable?
- A Drill press
 - B Bench grinder
 - C Hydraulic press
 - D Guillotine machine (1)
- 1.4 It is important to stand and work only in dry surroundings. Always keep your hands and clothing dry.
- In which joining equipment is the above statement applicable?
- A Hand riveter
 - B Gas welding
 - C Arc welding
 - D All the above-mentioned (1)

- 1.5 FIGURE 1.5 shows a spark test conducted on a material. Identify the material used during the spark test.

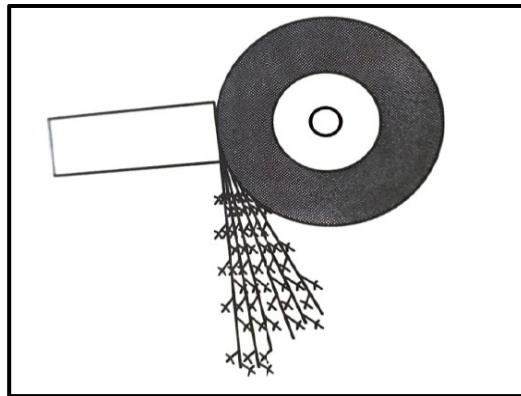


FIGURE 1.5

- A High-carbon steel
- B Low-carbon steel
- C Cast iron
- D None of the above-mentioned

(1)

- 1.6 FIGURE 1.6 below shows one of the heat treatment processes. Which heat-treatment process is represented by FIGURE 1.6?

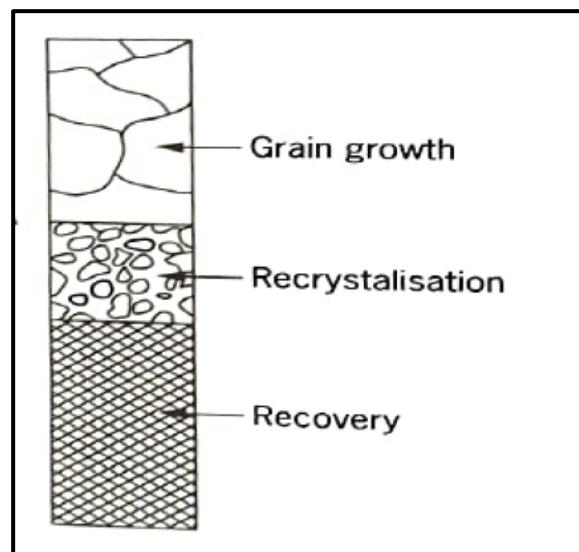


FIGURE 1.6

- A Hardening process
- B Tempering process
- C Normalising process
- D Annealing process

(1)
[6]

QUESTION 2: SAFETY (GENERIC)

- 2.1 List TWO safety precautions when handling gas cylinders in a workshop. (2)
- 2.2 Describe the employer's responsibility regarding safety in the workplace. (2)
- 2.3 State TWO safety measures to observe before switching on an angle grinder. (2)
- 2.4 Give any TWO reasons why it is important to wear welding goggles during gas welding. (2)
- 2.5 State TWO disadvantages of a process layout of machines. (2)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 Metals are usually marked or colourcoded on the ends. Why is it important to cut from the unmarked end of the metal? (1)

3.2 Tabulate the following heat-treatment processes and identify ONE property of each.

	PROCESS	PROPERTY
3.2.1	Hardening	
3.2.2	Tempering	
3.2.3	Annealing	
3.2.4	Normalising	

(4)

3.3 Explain THREE factors to considered when heat-treatment of steel is done. (3)

3.4 List THREE types of quenching media used to harden steel. (3)

3.5 State the type of test that can be used to obtain the following properties of metals:

3.5.1 Hardness (1)

3.5.2 Carbon content (1)

3.5.3 Ductility (1)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC) (COMPULSORY)

4.1 Which of the following components are part of an angle grinder?

- A Safety guard
- B Stand
- C Grinding wheel dresser
- D Tool rest

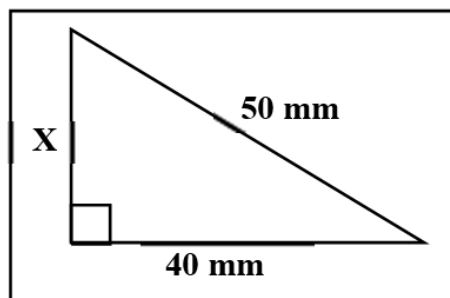
(1)

4.2 What does the abbreviation "OSU" stand for with regard to templates?

- A Only straight up
- B Only side up
- C Other steel users
- D Other side up

(1)

4.3 What is the value of **X** in the diagram below?



- A 90 mm
- B 60 mm
- C 30 mm
- D 120 mm

(1)

4.4 What is the function of a chuck on a drill press?

- A Changes the speed of the drill.
- B Adjusts the feed of the drill.
- C Holds the drill bit in position.
- D Adjusts the drill bit.

(1)

4.5 The maximum gap between the tool rest and the grinding wheel on a bench grinding machine is ...

- A 6 mm.
- B 3 mm.
- C 5 mm.
- D 4 mm.

(1)

- 4.6 Which ONE of the following is an example of a template makers' hand tool?
- A Trammel pins
 - B Arc welding machine
 - C Sanding machine
 - D Circular saw
- (1)
- 4.7 Stress can be defined as an internal force in a material resisting a/an ...
- A moving load.
 - B spin load.
 - C internal load.
 - D external load.
- (1)
- 4.8 In arc welding the electric arc is created between a/an ...
- A earth terminal and electrode.
 - B electrode and base metal.
 - C electrode and electrode terminal.
 - D base metal and earth terminal.
- (1)
- 4.9 Which ONE of the following testing methods used to test welded joints is a destructive test?
- A X-ray test
 - B Dye penetrant test
 - C Nick-break test
 - D Ultrasonic test
- (1)
- 4.10 Calculate Young's modulus of elasticity of a metal with a strain value of 2×10^{-3} caused by stress of 6 MPa.
- A 12 MPa
 - B 3 MPa
 - C 12 GPa
 - D 3 GPa
- (1)
- 4.11 Which ONE of the following tools is used to cut internal threads?
- A Set of taps
 - B Oval die
 - C Tap wrench
 - D Circular split die
- (1)
- 4.12 What is the maximum thickness of sheet metal that can be cut with a manual guillotine?
- A 3,2 mm
 - B 1,6 mm
 - C 1,2 mm
 - D 2,1 mm
- (1)

4.13 One of the reasons for locking-out and tagging equipment is to inform other workers that ...

- A there is a power failure.
- B maintenance work is in progress.
- C an accident has happened.
- D maintenance work has been completed.

(1)

4.14 How can friction be reduced when drilling holes?

- A Reduce feed speed.
- B Reduce drill speed.
- C Apply lubrication.
- D All the above-mentioned.

(1)

[14]

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

- 5.1 State any THREE reasons why the template loft is generally separated from the main workshop. (3)
- 5.2 Standard symbols and abbreviations saves time and ensures that everybody reads and interprets the drawing the same way.

Complete the table by filling in either the missing term or abbreviation. Write only the question numbers (5.2.1 to 5.2.3) and the answer in your ANSWER BOOK.

TERM	ABBREVIATION
Other side up	5.2.1
5.2.2	GALV
Top side up	5.2.3

(3)

- 5.3 A steel ring with an outside diameter of 600 mm must be manufactured from a 20 x 20 square bar.

Calculate the following:

- 5.3.1 The mean diameter of the ring (2)
- 5.3.2 The mean circumference of the ring (Round of your answer to the nearest whole number.) (3)
- 5.4 FIGURE 5.4 below shows a drawing with welding symbols.

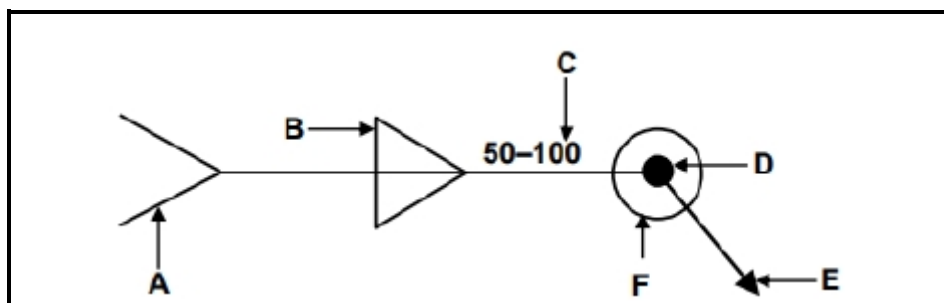


FIGURE 5.4

- Identify elements **A–F**. (6)
- 5.5 Name any TWO machine tools used in a template loft. (2)
- 5.6 Draw the weld symbols for the following types of resistance welds:
- 5.6.1 Spot (2)
- 5.6.2 Projection (2)

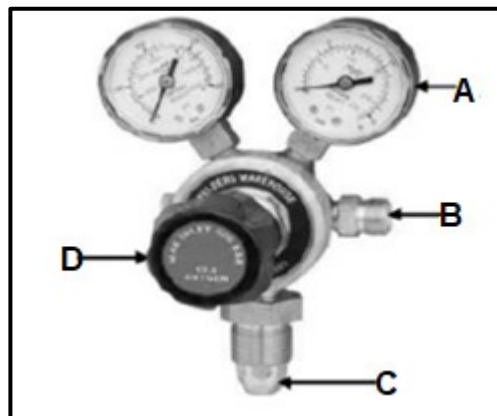
[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 Identify the machines as illustrated below and give ONE function of each.

 <p>6.1.1</p>	 <p>6.1.2</p>
 <p>6.1.3</p>	<p>(3 x 2) (6)</p>

6.2 The diagram below shows a component of a gas welding equipment. Answer the questions that follow.



6.2.1 Identify the component shown in the above diagram. (1)

6.2.2 Label parts **A–D**. (4)

6.3 Explain the working/operating principle of a power-driven guillotine. (4)

6.4 FIGURE 6.4 below shows a manual guillotine.

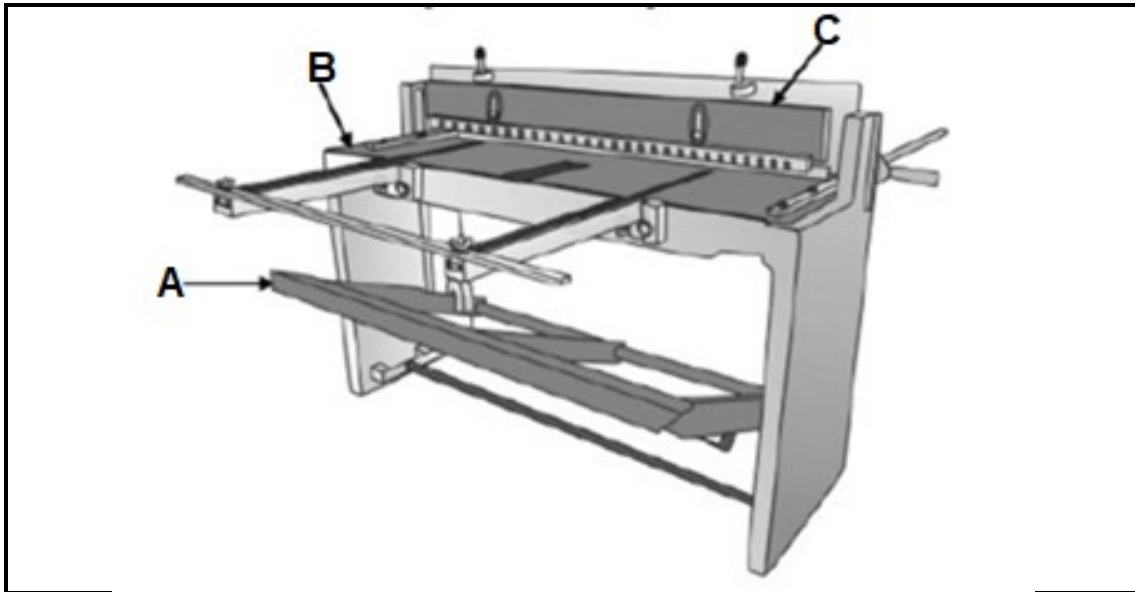


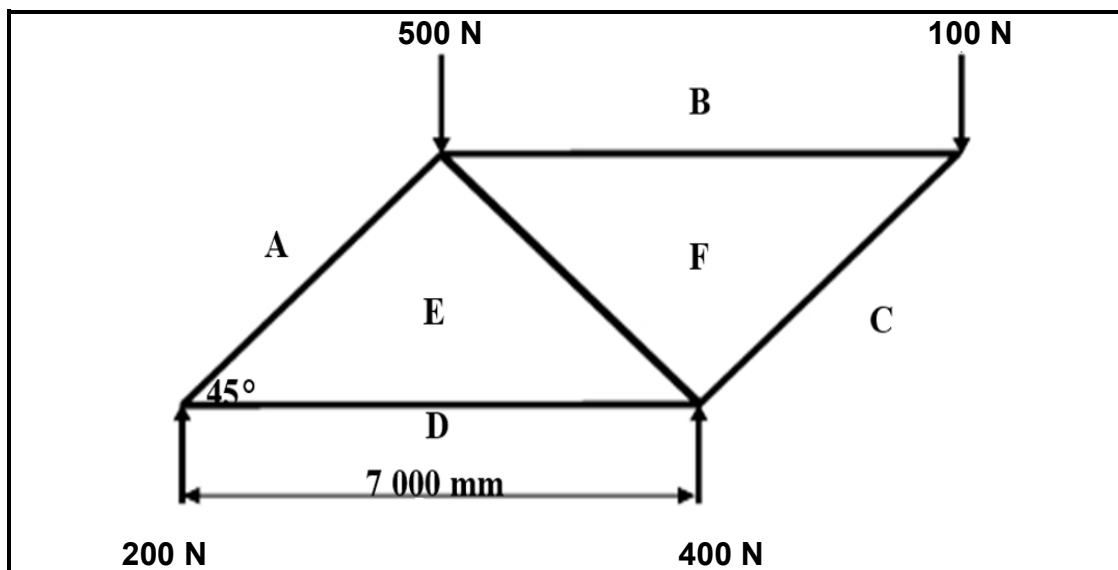
FIGURE 6.4

Label parts **A–C**.

(3)
[18]

QUESTION 7: FORCES (SPECIFIC)

7.1 FIGURE 7.1 below shows a steel framework.

**FIGURE 7.1**

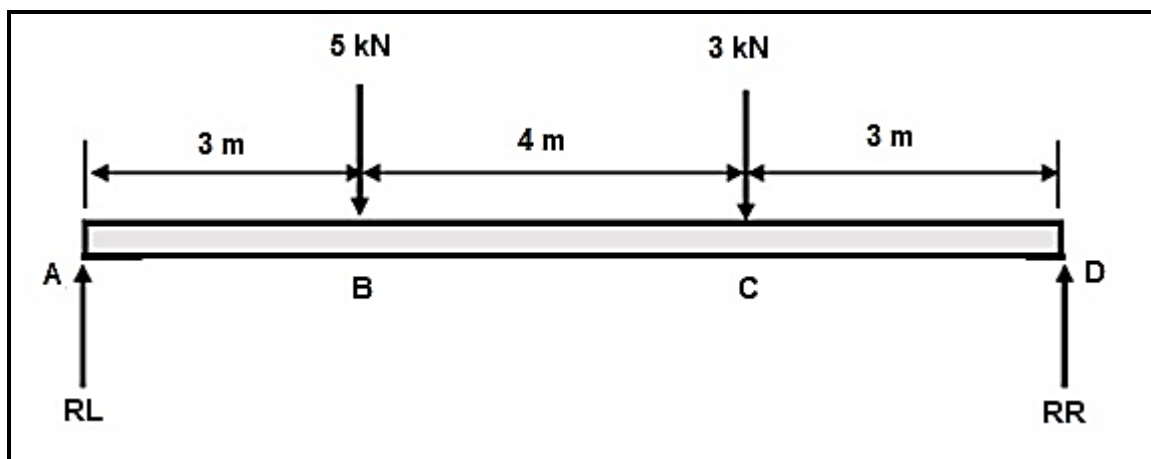
Determine graphically the magnitude and nature of the forces in the following members: **AE, BF, CF, DE** and **EF**.

SCALE: Space diagram: 1 : 100

Force diagram: 1 mm = 5 N

(19)

7.2 FIGURE 7.2 below shows a beam, that is 10 m long and is subjected to two vertical forces. A force of 5 kN is 3 m from point **A** and a force of 3 kN is 7 m from point **A**.

**FIGURE 7.2**

Calculate the following:

7.2.1 Reactions at supports **LR** and **RR** (6)

7.2.2 Bending moments (BM) at each point (**A–D**) on the beam (4)

7.2.3 Draw a bending moments (BM) diagrams.

Scale: Space diagram: 1 : 100

BM diagram: 5 mm = 1 kN.m (4)

7.3 A steel shaft of diameter 38 mm is lengthened by 0,5 mm when a tensile load of 100 kN is applied to it. The original length of the shaft is 150 mm.

Calculate:

7.3.1 The stress (6)

7.3.2 The strain (3)

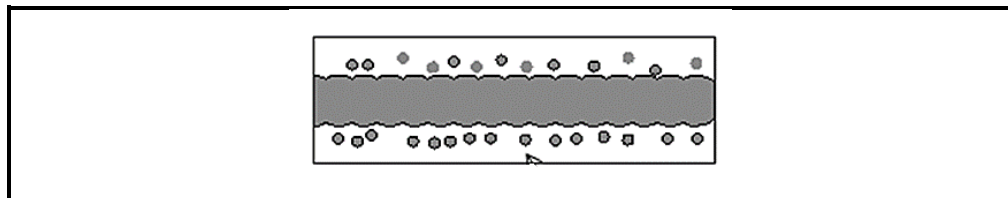
7.3.3 Young's modulus of elasticity (3)

[45]

QUESTION 8: JOINING METHODS (INSPECTION OF WELD) (SPECIFIC)

- 8.1 Name THREE elements that should be inspected by visual inspection of an arc welded joint. (3)
- 8.2 What does the abbreviation HAZ stands for with regards to a welded joint? (1)
- 8.3 Name THREE factors that should be considered during oxy-acetylene welding to ensure a good welded joint. (3)
- 8.4 State any THREE dimensions that can be measured by a weld gauge. (3)
- 8.5 Describe the steps to be followed when performing a nick-break test on a welded joint. (5)
- 8.6 State TWO causes of each of the following arc welding defects:
- 8.6.1 Slag inclusion (2)
- 8.6.2 Incomplete penetration (2)
- 8.7 State TWO disadvantages of using a liquid dye penetration test on a welded joint. (2)
- 8.8 Identify the arc welding defects in the butt joint shown in FIGURES 8.8.1 and 8.8.2 below.

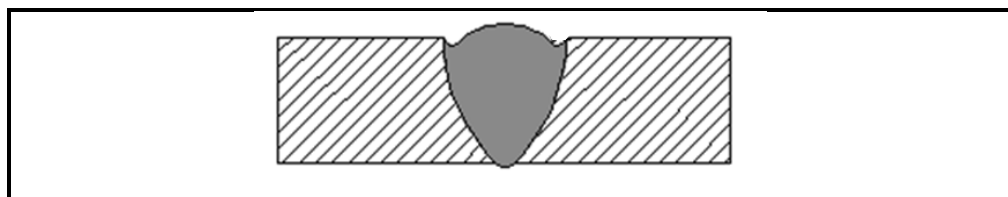
8.8.1



(1)

FIGURE 8.8.1

8.8.2

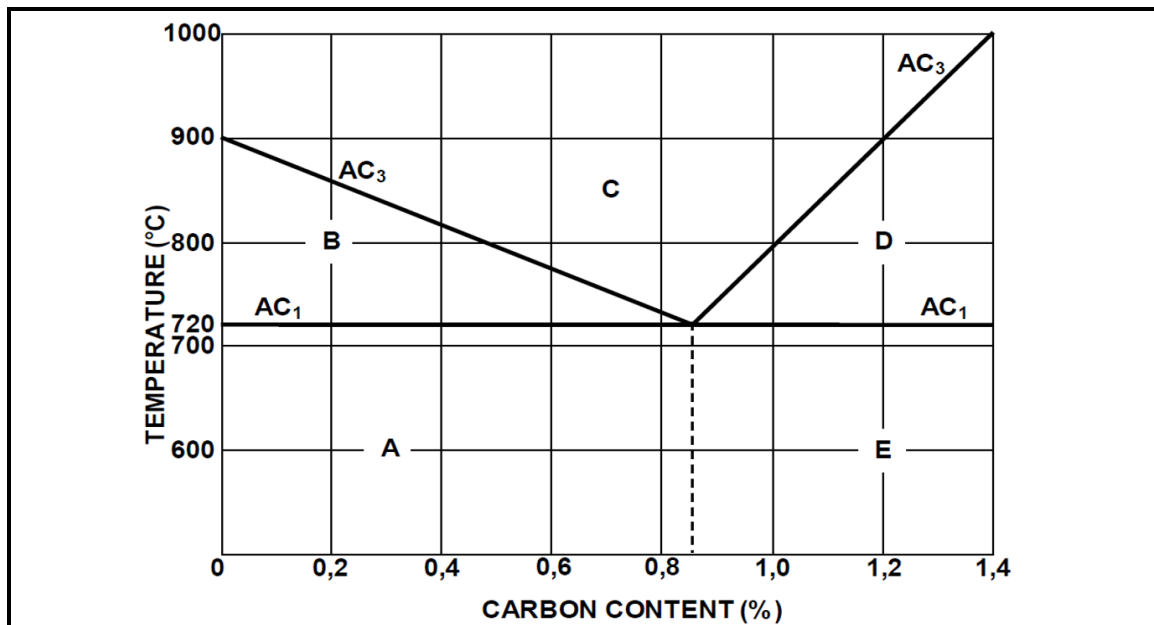


(1)

FIGURE 8.8.2**[23]**

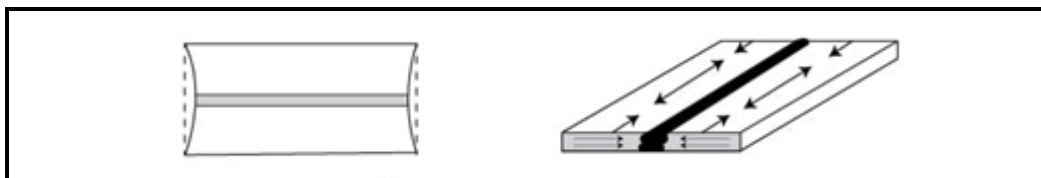
QUESTION 9: JOINING METHODS (STRESSES AND DISTORTION) (SPECIFIC)

- 9.1 Define the term *weld distortion*. (2)
- 9.2 Name any THREE quenching mediums used during the heat treatment of steel. (3)
- 9.3 FIGURE 9.3 below shows the iron-carbon equilibrium diagram.

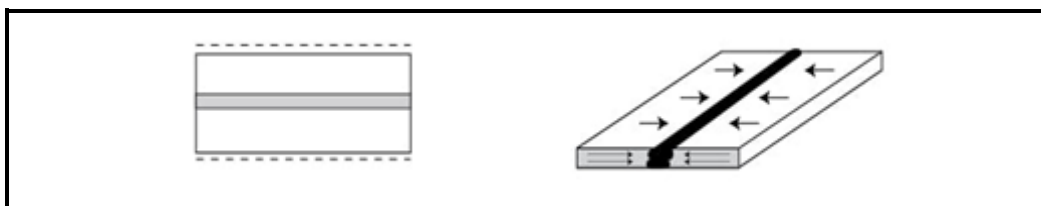
**FIGURE 9.3**

- Label the structures of steel according to the letters **A–F**. (5)
- 9.4 Define the following terms.
- 9.4.1 Elastic deformation (2)
- 9.4.2 Shrinkage (2)
- 9.5 State TWO methods used to reduce distortion. (2)
- 9.6 Identify the following types of shrinkage shown in FIGURES 9.6.1 and 9.6.2 below.

9.6.1

**FIGURE 9.6.1**

9.6.2

**FIGURE 9.6.2**(1)
[18]

QUESTION 10: MAINTENANCE (SPECIFIC)

- 10.1 State ONE effect of overloading on each of the following machines:
- 10.1.1 Punch and shear machine (1)
 - 10.1.2 Rolling machine (1)
- 10.2 Discuss TWO reasons for locking-out large machines before maintenance. (2)
- 10.3 What is the purpose of keeping service records of power machines? (2)
- 10.4 Explain why lubrication is not applicable to bench grinders? (2)
- [8]**

QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

11.1 Use freehand sketches to indicate the following:

11.1.1 Off-centre hopper (2)

11.1.2 On-centre hopper (2)

11.2 FIGURE 11.2 below indicates a conical hopper.

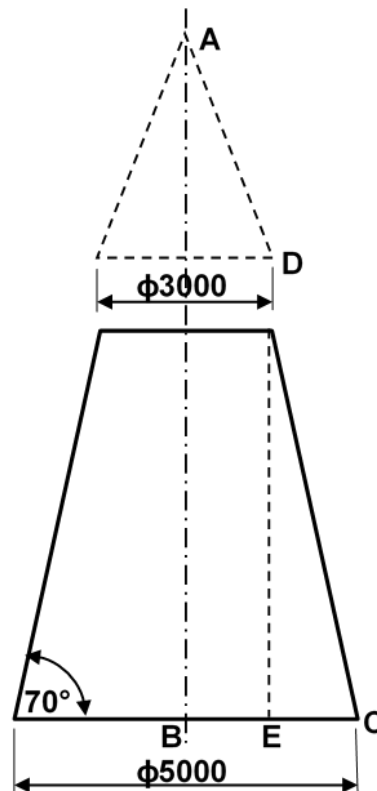


FIGURE 11.2

Calculate the following regarding the hopper:

11.2.1 The vertical height (DE) (2)

11.2.2 The main radius (AC) (3)

11.2.3 The small radius (AD) (4)

11.2.4 The circumference (2)

11.3 FIGURE 11.3 below shows the top view of a hopper with a vertical height (VH) of 450 mm. Answer the questions that follow.

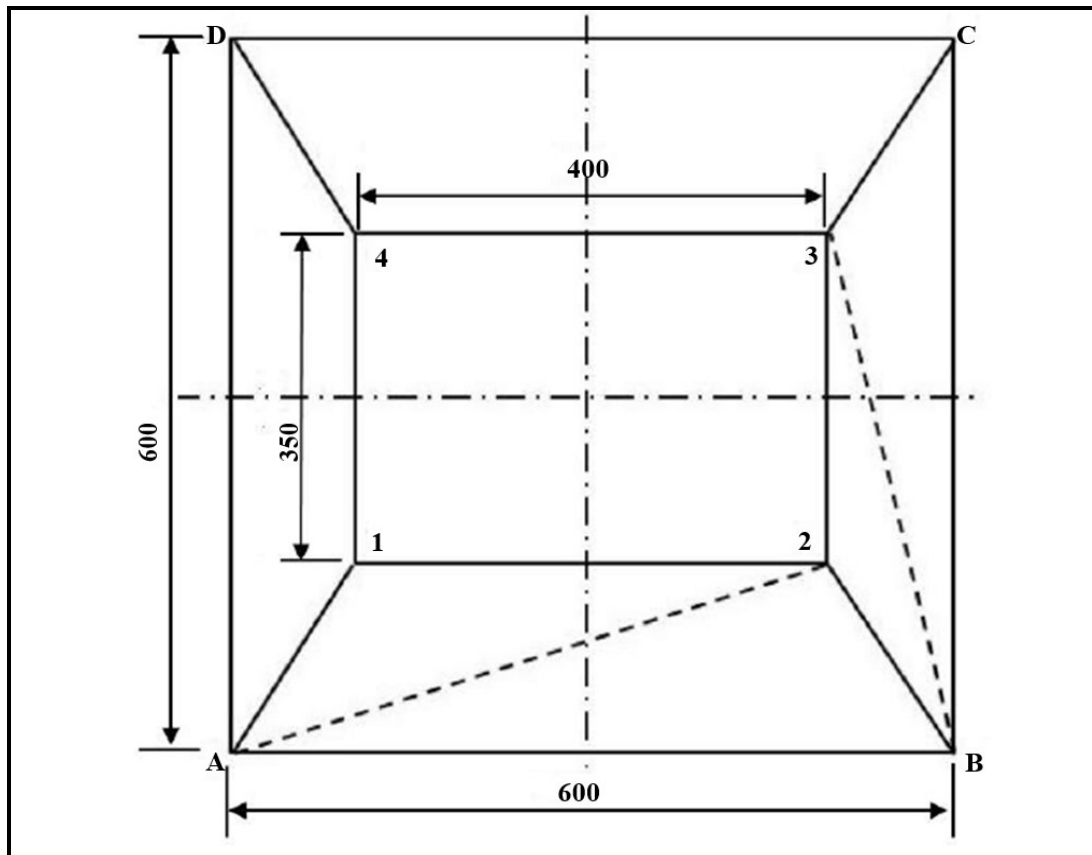


FIGURE 11.3

Calculate the true lengths of the following:

11.3.1 **A-1** (2)

11.3.2 **A-2** (2)

11.3.3 **B-3** (2)

[21]

TOTAL: 200

FORMULA SHEET FOR MECHANICAL TECHNOLOGY (WELDING AND METALWORK)

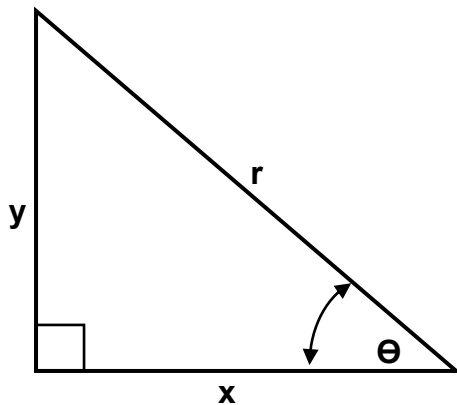
1. STRESS AND STRAIN

$$1.1 \quad \text{Stress} = \frac{\text{Force}}{\text{Area}} \quad \text{OR} \quad \sigma = \frac{F}{A}$$

$$1.2 \quad \text{Young's modulus} = \frac{\text{Stress}}{\text{Strain}} \quad \text{OR} \quad E = \frac{\sigma}{\varepsilon}$$

$$1.3 \quad \text{Strain} = \frac{\text{Change in length}}{\text{Original length}} \quad \text{OR} \quad \varepsilon = \frac{\Delta l}{l}$$

2. PYTHAGORAS' THEOREM AND TRIGONOMETRY



$$2.1 \quad \sin \theta = \frac{y}{r}$$

$$2.2 \quad \cos \theta = \frac{x}{r}$$

$$2.3 \quad \tan \theta = \frac{y}{x}$$

$$2.4 \quad r^2 = x^2 + y^2 \quad \text{OR} \quad a^2 = b^2 + c^2$$

3. TEMPLATES AND DEVELOPMENTS

$$3.1 \quad \begin{aligned} \text{Mean } \phi &= \text{Outside } \phi - \text{Plate thickness} \quad \text{OR} \\ \text{Mean } \phi &= \text{Inside } \phi + \text{Plate thickness} \end{aligned}$$

$$3.2 \quad \text{Mean circumference} = \pi \times \text{Mean } \phi$$