basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

MAY/JUNE 2026

MARKS: 200

TIME: 3 hours

This question paper consists of 20 pages and a 2-page formula sheet.

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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	Terminology (Templates)	23	20
6	Tools and Equipment	18	10
7	Forces	45	40
8	Joining Methods (Weld inspection)	23	20
9	Joining Methods (Stresses and Distortion)	18	20
10	Maintenance	8	10
11	Terminology (Development)	21	20
	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**.

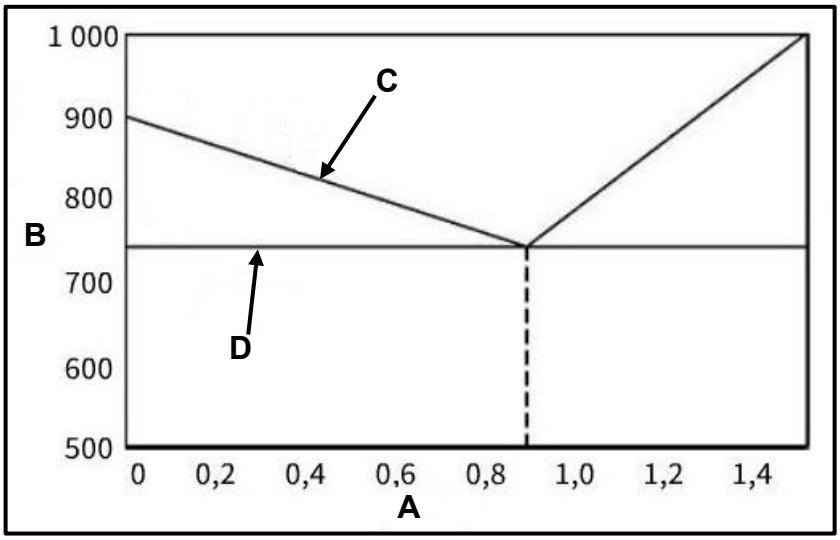


FIGURE 3.2 (4)

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**.

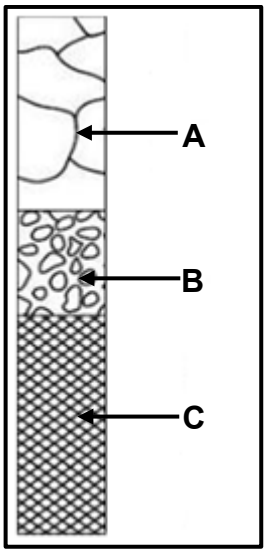


FIGURE 3.5

(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 What do contour symbols indicate?

A How the weld face must be shaped
B The type of filler rod to be used
C The correct current settings to use
D The type of material to use (1)

4.2 What type of weld is indicated by the supplementary symbol **A** shown in FIGURE 4.2 below?

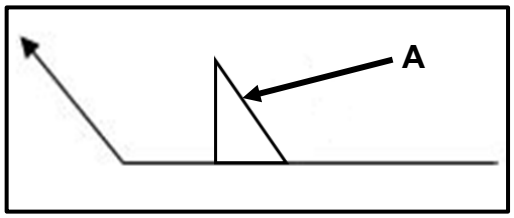


FIGURE 4.2

A Contour weld
B Fillet weld
C Convex weld
D Seam weld (1)

4.3 Which ONE of the following ensures proper lubrication in a power-driven guillotine during its operations?

A Air
B Electricity
C Oil
D Steam (1)

4.4 Identify the girder shown in FIGURE 4.4 below.

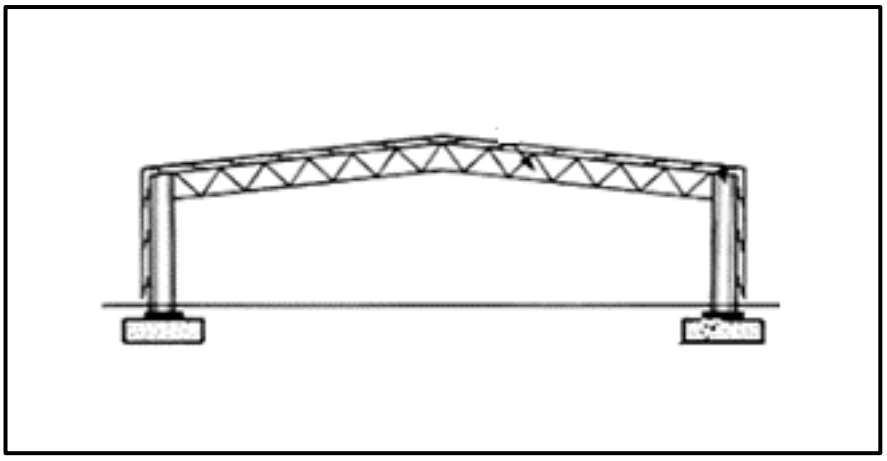


FIGURE 4.4

A Top girder
B Purlin girder
C Lattice girder
D Plate girder (1)

4.5 The purpose of flashback arresters in gas welding is to …

A clamp a work piece together during gas welding.
B protect the flux-coated wire.
C create a molten pool for electrode feed.
D prevent back feeding. (1)

4.6 FIGURE 4.6 below shows a resistance welded joint. Identify **X**.

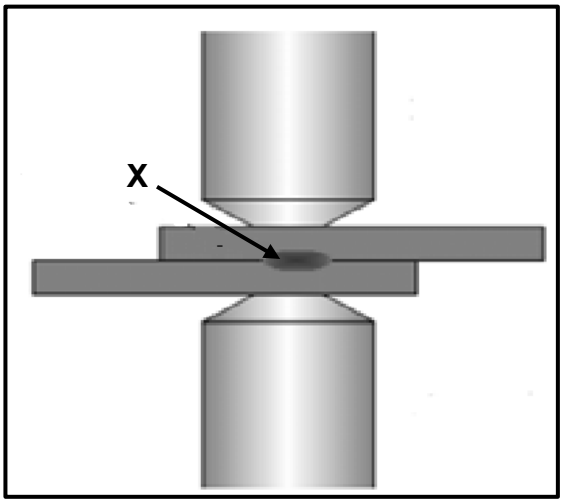


FIGURE 4.6

A Weld all around
B Welding worm
C Weld nugget
D Weld spatter (1)

4.7 Which weld defect has gas entrapped in the weld metal?

A Porosity
B Undercutting
C Incomplete penetration
D Lack of fusion (1)

4.8 Which class of carbon steel would be the hardest?

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

4.9 Which ONE of the following is the CORRECT definition for strain?

A Length at which an object is bent
B Ratio between change in length and the original length
C Length of an object before an external load is applied
D Length of an object after an external load has been applied (1)

4.10 Strongbacks are used when …

A riveting two pieces of sheet metal.
B drilling sheet metal.
C butt welding is used to join plates.
D conducting resistance welding. (1)

4.11 FIGURE 4.11 below shows a test being carried out. Identify the type of test.

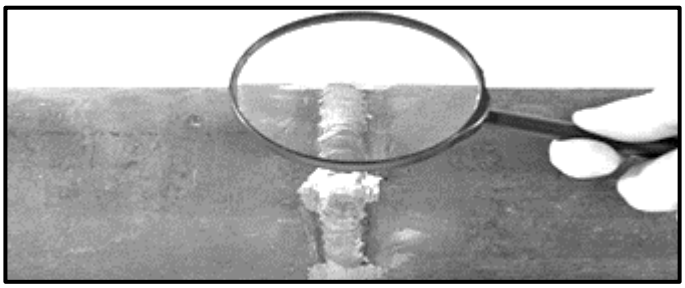


FIGURE 4.11

A Nick-break test
B Guided bend test
C Visual inspection test
D Ultrasonic test (1)

4.12 Which grain structure of steel is characterised as soft and ductile?

A Ferrite
B Pearlite
C Cementite
D Austenite (1)

4.13 Identify the type of load applied to the work piece shown in FIGURE 4.13 below.

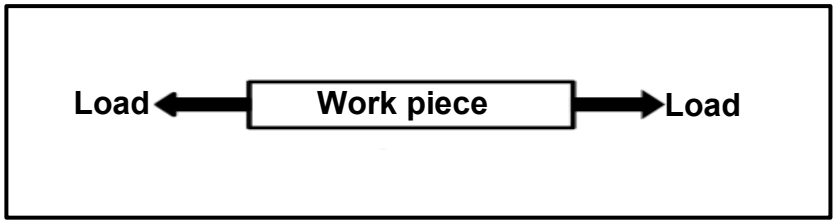


FIGURE 4.13

A Tensile
B Strain
C Compression
D Shearing (1)

4.14 What type of hopper is shown in FIGURE 4.14 below?

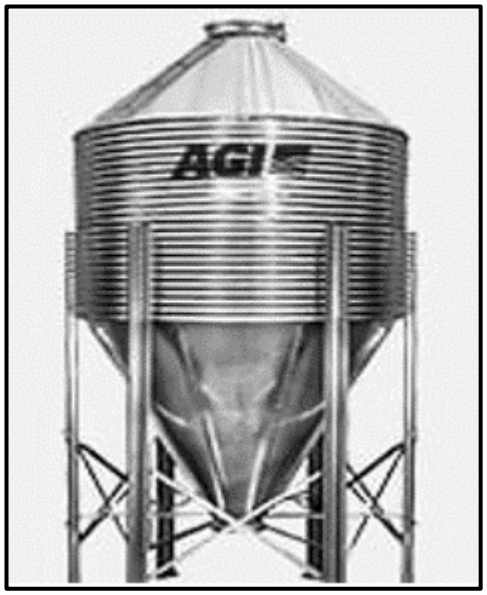


FIGURE 4.14

A Square-to-square hopper
B Square-to-round hopper
C Transformer
D Gravity-flow hopper (1)
[14]

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 The basketball hoop shown in FIGURE 5.1 below must be manufactured using a 16 mm diameter round bar. The ring has an inside diameter of 550 mm.

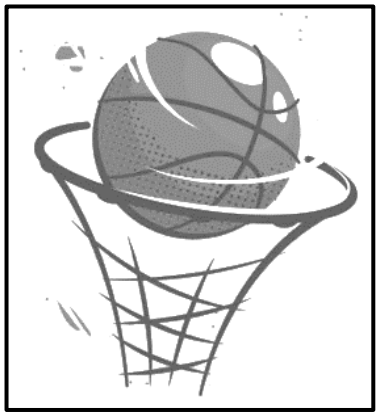


FIGURE 5.1

Calculate the following:

5.1.1 The mean diameter of the ring (2)

5.1.2 The mean circumference of the ring

NOTE: Round off your answer to the nearest whole number. (3)

5.2 Draw the fusion weld symbols for the following:

5.2.1 J-butt weld (2)

5.2.2 Double-U butt weld (2)

5.3 FIGURE 5.3 below shows a welded joint with a welding symbol.

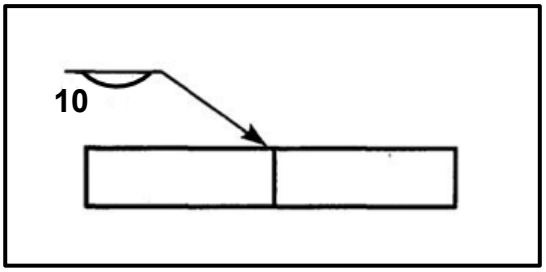


FIGURE 5.3

Identify the following:

5.3.1 Type of joint (1)

5.3.2 Type of weld (1)

5.3.3 Size of weld (1)

5.4 Name THREE hand cutting tools used by a template maker. (3)

5.5 Describe the function of web stiffeners. (2)

5.6 Describe ONE function of each of the following components in a roof truss:

5.6.1 Purlin (2)

5.6.2 Gusset plates (2)

5.7 Name TWO types of templates used on channel iron, angle irons and I-beams. (2)
[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 Identify tools **A** and **B**, as shown in FIGURE 6.1 below.

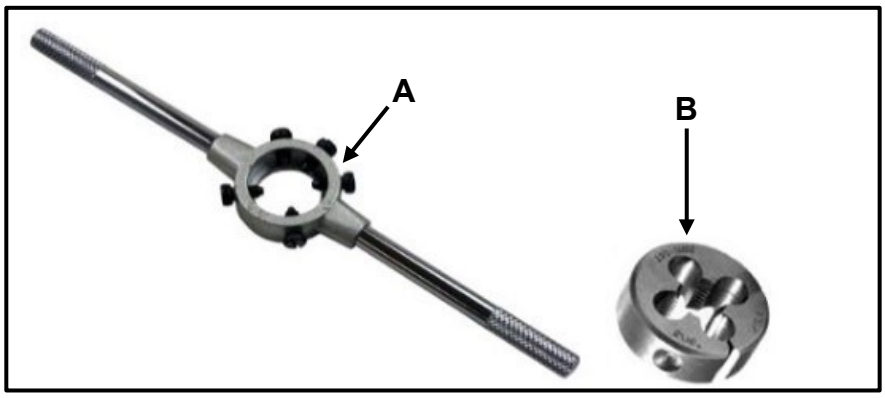


FIGURE 6.1 (2)

6.2 State ONE use of EACH of the following machines:

6.2.1 Power-driven guillotine (1)

6.2.2 Hydraulic press machine (1)

6.2.3 Resistance-welding machine (1)

6.2.4 Plasma cutter (1)

6.3 FIGURE 6.3 below shows a gas welding set-up. Answer the questions that follow.

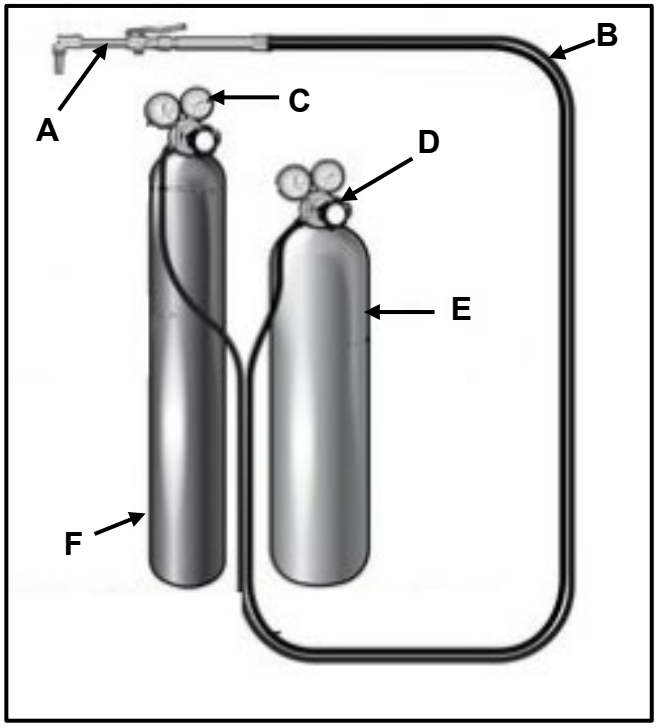


FIGURE 6.3

6.3.1 Label **A**–**F**. (6)

6.3.2 State the function of part **D**. (1)

6.4 State THREE uses of an angle grinder. (3)

6.5 Name TWO metals that can be welded with an inverter welding machine. (2)
[18]

QUESTION 7: FORCES (SPECIFIC)

7.1 A steel bar with a diameter of 12 mm stretches by 0,8 mm under a tensile load of 66 kN. The original length of the bar is 20 m.

Calculate the following:

7.1.1 The stress in the bar in MPa (4)

7.1.2 The strain (3)

7.2 FIGURE 7.2 below shows a uniform beam that is supported by two vertical supports, **RL** and **RR**. The beam is subjected to TWO point loads and a uniformly distributed load (UDL).

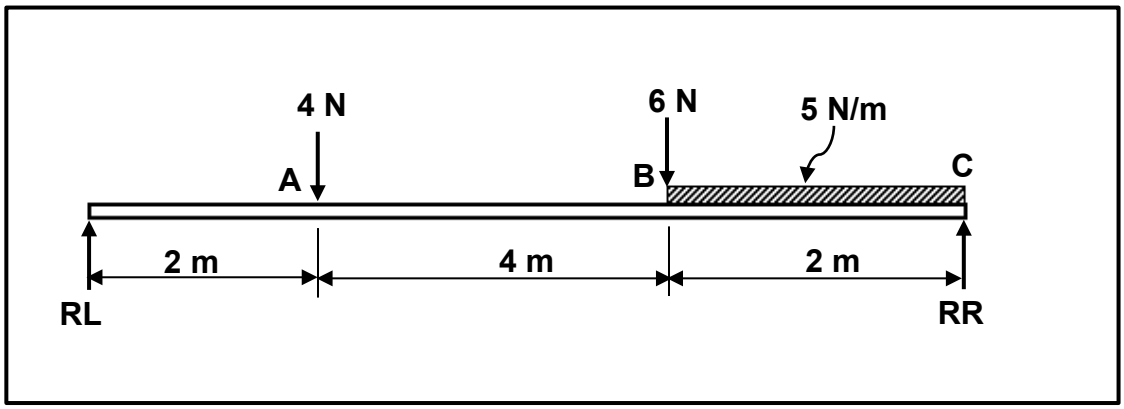


FIGURE 7.2

Calculate the following:

7.2.1 The magnitude of the point load representing the UDL (2)

7.2.2 The reactions at **RL** and **RR** (8)

7.2.3 The shear forces at **A**, **B** and **C** on the beam (6)

7.2.4 Draw the shear force diagram.

Scale: Length of beam: 1 m = 10 mm
Shear force diagram: 1 N = 5 mm (8)

7.3 A framework is shown in FIGURE 7.3 below. Answer the questions that follow.

Scale: Space diagram: 1 : 100
Vector diagram: 1 kN = 1 mm

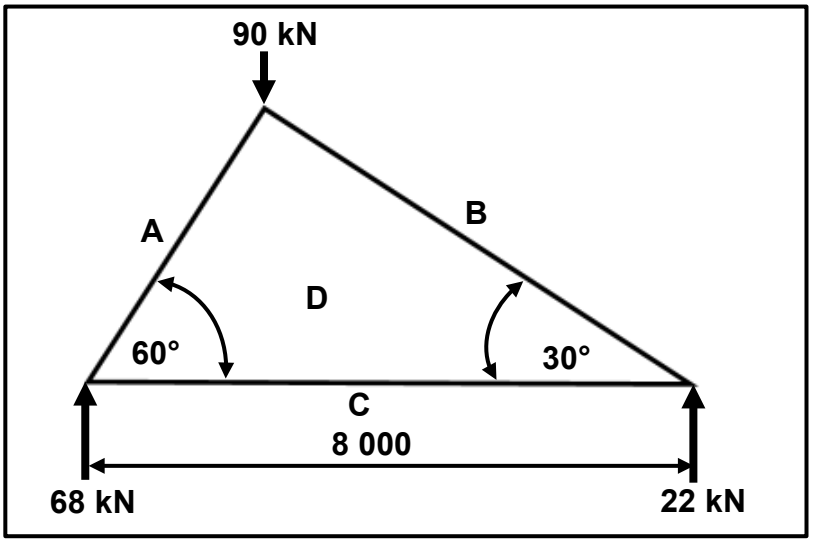


FIGURE 7.3

7.3.1 Draw the space diagram according to the given scale and use arrows to indicate the struts and ties. (3)

7.3.2 Draw the vector diagram according to the given scale. (5)

7.3.3 Determine graphically the magnitude and nature of the following members: **AD**, **BD** and **CD**. (6)
[45]

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

8.1 State TWO measures to prevent EACH of the following welding defects:

8.1.1 Incomplete penetration (2)

8.1.2 Spatter (2)

8.2 State THREE uses of weld gauges. (3)

8.3 Explain the steps that should be followed when conducting a nick-break test on a welded joint. (5)

8.4 State THREE examples of surface weld defects. (3)

8.5 Name THREE destructive tests, excluding the nick-break test, that can be conducted on a welded joint. (3)

8.6 Name THREE internal defects that can be detected when performing an X-ray test on welded joints. (3)

8.7 Name TWO types of dyes used in a liquid dye penetration test. (2)
[23]

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

9.1 Give THREE reasons for relieving stress caused by heat-treatment processes. (3)

9.2 State TWO factors that affect the rate of cooling of the molten pool in a welded joint. (2)

9.3 State THREE mechanical properties which are affected by temperature change during heat treatment. (3)

9.4 State THREE factors that influence the grain size of cold-worked steel. (3)

9.5 What is the primary cause of shrinkage in welded joints? (1)

9.6 How does the diameter of the electrode affect the current setting required in arc welding? (2)

9.7 State FOUR welding methods to reduce distortion. (4)
[18]

QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 State ONE routine maintenance guideline for EACH of the following:

10.1.1 Electrical switches on the punch and shear machine (1)

10.1.2 Tool rest on the bench grinder (1)

10.1.3 Coolant on the horizontal band saw (1)

10.2 What are the TWO common causes of the failure of rollers in a rolling machine? (2)

10.3 Give TWO reasons for keeping service records of machines. (2)

10.4 Who is responsible for conducting mechanical or electrical maintenance on machines in the workshop? (1)
[8]

QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

11.1 FIGURE 11.1 below shows a cone with a base diameter of 800 mm, a top diameter of 400 mm and a vertical height of 1 000 mm. Answer the questions that follow.

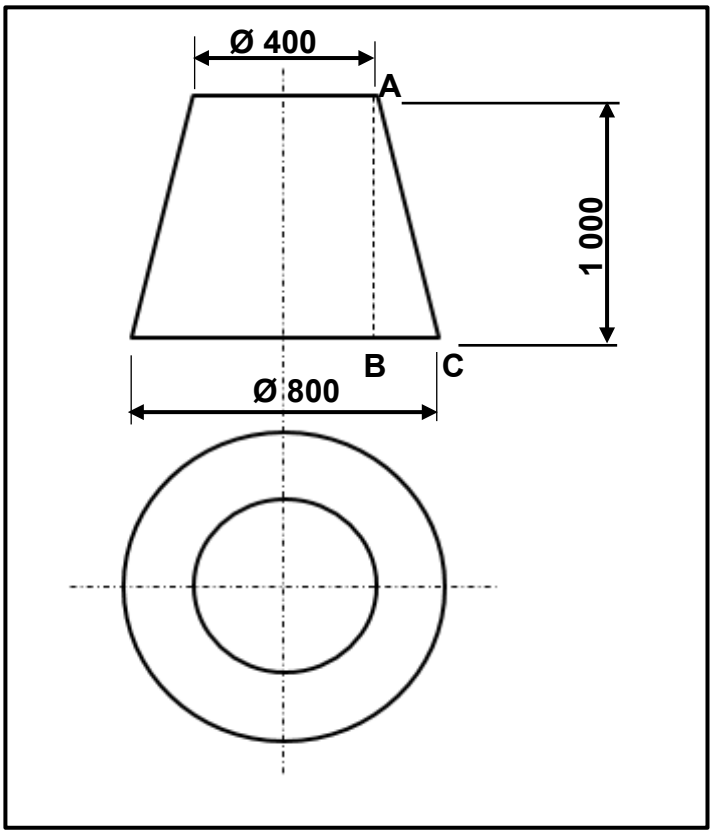


FIGURE 11.1

11.1.1 Identify the type of cone above. (2)

Calculate the following:

11.1.2 The length of **B**–**C** (3)

11.1.3 The true length of **A**–**C** (4)

11.2 FIGURE 11.2 below shows a square-to-square off-centre hopper.

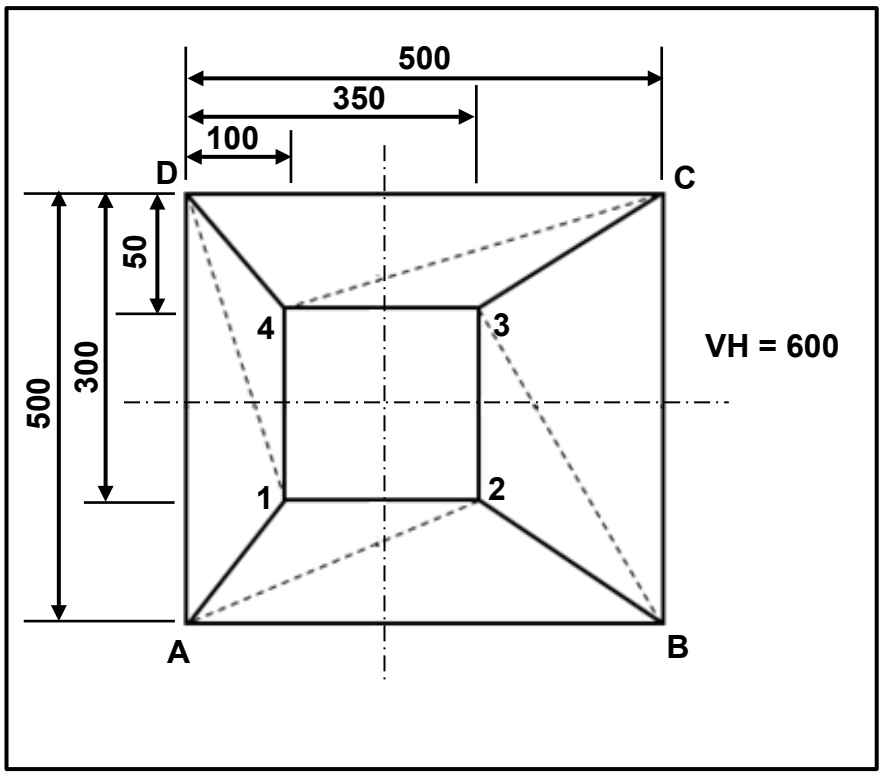


FIGURE 11.2

Calculate the following true lengths:

11.2.1 **A–2** (4)

11.2.2 **B–3** (4)

11.2.3 **C–3** (4)
[21]

TOTAL: 200

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FORMULA SHEET FOR MECHANICAL TECHNOLOGY: WELDING AND METALWORK

1. STRESS AND STRAIN

1.1 $A_{shaft} = \frac{\pi d^2}{4}$

1.2 $A_{pipe} = \frac{\pi\left(D^2 - d^2\right)}{4}$

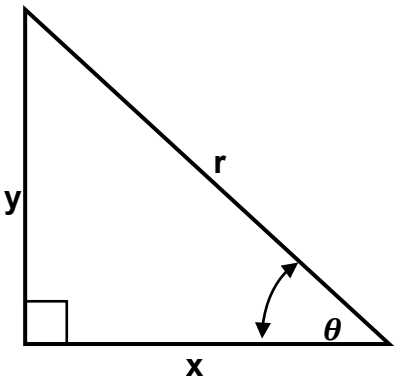
1.3 $Safety\ factor = \frac{Maximum\ stress\ /\ Break\ stress}{Safe\ working\ stress}$

1.4 $Stress = \frac{Force}{Area}$ ***OR*** $\sigma = \frac{F}{A}$

1.5 $Strain = \frac{Change\ in\ length}{Original\ length}$ ***OR*** $\varepsilon = \frac{\Delta L}{oL}$

1.6 $Young's\ modulus = \frac{Stress}{Strain}$ ***OR*** $E = \frac{\sigma}{\varepsilon}$

2. PYTHAGORAS' THEOREM AND TRIGONOMETRY



2.1 $Sin\ \theta = \frac{y}{r}$

2.2 $Cos\ \theta = \frac{x}{r}$

2.3 $Tan\ \theta = \frac{y}{x}$

2.4 $r^2 = x^2 + y^2$ ***OR*** $a^2 = b^2 + c^2$

3. TEMPLATES AND DEVELOPMENTS

3.1 *Mean Ø = Outside Ø – Plate thickness* ***OR*** *Mean Ø = Inside Ø + Plate thickness*

3.2 *Mean circumference = π x Mean Ø*

Where:

Ø = Diameter

4. SCREW THREADS

4.1 *Drill size = Outside Ø – Pitch*

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