basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

MAY/JUNE 2025

MARKS: 200

TIME: 3 hours

This question paper consists of 16 pages and a 2-page formula sheet.

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 answers to TWO decimal places.
7. Candidates may use non-programmable scientific calculators and drawing instruments.
8. The value of gravitational acceleration could 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 (Inspection of Welds)	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 ONE of the following is a safety device on the power-driven guillotine?

A Rear light curtain
B Chuck
C Cutting table
D Blade (1)

1.2 Which statement forms part of the general responsibilities of the employee according to the Occupational Health and Safety (OHS) Act, 1993 (Act 85 of 1993)?

A Eliminate hazards in the workplace.
B Make provision for maintenance at the workplace.
C Report any accidents immediately.
D Inform all employees of their scope of work. (1)

1.3 Which recommendation below is important when applying first aid?

A Cover the wound with an adhesive plaster.
B If necessary, cool the wound with cold water.
C Pull out all sharp objects.
D Do not check for any broken limbs. (1)

1.4 Which test determines the ductility of a metal?

A Sound test
B Hardness test
C X-ray test
D Bending test (1)

1.5 The spark test is useful for testing the … content of many metals.

A magnesium
B carbon
C aluminium
D chrome (1)

1.6 The hardening temperatures used as a rule during the hardening process is … above the critical temperature.

A 10 °C–38 °C
B 10 °C–720 °C
C 10 °C–268 °C
D 10 °C–100 °C (1)

[6]

QUESTION 2: SAFETY (GENERIC)

2.1 State THREE safety precautions to adhere to when using a manual guillotine.

(**NOTE:** ALL PPE and environmental factors have been taken care of.) (3)

2.2 State THREE examination procedures when performing first aid. (3)

2.3 Why must one always leave the acetylene cylinder spindle key on the cylinder valve when working? (1)

2.4 State whether EACH of the following is a result of product layout or process layout:

2.4.1 Machines are grouped according to their type of operation (1)

2.4.2 Greater flexibility during manufacturing (1)

2.4.3 Handling of material is limited to a minimum (1)
[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 State the THREE factors that affect the hardness of steel during the heat-treatment process. (3)

3.2 State if EACH of the following materials is easy or difficult to cut during a machining test:

3.2.1 Cast iron (1)

3.2.2 Cast steel (1)

3.2.3 Mild steel (1)

3.3 Give ONE reason why steel is annealed during the heat-treatment process. (1)

3.4 Complete the following definition for normalising by filling in the missing words. Write only the words next to the question numbers (3.4.1 to 3.4.4) in the ANSWER BOOK.

The process of normalising is when an iron base alloy or steel is heated to approximately 56 °C (3.4.1) ... the critical temperature, (3.4.2) … the metal until it is uniformly heated, followed by (3.4.3) … it down to (3.4.4) … temperature in still air, away from draughts. (4)

3.5 Why must steel be cooled rapidly during the hardening process? (1)

3.6 State TWO manufacturing processes that cause internal stress in steel. (2)
[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 does the '**80**' on the weld symbol in FIGURE 4.1 below represent?

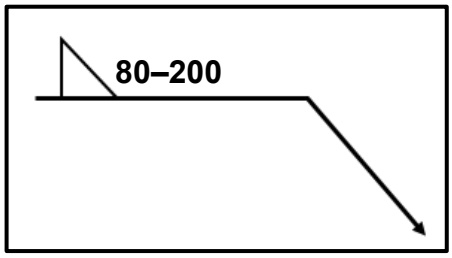


FIGURE 4.1

A Length of weld
B Size of weld
C Pitch of weld
D Root of weld (1)

4.2 Identify the template shown in FIGURE 4.2 below.

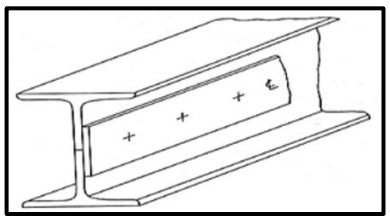


FIGURE 4.2

A Flange template
B Strip template
C Gusset plate
D Web template (1)

4.3 Identify the supplementary weld symbol shown in FIGURE 4.3 below.

FIGURE 4.3

A Chisel
B Flush
C Convex
D Concave (1)

4.4 What is the purpose of permanent markings on the floor in a template loft?

A Keeps the floor clean
B Saves time when marking out
C Prevents accidents
D Helps when drilling holes (1)

4.5 Which ONE of the following tools is used to remove the drill chuck from a radial arm drilling machine?

A Drift
B Allen key
C Ring spanner
D Chuck key (1)

4.6 Which ONE of the following is used to cut external threads?

A Taper tap
B Chisel
C Stock
D Die (1)

4.7 Which ONE of the following components is part of an angle grinder?

A Safety guard
B Electrode holder
C Tool rest
D Wheel dresser (1)

4.8 Which ONE of the following equipment is used to reduce the cylinder pressure to operating pressure when conducting gas welding?

A Regulator
B Pressure gauge
C Flashback arrester
D Pressure valve (1)

4.9 The screw thread of the regulator for an acetylene cylinder is … threaded.

A right-hand
B square
C left-hand
D vertical (1)

4.10 Stress can be defined as an internal force in a material resisting a/an … load.

A moving
B spinning
C external
D internal (1)

4.11 What is the reason for lock-out and tagging?

A Lock-out to save time
B Lock-out of a machine when conducting maintenance
C Lock-out of a machine for lunch time
D Lock-out of a tool on a machine (1)

4.12 Which ONE of the following factors affects the grain size of steel when being cold worked?

A Continuous welding
B The cooling rate of the steel
C The temperature and time of the annealing process
D The melting point of steel (1)

4.13 Which ONE of the following tests is a non-destructive test on a welding joint?

A Nick-break test
B Guided bend test
C X-ray test
D Machinability test (1)

4.14 Identity the type of hopper shown in FIGURE 4.14 below.

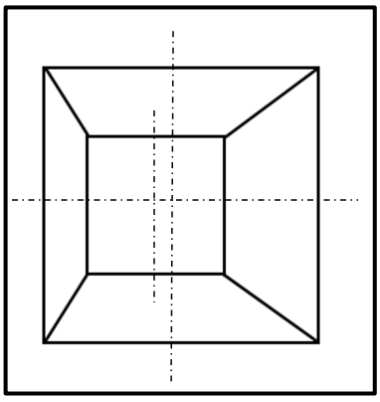


FIGURE 4.14

A Square-to-rectangle on-centre
B Square-to-square off-centre
C Square-to-rectangle off-centre
D Square-to-square on-centre (1)

[14]

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 An aluminium ring must be manufactured using a 20 x 20 mm square bar. The ring has an outside diameter of 720 mm.

5.1.1 Calculate the mean diameter of the ring. (2)

5.1.2 Calculate the mean circumference of the ring.
(Round off your answer to the nearest whole number.) (3)

5.1.3 Make a neat drawing indicating the outside diameter, thickness of the bar and the mean diameter. (4)

5.2 State THREE types of resistance weld methods. (3)

5.3 FIGURE 5.3 below shows a welding symbol. Identify the information required in QUESTIONS 5.3.1 to 5.3.6 and write the answers in the ANSWER BOOK.

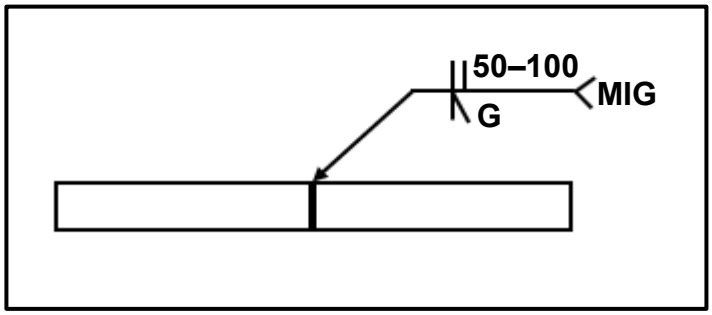


FIGURE 5.3

5.3.1 Type of welding process (1)

5.3.2 Type of weld on the arrow side (1)

5.3.3 Type of weld on the other side (1)

5.3.4 Length of weld (1)

5.3.5 Pitch of weld (1)

5.3.6 Finish required (1)

5.4 Name FOUR cutting machines used in a template loft. (4)

5.5 Identify part **A** shown in FIGURE 5.5 below.

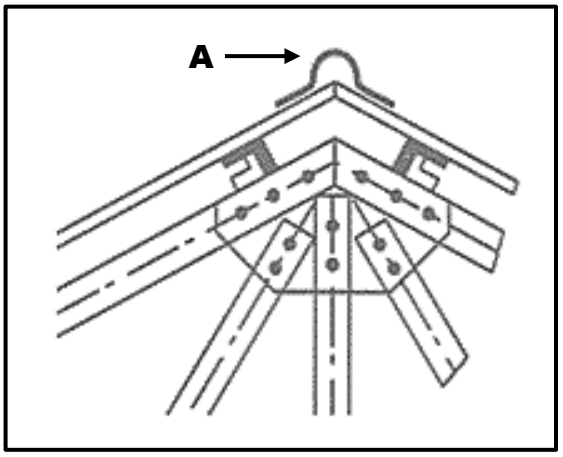


FIGURE 5.5 (1)

[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 FIGURE 6.1 below shows a drill press. Label **A**–**F**.

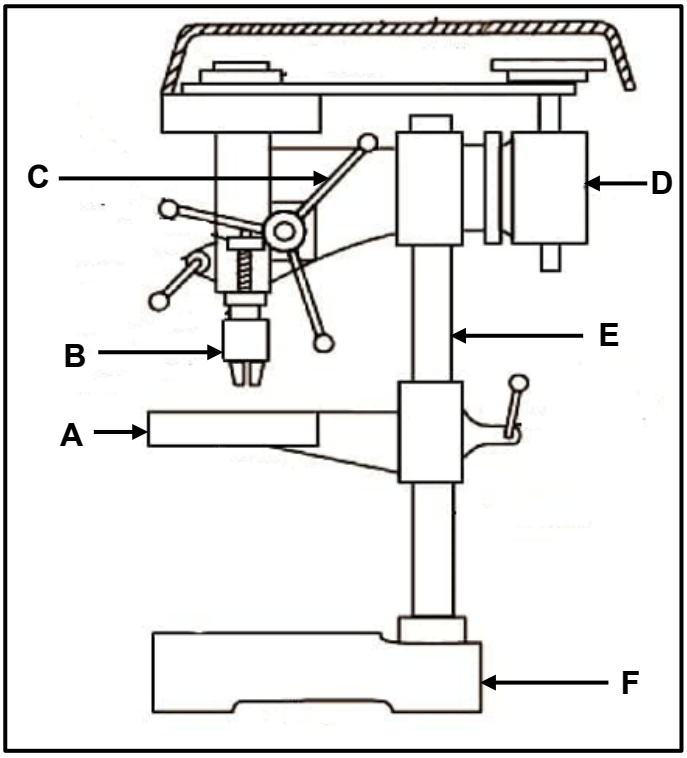


FIGURE 6.1 (6)

6.2 Describe the operating principle of a spot-welding machine. (5)

6.3 State THREE uses of a bench grinder fitted with a grinding wheel. (3)

6.4 FIGURE 6.4 below shows MIG welding in progress. Label **A**–**D**.

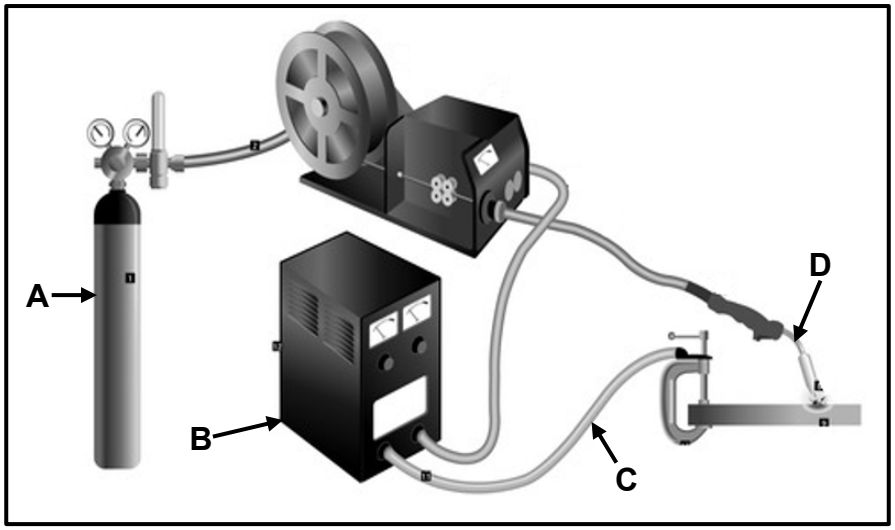


FIGURE 6.4 (4)

[18]

QUESTION 7: FORCES (SPECIFIC)

7.1 A steel framework is shown in FIGURE 7.1 below. Answer the questions that follow.

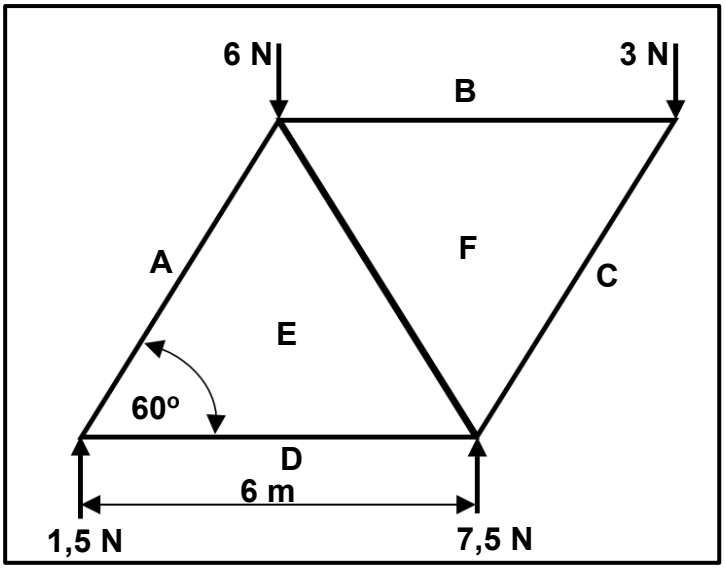


FIGURE 7.1

7.1.1 Draw the space diagram to scale 10 mm = 1 m. (4)

7.1.2 Draw the vector diagram to scale 10 mm = 1 N. (9)

7.1.3 Determine the magnitude of forces in members **AE**, **EF** and **BF**. Identify the members as struts or ties. (6)

7.2 FIGURE 7.2 below shows a simply supported beam subjected to THREE point loads.

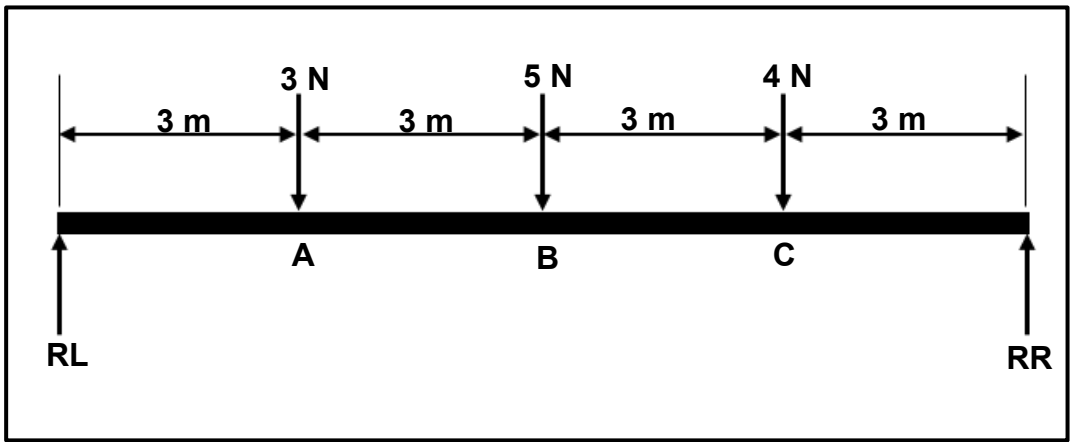


FIGURE 7.2

7.2.1 Calculate the reactions **RL** and **RR**. (8)

7.2.2 Calculate the shear forces at **A**, **B** and **C** on the beam. (6)

7.2.3 Draw the shear force diagram.

Scale: Beam: 1 m = 10 mm

Shear force diagram: 1 N = 10 mm (6)

7.3 A round brass bar of 40 mm diameter is lengthened by 0,6 mm when a tensile load of 120 kN is applied to it. The original length of the bar is 120 mm.

Calculate the following:

7.3.1 The cross-sectional area of the bar in m^2 (2)

7.3.2 The stress in the bar in MPa (2)

7.3.3 The strain (2)
[45]

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

8.1 State TWO uses of weld gauges. (2)

8.2 State TWO causes of EACH of the following arc-welding defects:

8.2.1 Lack of fusion (2)

8.2.2 Incomplete penetration (2)

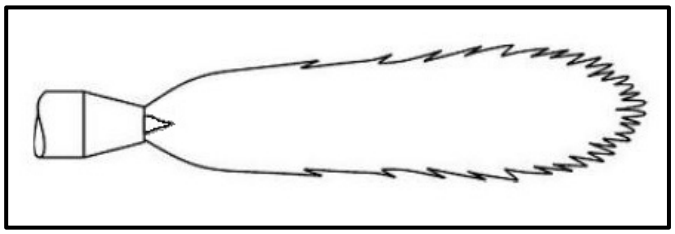
8.3 State TWO methods used to reduce EACH of the following cracks caused by the arc welding process:

8.3.1 Transverse cracks (2)

8.3.2 Centre-line cracks (2)

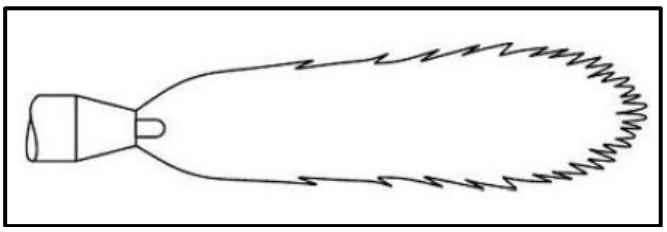
8.4 Identify the types of flames shown in QUESTIONS 8.4.1 to 8.4.3 below.

8.4.1



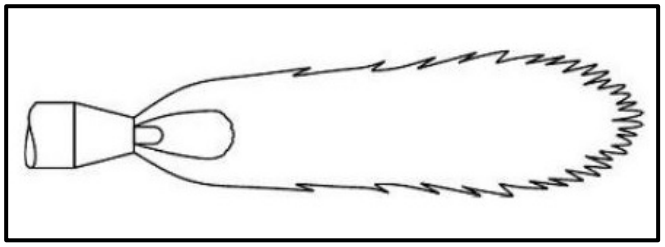
(1)

8.4.2



(1)

8.4.3



(1)

8.5 Describe the term *weld spatter* as caused during arc welding. (2)

8.6 Explain how the nick-break test is conducted on a welded joint. (4)

8.7 Give TWO reasons for inspecting welds. (2)

8.8 State TWO disadvantages of conducting the liquid dye penetration test on a welded joint. (2)

[23]

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

9.1 State TWO factors that cause residual stress in welds. (2)

9.2 State TWO factors that influence the cooling rate of a welded joint. (2)

9.3 Define the following welding terms:

9.3.1 Distortion (2)

9.3.2 Shrinkage (2)

9.4 Use a neatly labelled sketch to explain *back-step welding.* (4)

9.5 Name the THREE main carbon steel groups with their percentage of carbon content. (6)
[18]

QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 How can the life span of equipment be extended? (2)

10.2 What would be the negative effect of friction on the following equipment?

10.2.1 Power-driven guillotine (1)

10.2.2 Horizontal band saw (1)

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

10.4 Name TWO factors to be considered when selecting the cutting speed for drilling. (2)
[8]

QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

11.1 A truncated cone is shown in FIGURE 11.1 below. The vertical height of the truncated cone is 500 mm. The base diameter is 400 mm and the top diameter is 300 mm.

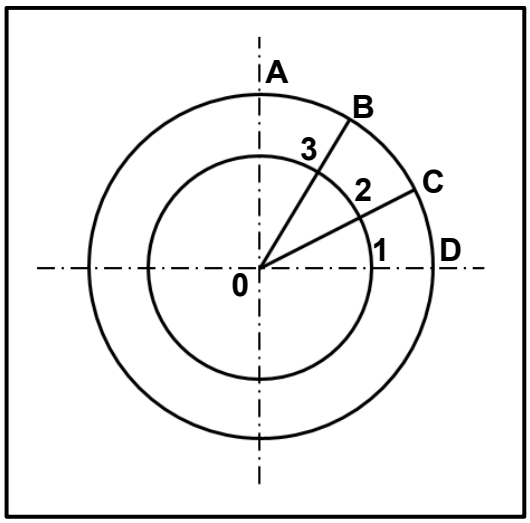


FIGURE 11.1

Calculate the following:

11.1.1 Base circumference of the cone (2)

11.1.2 True length of **A**–**D** (3)

11.1.3 Top circumference of the cone (2)

11.1.4 True length of **1**–**2** (3)

11.2 FIGURE 11.2 below shows a square-to-square on-centre hopper. The vertical height (VH) of the hopper is 600 mm.

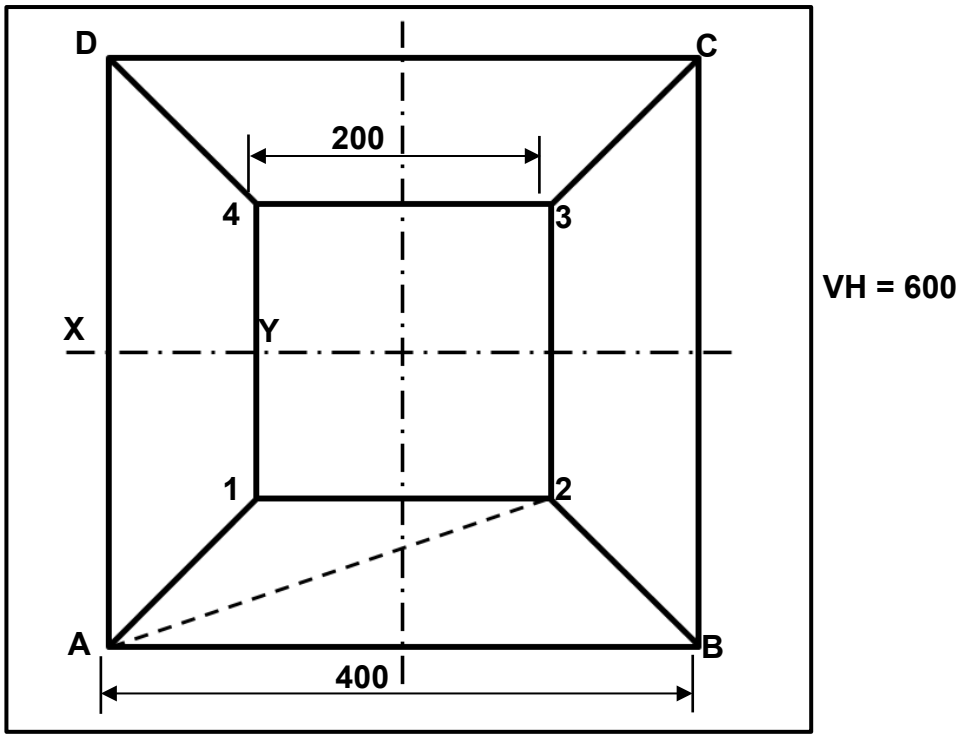


FIGURE 11.2

Calculate the following true lengths:

11.2.1 **A–1** (4)

11.2.2 **A–2** (4)

11.2.3 **X–Y** (3)
[21]

TOTAL: 200

FORMULA SHEET FOR MECHANICAL TECHNOLOGY: WELDING AND METALWORK

1. STRESS AND STRAIN

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

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

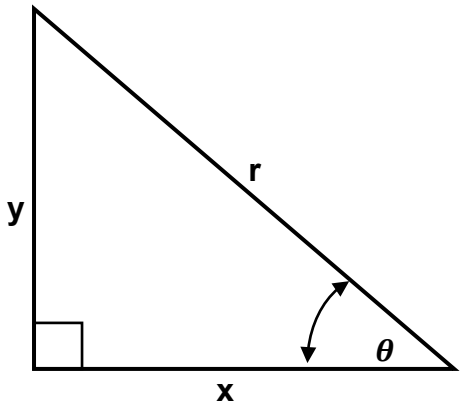
1.3 $Safety\ factor = \frac{Maximum\ stress/Break\ stress}{Safe\ working\ stress}$

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. PYTHAGORA'S 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*