basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

EXEMPLAR 2018

MARKS: 200

TIME: 3 hours

This question paper consists of 12 pages and a 1-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. Write your examination number 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 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 to the question paper
12. Use the criteria below to assist you with your time management.

QUESTION	CONTENT	MARKS	TIME
	Generic		
1	Multiple-choice questions	6	6 minutes
2	Safety	10	10 minutes
3	Materials	14	14 minutes
	Specific		
4	Multiple-choice questions	14	10 minutes
5	Terminology (Templates)	23	20 minutes
6	Tools and Equipment	18	10 minutes
7	Forces	45	40 minutes
8	Joining Methods (Inspection of Weld)	23	20 minutes
9	Joining Methods (Stresses and Distortion)	18	20 minutes
10	Maintenance	8	10 minutes
11	Terminology (Development)	21	20 minutes
	TOTAL	**200**	**180 minutes**

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 to D) next to the question number (1.1 to 1.6) in the ANSWER BOOK, e.g. 1.7 A.

1.1 What is the purpose of the Occupational Health and Safety Act, 1993 (Act 85 of 1993) regarding HIV/Aids awareness?

A The safety laws state that all employers must make sure that the workplace is safe, and that employees are not at risk of becoming infected with HIV at work.
B It contains common guidelines on how employers, employees and trade unions should respond to HIV in the workplace.
C Employers may not demote or promote an employee based on his/her HIV status.
D Employers cannot simply dismiss a person who is infected with HIV. (1)

1.2 Which ONE of the following types of personal protective equipment is applicable when executing oxy-acetylene welding?

A Welding helmet
B Welding goggles
C Hard hat
D Welding mask (1)

1.3 What is the maximum gap allowed between the tool rest and the grinding wheel of a bench grinder?

A 4 mm
B 3 mm
C 5 mm
D 4,5 mm (1)

1.4 Which heat treatment process is used to decrease the brittleness in hardened steel?

A Annealing
B Tempering
C Hardening
D Normalising (1)

1.5 What is the purpose of annealing steel?

A To harden it
B To temper it
C To soften it
D To cool it down (1)

1.6 Which test is used to determine the ductility of a metal?

A Sound test
B Hardness test
C Bending test
D Machining test (1)

[6]

QUESTION 2: SAFETY (GENERIC)

2.1 What safety rule must be adhered to after the work procedures on any machine have been completed? (1)

2.2 Which safety precaution should be adhered to when drilling a small work piece on a drill press? (1)

2.3 State TWO safety rules to be observed when using the hydraulic press. (2)

2.4 Give TWO reasons for wearing surgical gloves when treating a co-worker with open wounds. (2)

2.5 State TWO safety precautions for the handling of gas cylinders. (2)

2.6 Name ONE responsibility of an EMPLOYER regarding safety in the workplace. (1)

2.7 Name ONE responsibility of an EMPLOYEE regarding safety in the workplace. (1)
[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 Explain how you will conduct the following tests to identify various metals:

3.1.1 Filing test (2)

3.1.2 Machining test (2)

3.2 When executing a sound test on steel, what sound is made by the following materials?

3.2.1 High carbon steel (HCS) (2)

3.2.2 Low carbon steel (LCS) (2)

3.3 What is the reason for executing the following heat treatment processes on steel?

3.3.1 Case hardening (2)

3.3.2 Hardening (2)

3.3.3 Normalising (2)
[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

Various options are provided as possible answers to the following questions. Choose the correct answer and write only the letter (A to D) next to the question number (4.1 to 4.14) in the ANSWER BOOK, e.g. 4.15 A.

4.1 What does the abbreviation *TSU* stand for?

A Template Side Up
B Truss Side Up
C This Side Up
D Top Side Under (1)

4.2 Which ONE of the following is an example of a template maker's hand tool?

A Planer
B Chisel
C Circular saw
D Sanding machine (1)

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

A Safety guard
B Stand
C Tool rest
D Grinding wheel dresser (1)

4.4 What is the maximum thickness of sheet metal that can be cut with a hand guillotine?

A 3,2 mm
B 1,6 mm
C 1,2 mm
D 2,1 mm (1)

4.5 What is understood by the term *Young's elasticity modulus*?

A It is the ratio between stress and strain in a metal, provided that the limit of elasticity is not exceeded.
B It is a measurement of the extension or contraction of material due to the load experienced.
C It is the force value required to produce a unit area in a tensile test specimen.
D It is a ratio of the deformation because of the application of an external force. (1)

4.6 How would one describe the term *stress* in materials?

A Internal force in a material resisting a shearing load
B Internal force in a material resisting a pulling load
C Internal force in a material resisting an external load
D Internal force in a material resisting a compressive load (1)

4.7 Which ONE of the following steps may be taken to prevent a transverse crack from forming?

A Quick cooling after welding
B Slow cooling after welding
C Use the correct welding current
D Prepare the root gap correctly (1)

4.8 Which ONE of the following tests is an example of a destructive test?

A Ultrasonic test
B Dye penetration test
C X-ray test
D Machinability test (1)

4.9 Which ONE of the following factors influences the rate of cooling of the weld metal during the welding process?

A Weld metal thickness
B Amount of oxygen used in process
C Current setting of the welding machine
D Electrode thickness (1)

4.10 This method may be used to reduce distortion during the welding process?

A Continuous welding
B Controlled cooling
C Round-step welding
D Back-step welding (1)

4.11 What is meant by the term *lock-out and tagging* during maintenance?

A The workshop is locked out and tagged to inform other workers that maintenance work is being done.
B Switches are locked out and tagged to inform other workers that maintenance work is being done.
C Maintenance personnel is locked out and tagged to inform other workers that maintenance work is being done.
D Switches are unlocked and not tagged to inform other workers that maintenance work has been incomplete. (1)

4.12 Which ONE of the following is a factor that should be considered when selecting the cutting speed of a drill bit?

A Overloading
B The spindle size
C The cutting angle
D The type of metal (1)

4.13 Which formula would you use to calculate sinβ?

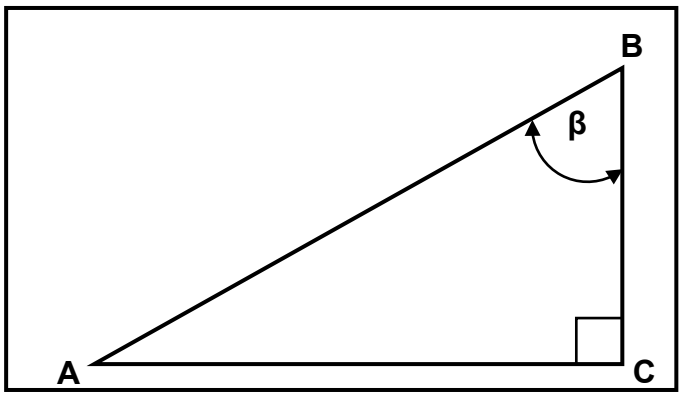


FIGURE 4.13

A $\sin\beta = \frac{AC}{AB}$

B $\sin\beta = \frac{BC}{AB}$

C $\sin\beta = \frac{AB}{AC}$

D $\sin\beta = \frac{AB}{BC}$ (1)

4.14 What is the value of **X** indicated in FIGURE 4.14 below?

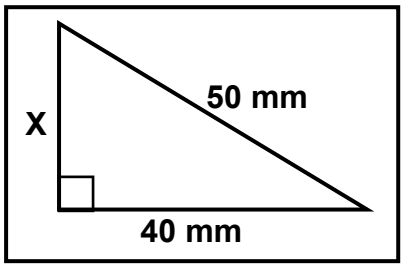


FIGURE 4.14

A 90 mm
B 60 mm
C 30 mm
D 120 mm (1)

[14]

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 FIGURE 5.1 below shows a roof truss. Label parts **A** to **E**.

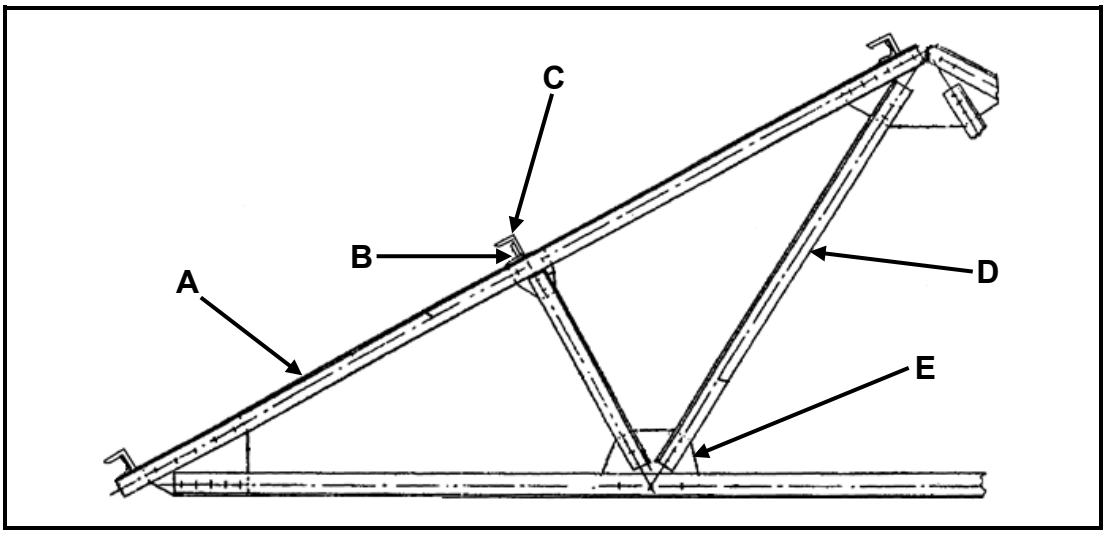


FIGURE 5.1 (5)

5.2 Make a neat sketch of a weld symbol indicating the following information on a T-joint done with arc-welding:

The intermittent fillet weld on both sides is 5 mm in size.
The lengths of the weld beads are 50 mm each.
The pitch of the weld is 100 mm. (8)

5.3 A mild steel ring must be manufactured using a 16 x 16 mm square mild steel bar. The inside diameter of the ring is 230 mm.

5.3.1 Calculate the dimensions of the material needed to manufacture the ring. (6)

5.3.2 Draw a neat sketch indicating the dimensions needed for the calculations. (4)

[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 Explain the operating principle of the following machines used in the welding workshop:

6.1.1 Punch and cropping machine (4)

6.1.2 Spot welding equipment (4)

6.1.3 Power-driven guillotine (4)

6.2 State THREE uses of the bench grinder. (3)

6.3 Name THREE types of rolling machines. (3)

[18]

QUESTION 7: FORCES (SPECIFIC)

7.1 Determine graphically the magnitude and nature of the forces in ALL the members in FIGURE 7.1 below.

SCALE: Space diagram 1 : 100
Force diagram 2 mm = 1 kN

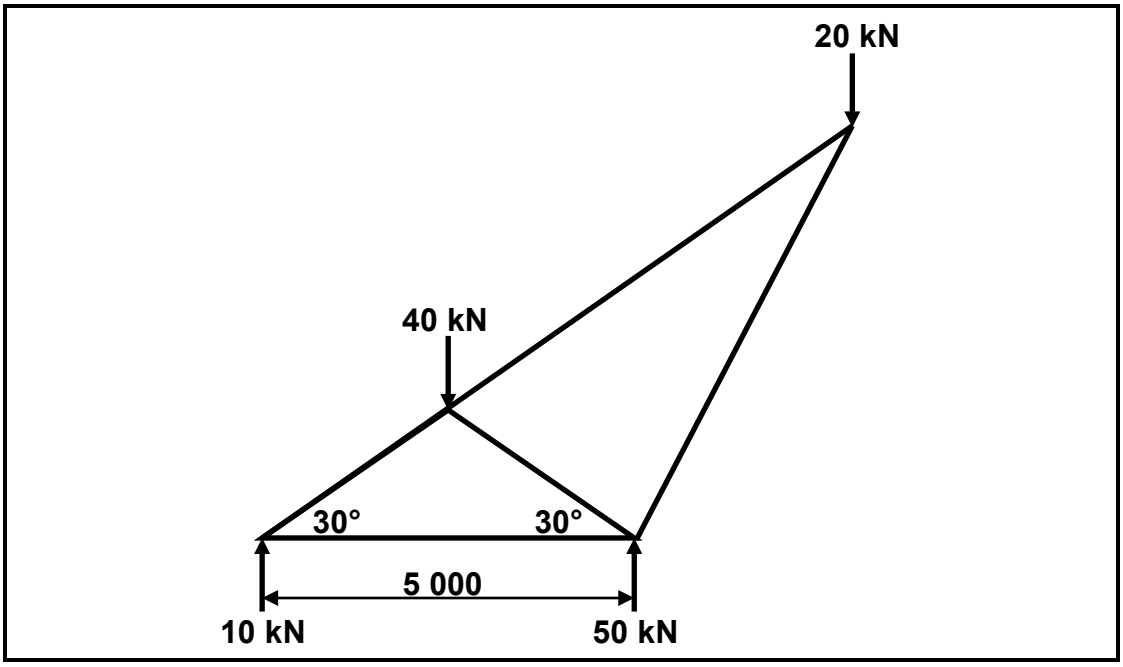


FIGURE 7.1 (20)

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

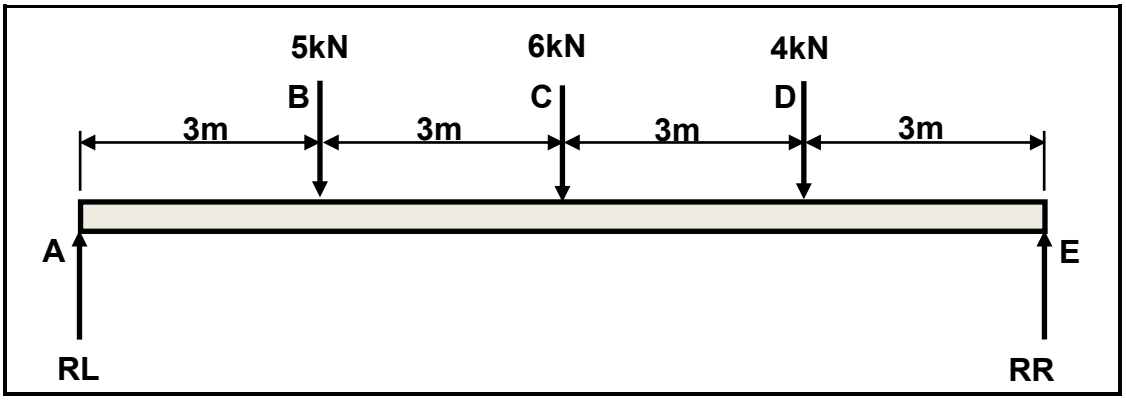


FIGURE 7.2

7.2.1 Calculate the reactions at the supports **RL** and **RR**. (6)

7.2.2 Calculate shear forces at points **A**, **B**, **C**, **D** and **E**. (5)

7.2.3 Calculate the bending moments at points **A**, **B**, **C**, **D** and **E**. (5)

7.2.4 Draw a shear force diagram of the beam. (4)

7.2.5 Draw a bending moment diagram of the beam.

SCALE: Space diagram: 10 mm = 1 m
Shear force diagram: 5 mm = 1 kN
Bending moment diagram: 5 mm = 1 kN.m (5)

[45]

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

8.1 Name THREE factors that should be observed to ensure a good welded joint during the arc-welding process. (3)

8.2 State TWO causes of EACH of the following during arc welding:

8.2.1 Welding spatter (2)

8.2.1 Incomplete penetration (2)

8.3 State ONE precautionary measurement that needs to be taken to prevent EACH of the following arc-welding defects:

8.3.1 Porosity (1)

8.3.2 Slag inclusion (1)

8.4 What is the purpose of a *nick-break test* on a welded joint? (2)

8.5 State TWO weld defects that can be detected when conducting a guided bend test on a welded joint. (2)

8.6 What property of the weld deposit and the heat-effected area adjacent to the weld is measured by performing a free-bend test? (1)

8.7 Name THREE elements that should be inspected during visual inspection of arc-welded joints. (3)

8.8 Describe the procedures followed when performing a liquid dye penetration test on a welded joint. (6)

[23]

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

9.1 What is *weld distortion*? (2)

9.2 What is meant by *residual stresses* in a welded joint? (4)

9.3 Name THREE factors which affect distortion and residual stress in a welded joint. (3)

9.4 State THREE methods used to reduce distortion. (3)

9.5 Describe the difference between *cold working* and *hot working* of steel. (4)

9.6 Name TWO factors that affect the grain size of steel when it is being cold-worked. (2)

[18]

QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 Discuss TWO reasons for locking out large machines before maintenance. (2)

10.2 Why do tagging plates have multiple holes? (1)

10.3 Compare the service requirements of a major and a minor service for a power-driven guillotine. (2)

10.4 State TWO general maintenance guidelines for a pedestal drilling machine. (2)

10.5 State ONE effect of overloading a punch and shearing machine. (1)
[8]

QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

11.1 FIGURE 11.1 below indicates a conical hopper. Calculate the following regarding the hopper:

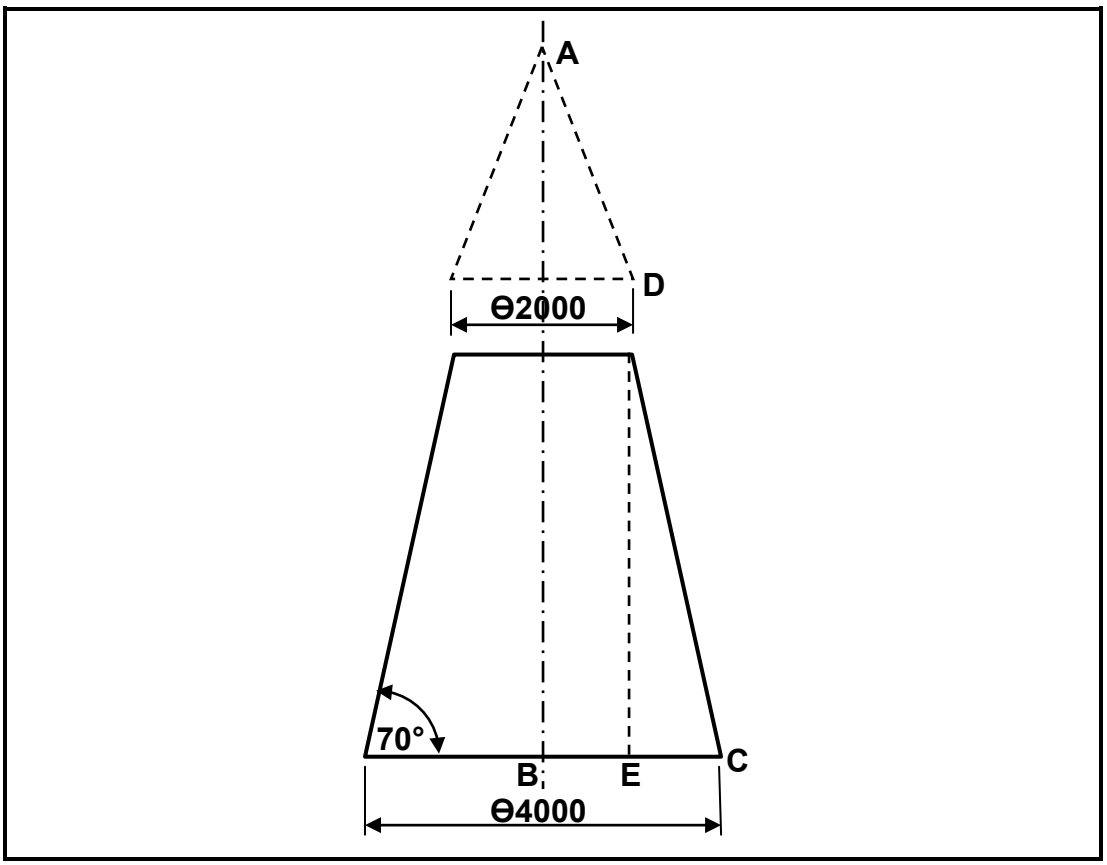


FIGURE 11.1

11.1.1 The vertical height (DE) (2)

11.1.2 The main radius (AC) (2)

11.1.3 The small radius (AD) (3)

11.1.4 The circumference (2)

11.2 FIGURE 11.2 below shows a square-to-round transition piece. In order to develop the transition, the true lengths must be calculated:

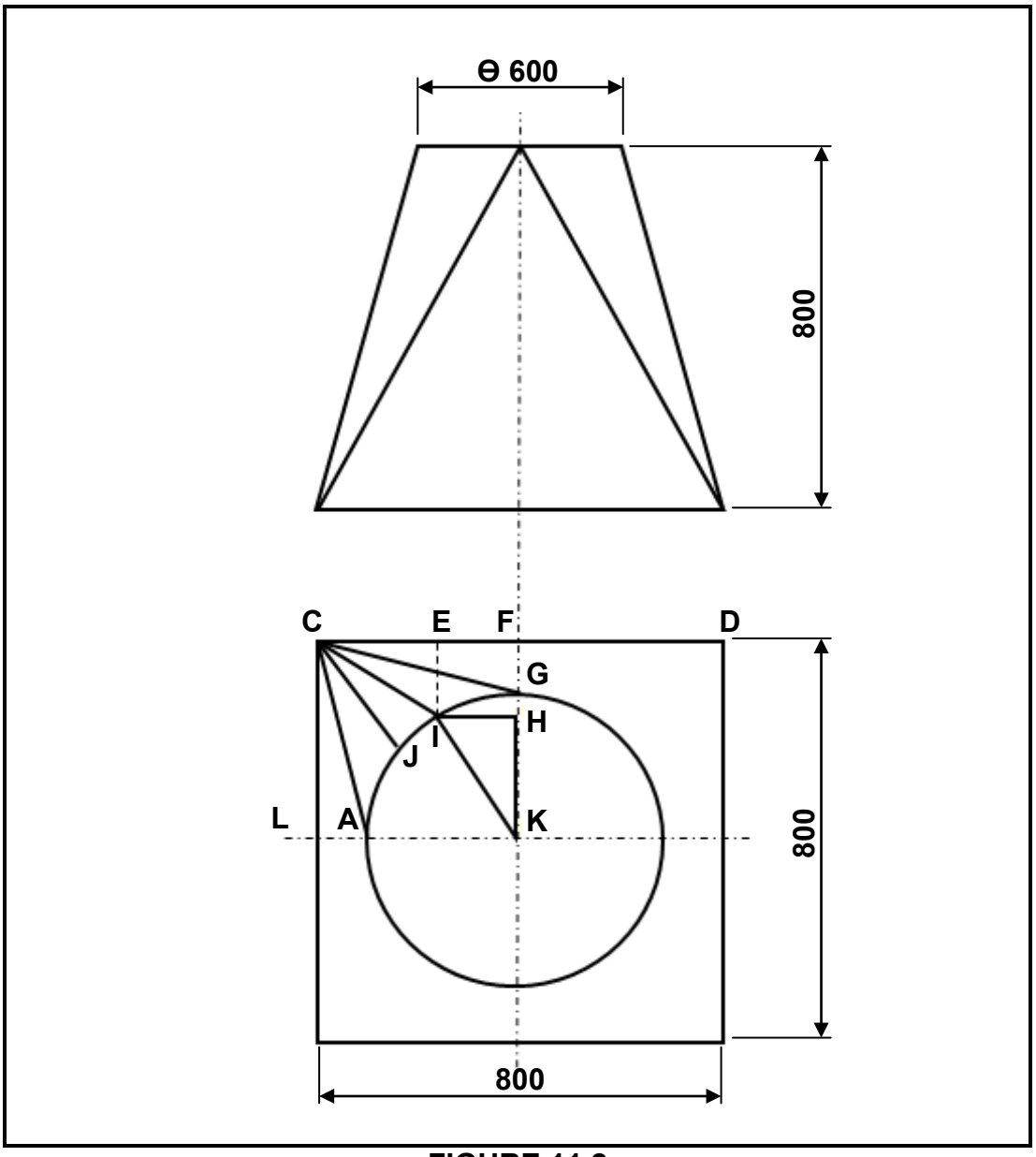


FIGURE 11.2

Determine the following true lengths with the help of calculations:

11.2.1 True length FG (5)

11.2.2 True length CI (4)

11.2.3 True length JI (3)

[21]

TOTAL: 200

FORMULA SHEET FOR MECHANICAL TECHNOLOGY (WELDING AND METALWORK)

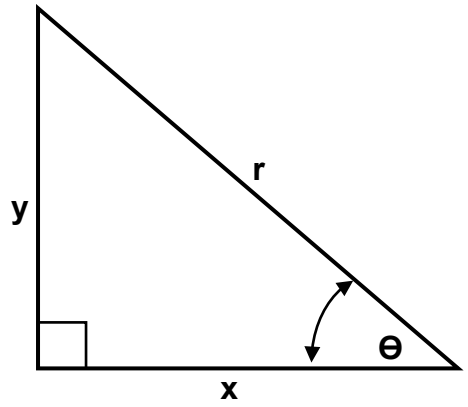
1. STRESS AND STRAIN

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

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

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

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 $\text{Mean } \varphi = \text{Outside } \varphi - \text{Plate thickness}$ or
$\text{Mean} \varphi = \text{Inside } \varphi + \text{Plate thickness}$

3.2 $\text{Mean circumference} = \pi \times \text{Mean } \varphi$