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NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2025

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

MARKS: 200

TIME: 3 hours



This question paper consists of 21 pages, including a 1-page formula sheet.



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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 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 the 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 millimeters, 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 (Weld Inspection)	23	20
9	Joining methods (Stresses and Distortion)	18	20
10	Maintenance	8	10
11	Terminology (Development)	21	15
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 ONE is the first stage of basic first aid treatment to apply to an injured person?
- A Examination
 - B Diagnosis
 - C Treatment
 - D None of the above
- (1)
- 1.2 It contains common guidelines on how employers, employees and trade unions should respond to HIV/AIDS in the workplace.
- A The Labour Relations Act (LRA No. 66 of 1995)
 - B The Constitution – Bill of Rights.
 - C The Code of good practice on HIV/Aids and employment.
 - D Occupational Health and Safety Act (OHS Act No. 85 of 1993)
- (1)
- 1.3 What is the maximum thickness of a sheet metal that the manual guillotine can cut?
- A 120 mm
 - B 12 mm
 - C 1,2 mm
 - D 0,12 mm
- (1)
- 1.4 Which ONE of the following safety precautions is applicable when using the drill press?
- A Always wear tinted goggles
 - B Do not hold the work piece by hand
 - C You may leave the key in the drill chuck
 - D You may leave the machine running unattended.
- (1)
- 1.5 When mild steel material is tested it produces a ... sound.
- A medium metallic
 - B lower ringing
 - C high ringing
 - D very dull
- (1)
- 1.6 During normalising of iron-based alloys, it is heated to an approximately ... above the upper critical temperature.
- A 356°C
 - B 256°C
 - C 156°C
 - D 56°C
- (1)

[6]

QUESTION 2: SAFETY (GENERIC)

- 2.1 State TWO safety precautions that must be adhered to when using a power saw.



(2)

- 2.2 Name TWO responsibilities of an EMPLOYEE regarding safety in the workplace.

(2)

- 2.3 Give TWO safety rules that should be followed while the bench grinder is in operation.

(2)



- 2.4 State TWO advantages of the product layout.

(2)

- 2.5 Name the TWO main categories into which the causes of accidents can be divided according to the Occupational Health and Safety Act.

(2)

[10]

**QUESTION 3: MATERIALS (GENERIC)**

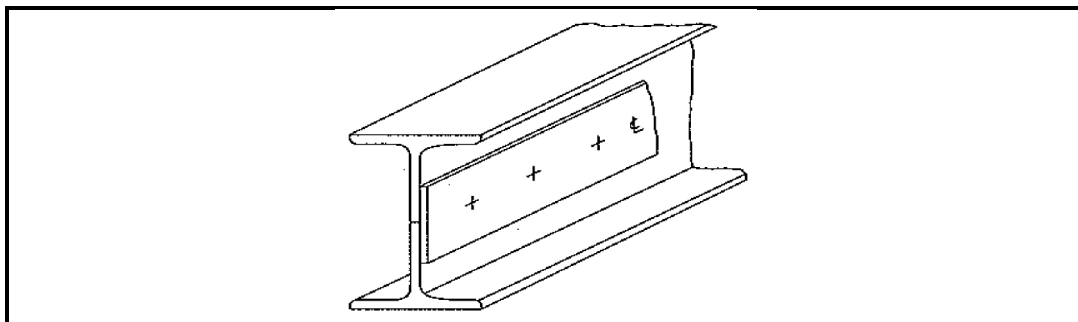
- 3.1 Name any THREE tests used to distinguish between the different types of materials. (3)
- 3.2 Name the THREE groups of carbon steel and state the percentage carbon content range of each. (6)
- 3.3 What is the purpose of normalising ferrous metals? (2)
- 3.4 Describe the tempering process of steel. (3)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC) (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 (4.1 to 4.14) in the ANSWER BOOK, for example 4.15 D.

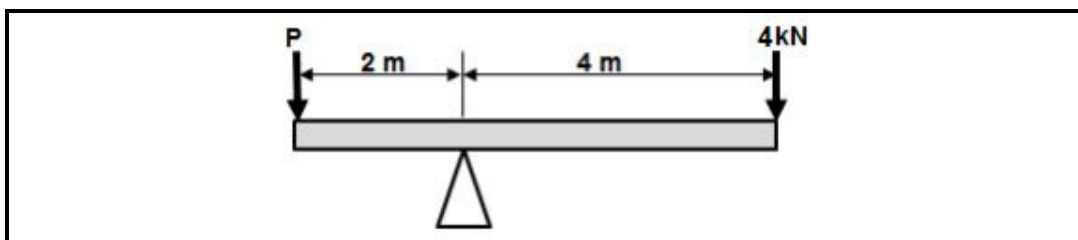
4.1 Identify the template shown in the diagram below.



- A Left-hand flange template
- B Right-hand flange template
- C Strip template
- D Web template

(1)

4.2 What is the magnitude of force **P** in the diagram below?



- A 6 kN
- B 8 kN
- C 4 kN
- D 12 kN

(1)

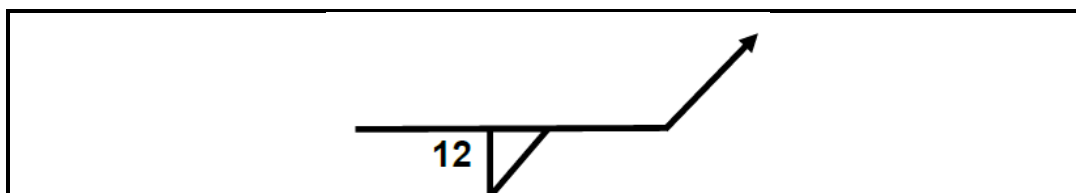
4.3 Which ONE of the following is a cause of a malfunctioning guillotine?

- A Incorrect chuck key size
- B Incorrect cutting angle size
- C Incorrect arc wire
- D Overloading

(1)



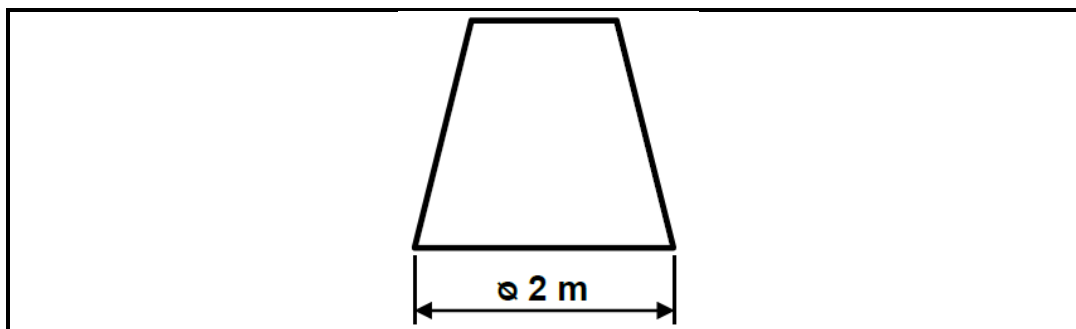
4.4 What does 12 in the diagram below represent of the weld.



- A Length
- B Size
- C Pitch
- D Root

(1)

4.5 What is the magnitude of the base circumference of the cone shown in the diagram below?



- A 3,10 m
- B 3,14 m
- C 5,28 m
- D 6,28 m

(1)

4.6 Which ONE of the following safety regulations applies to the MIG/MAGS welding process?



- A Check the colour coding on cylinders.
- B Hold the work piece in your hand during the welding process.
- C Turn the relief valve very slowly
- D Ensure that the welding area is well-ventilated.

(1)



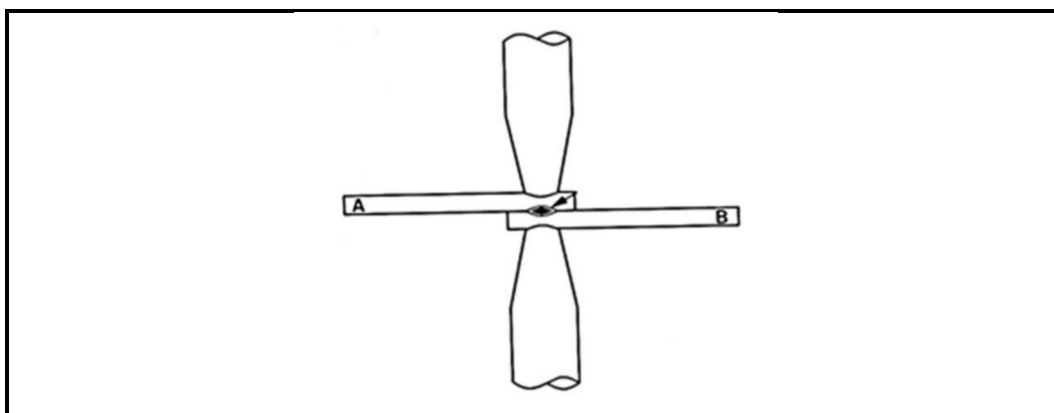
4.7 A destructive test is a method of testing a weld ...

- A without destroying the finished product.
- B by destroying the finished product.
- C by weld defects.
- D without weld defects. (1)

4.8 Which ONE of the following is used by a hydraulic press in its operation?

- A Air
- B Water
- C Oil (1)
- D Grease

4.9 Identify the welding process shown in the diagram below:



- A Spot welding
- B Arc welding
- C Oxy-acetylene welding
- D Gas welding (1)

4.10 The off-set pinch roll used for rolling ...

- A square bar
- B thin sheet metal
- C round bars (1)
- D angle iron

4.11 The ability of a material to be drawn into a wire form is known as ...

- A elasticity
- B malleability
- C ductility (1)
- D plasticity

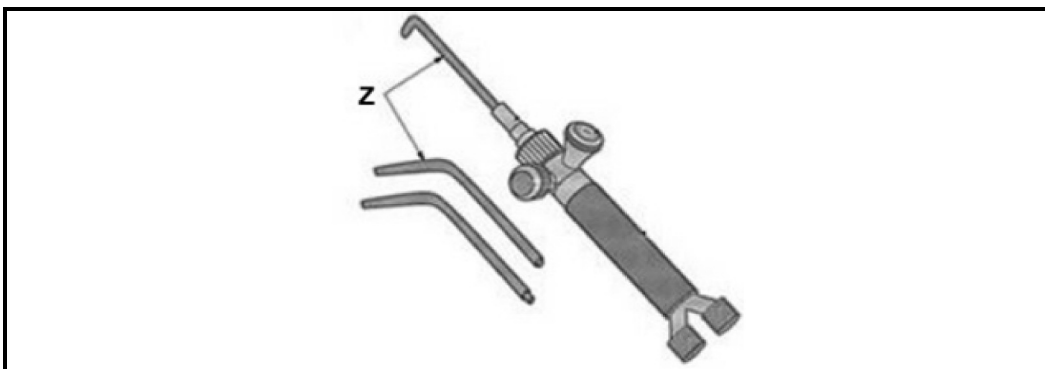


4.12 Which ONE of the following factors influences the rate of cooling of the weld metal during the welding process?

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

(1)

4.13 The diagram below shows a welding torch. Identify part Z.



- A Welding nozzle
- B Torch valve
- C Cutting nozzle
- D Torch body

(1)

4.14 The function of a tie in a framework is to hold ...

- A tools together.
- B pieces together when welding.
- C roof covering together.
- D parts of a structure together.

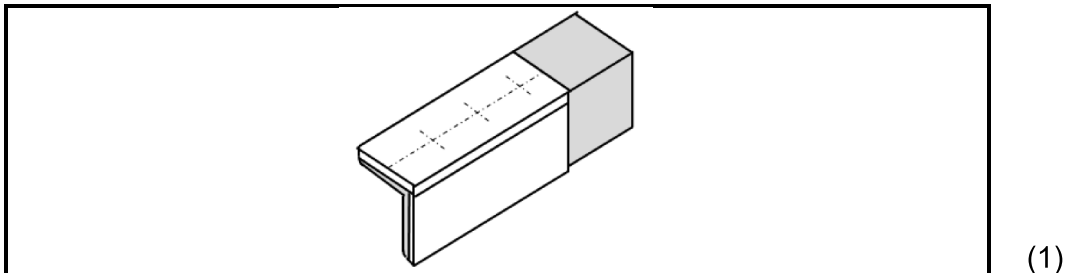
(1)
[14]

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

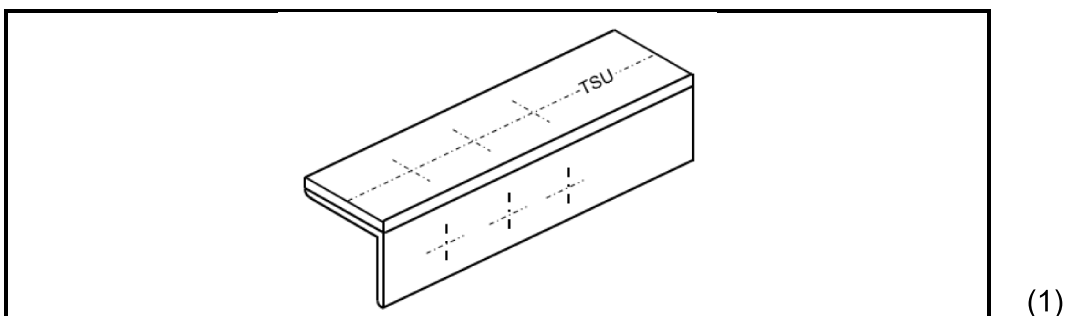
5.1 State FOUR examples of fusion welds. (4)

5.2 Identify the templates shown below.

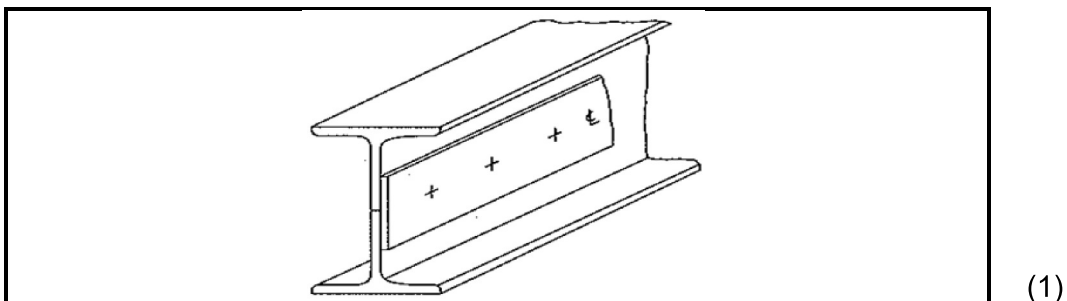
5.2.1



5.2.2



5.2.3



5.3 A steel ring must be manufactured using a 60 x 60 mm square steel bar. The ring has an outside diameter of 900 mm.

5.3.1 Calculate the mean diameter of the ring. (3)

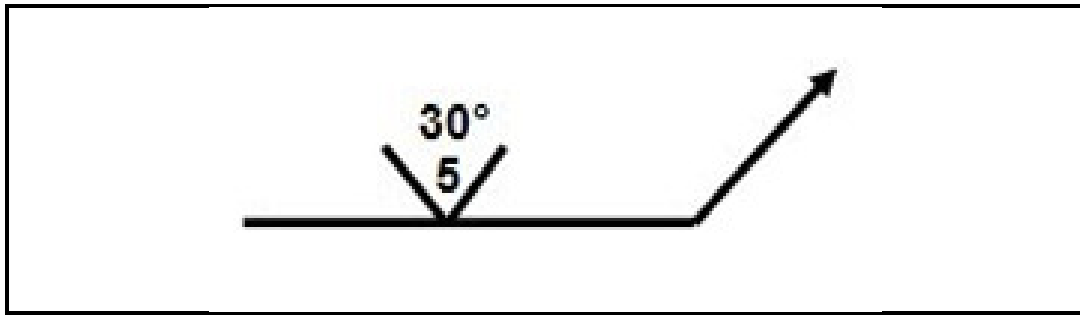
5.3.2 Calculate the mean circumference of the ring. (3)

5.4 Give THREE reasons why the template loft is separated from the workshop in most cases. (3)

5.5 Name THREE hand tools that are used by template makers. (3)



5.6 Identify the TWO dimensions of the weld as shown in the diagram below.



(2)

5.7 Explain what a plate girder is as used on a beam.

(2)

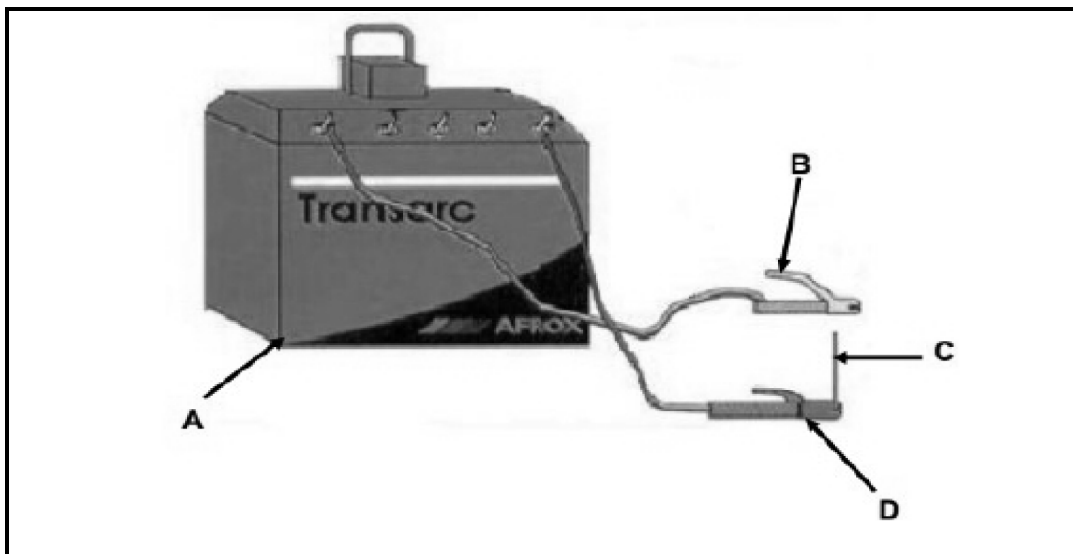
[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 What is the function of stock and dies? (1)



6.2 The diagram below shows arc welding equipment. Answer the questions that follow.



6.2.1 Label the components **A–D** (4)

6.2.2 What is the function of component **D**. (1)

6.3 Describe the working principles of the spot-welding machine. (5)

6.4 Name TWO primary functions of flashback arrestors fitted to the gas cylinders of oxy-acetylene equipment. (2)

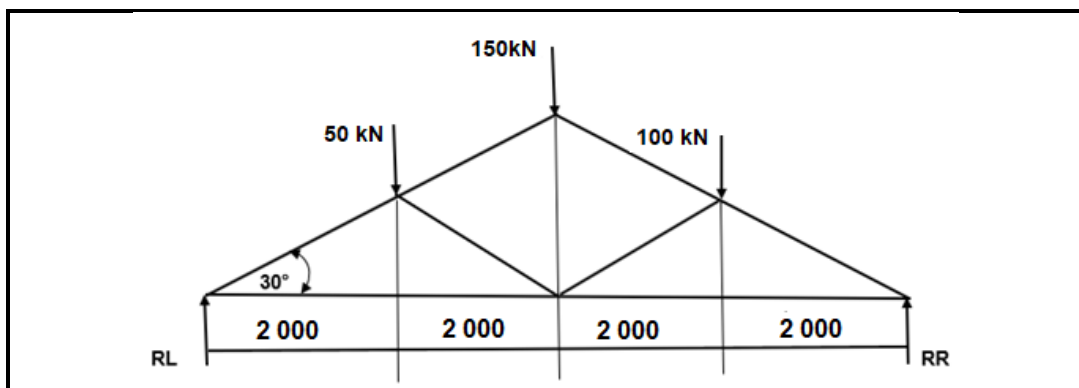
6.5 State any THREE advantages of using a MIGS/MAGS welding machine. (3)

6.6 Name TWO types of material that can be cut with a plasma cutter. (2)

[18]

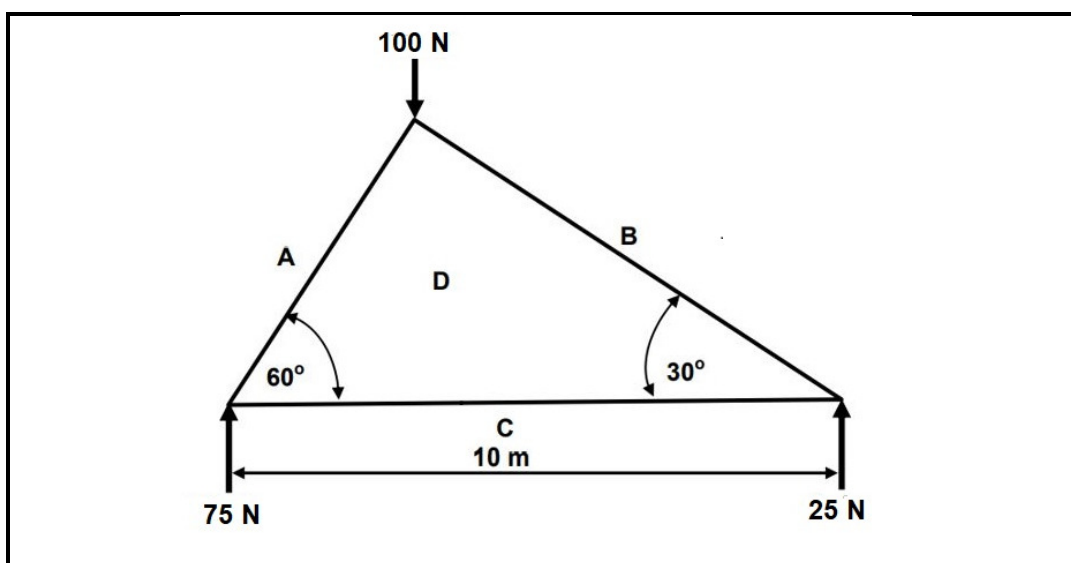
**QUESTION 7: FORCES (SPECIFIC)**

7.1 Calculate the left (**RL**) and right (**RR**) reaction of the frame structure below.



(8)

7.2 The diagram below shows a steel framework. Answer the questions that follow.

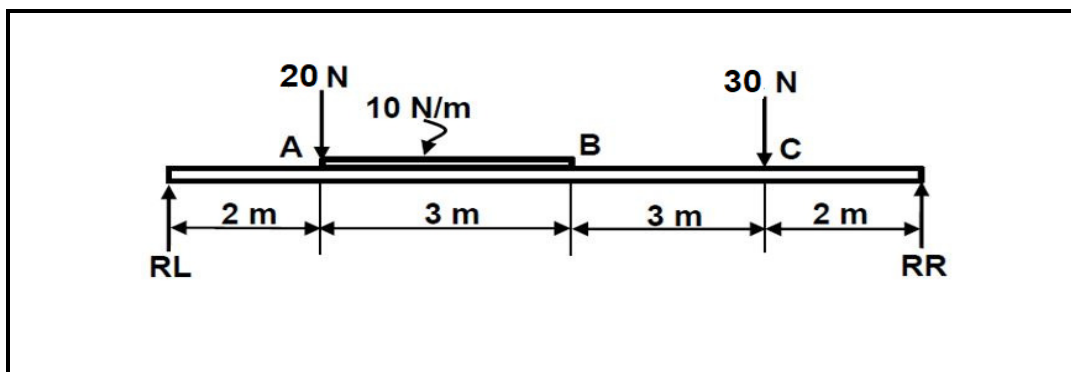


7.2.1 Construct the vector/ force diagram using scale 1 mm = 1 N. (5)

7.2.2 Determine graphically the magnitude and nature of the force in **AD**, **BD** and **CD** in the steel frame structure by using space diagram in the diagram. (6)



- 7.3 The diagram below shows a beam of 10 metres long, supported by two vertical supports, **RL** and **RR**. Two vertical point loads, 20 N and 30 N, are exerted onto the beam. A uniformly distributed load of 10 N/m is exerted over a length of 3 m. Answer the questions that follow.



- 7.3.1 Calculate the magnitude of the reactions in supports **RL** and **RR**. (6)
- 7.3.2 Calculate the shear force at points **A**, **B** and **C** (6)
- 7.3.3 Use a scale below to draw the shear force diagram.

Scale: Space diagram: 10 mm = 1 m

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

- 7.4 A steel shaft of diameter 32 mm is lengthened by 0,5 mm when a tensile load of 120 kN is applied to it. The original length of the shaft is 120 mm.

Calculate:

- 7.4.1 The stress (5)
- 7.4.2 The strain (3)

[45]



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

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

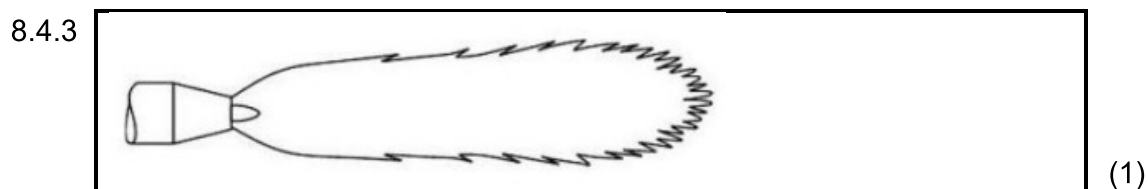
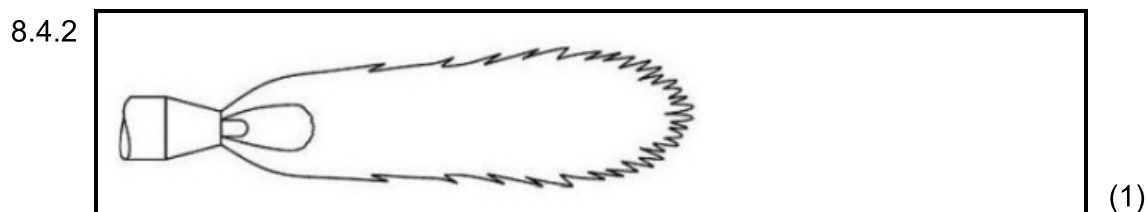
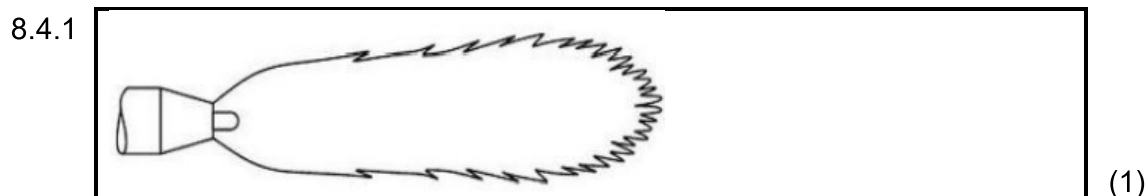
8.2 State TWO visual requirements for an acceptable weld. (2)

8.3 Give ONE reason for performing the following tests on a welded joint.

8.3.1 Free-bend test (1)

8.3.2 X-ray test (1)

8.4 The diagrams in QUESTIONS 8.4.1–8.4.3 below shows three different types of flames used in gas welding. Identify each flame.



8.5 State TWO causes of EACH of the following arc welding defects:

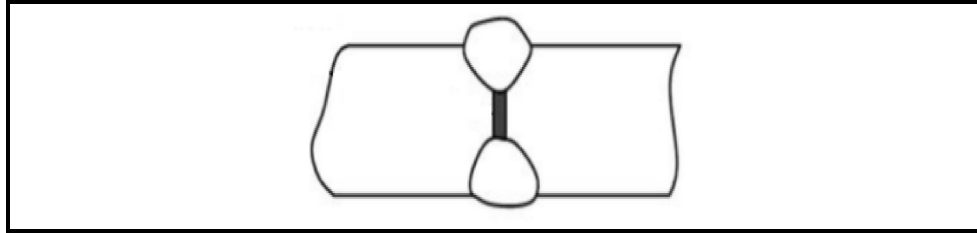
8.5.1 Welding spatter (2)

8.5.2 Incomplete penetration (2)



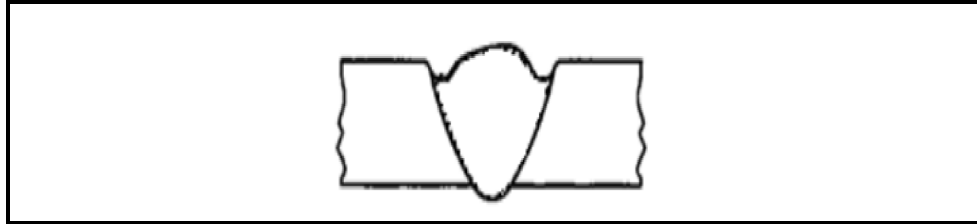
- 8.6 Identify the arc welding defects in the butt joint shown in QUESTION 8.6.1 and QUESTION 8.6.2 below.

8.6.1



(1)

8.6.2



(1)

- 8.7 Describe the steps to be followed when performing a nick-break test on a welded joint.

(4)

- 8.8 Name THREE factors that determine the current setting in arc welding.

(3)

[23]

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

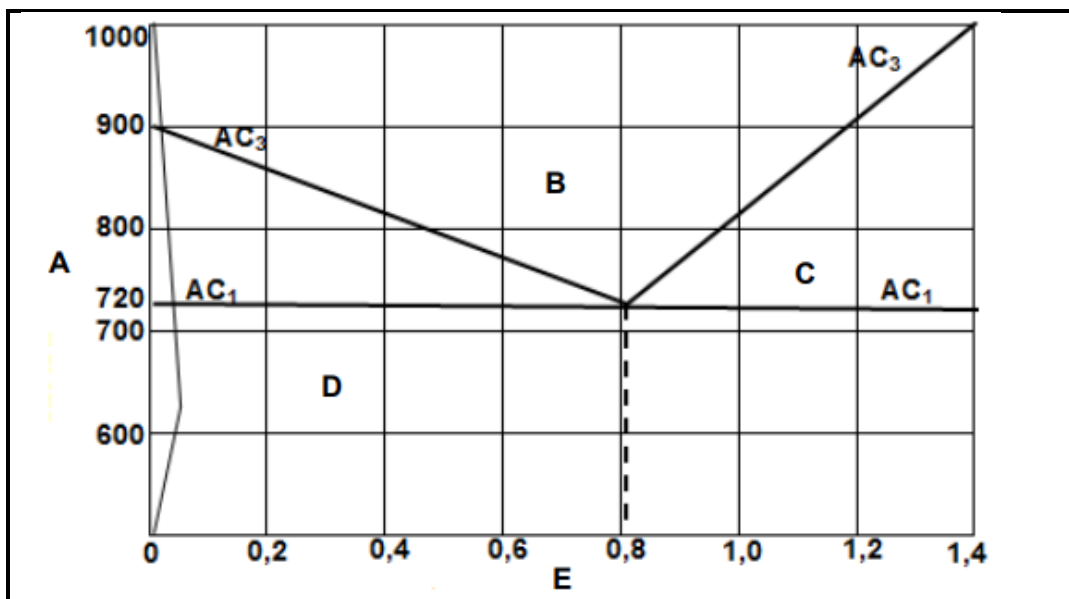
9.1 State TWO methods to reduce distortion in a welded joint. (2)

9.2 Define the following terms:

9.2.1 *Weld distortion* (2)

9.2.2 *Residual stress* (2)

9.3 Study the diagram below and answer the questions that follow.



9.3.1 Identify the diagram shown above. (1)

9.3.2 Label **A–E** indicated on the diagram. (5)

9.4 What is *elastic deformation*? (2)

9.5 What effect do the following factors have on shrinkage of steel during arc welding? (2)

9.5.1 Electrode size

9.5.2 Welding speed (2)

[18]



QUESTION 10: MAINTENANCE (SPECIFIC)

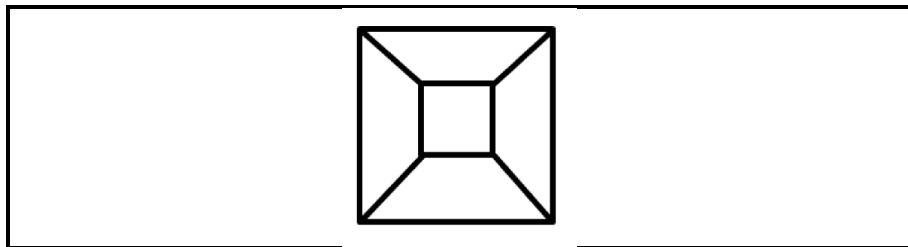
- 10.1 Give TWO reasons for the maintenance of machines in the welding workshop. (2)
- 10.2 Explain how the following machines can be overloaded:
- 10.2.1 Guillotine (2)
- 10.2.2 Horizontal band saw (2)
- 10.3 Give reasons why it is important to keep service records of the machines. (2)
- [8]**



**QUESTION 11: TERMINOLOGY DEVELOPMENT (SPECIFIC)**

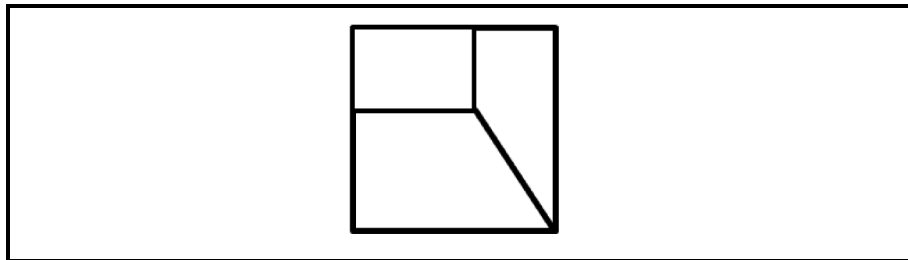
11.1 Identify the hopper shown below.

11.1.1



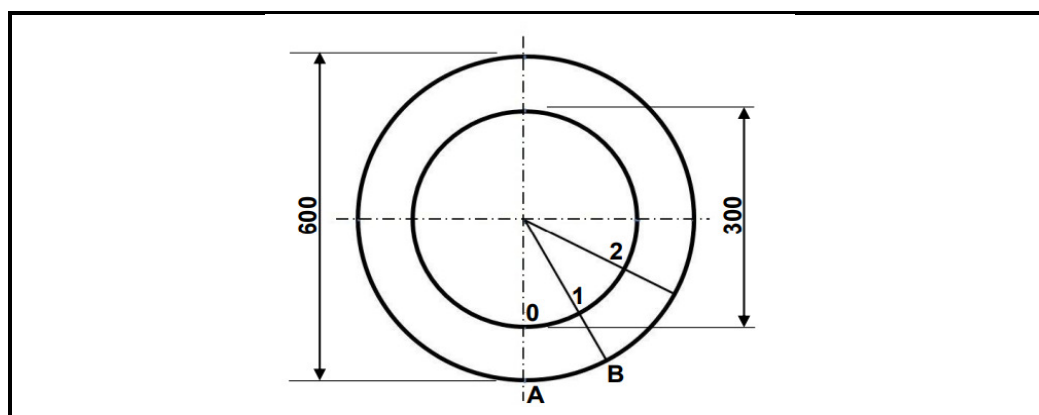
(1)

11.1.2



(1)

11.2 The diagram below shows the top view of a cone frustum



Calculate the true lengths of the following:

11.2.1 **1 – 2** (3)

11.2.2 **A – B** (3)



- 11.3 FIGURE 11.1 below shows a square-to-round transition piece. In order to develop the transition, the true lengths must be calculated.

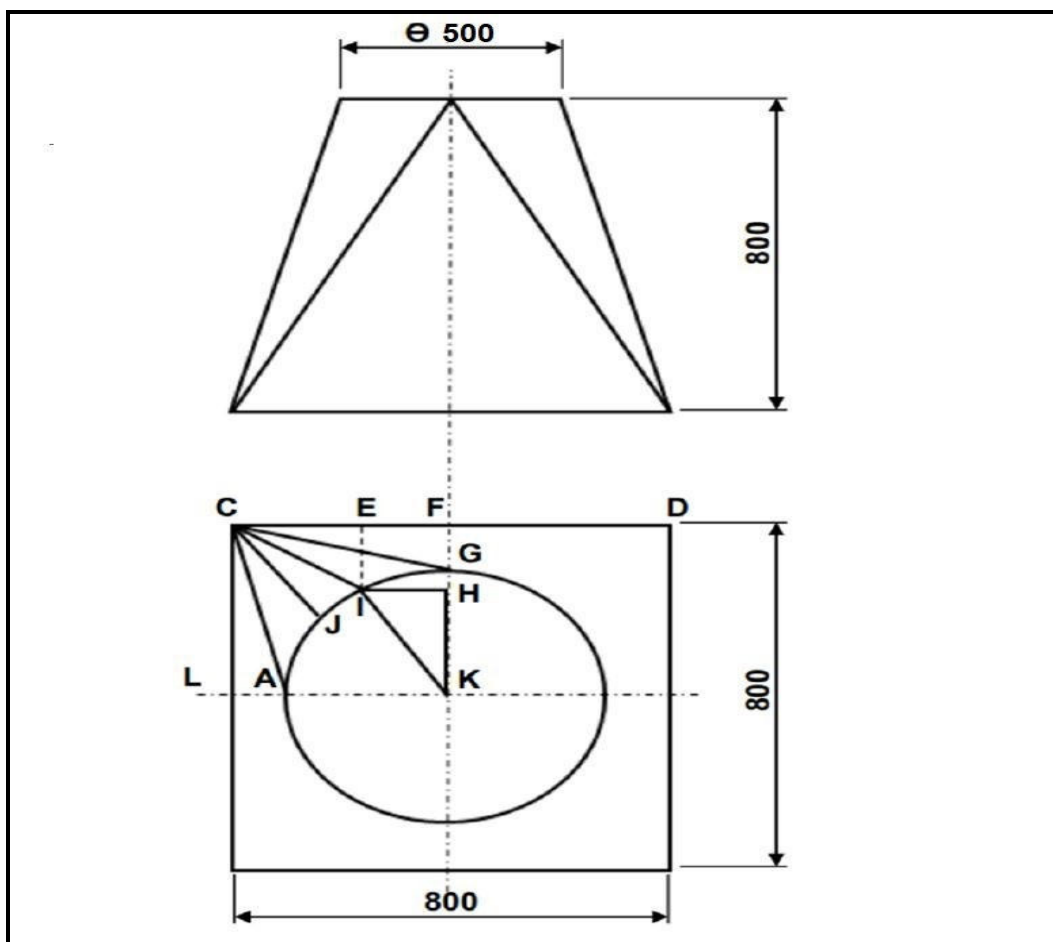


FIGURE 11.1

Determine the following true lengths with the help of calculations:

- 11.3.1 True length **FG** (5)
 11.3.2 True length **CI** (5)
 11.3.3 True length **JI** (3)

[21]

TOTAL: 200





FORMULA SHEET FOR MECHANICAL TECHNOLOGY (WELDING AND METALWORK)

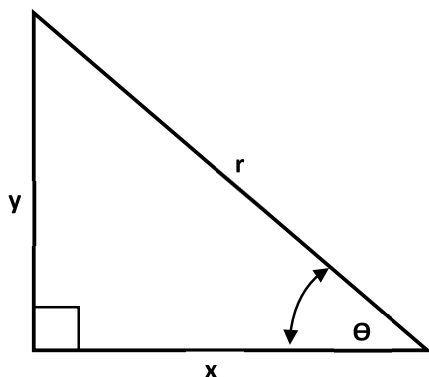
1. STRESS AND STRAIN

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

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

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

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

$$3.1 \quad \text{Mean } \phi = \text{Outside } \phi - \text{Plate thickness} \quad \text{or} \\ \text{Mean } \phi = \text{Inside } \phi + \text{Plate thickness}$$

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

