



# basic education

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Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

## **NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**MECHANICAL TECHNOLOGY: WELDING AND METALWORK**

**NOVEMBER 2018**

**MARKING GUIDELINES**

**MARKS: 200**

**These marking guidelines consist of 19 pages and Annexure A.**

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

- |     |     |     |
|-----|-----|-----|
| 1.1 | A ✓ | (1) |
| 1.2 | C ✓ | (1) |
| 1.3 | A ✓ | (1) |
| 1.4 | B ✓ | (1) |
| 1.5 | D ✓ | (1) |
| 1.6 | A ✓ | (1) |

**TOTAL QUESTION 1: [6]**

## QUESTION 2: SAFETY (GENERIC)

### 2.1 Angle grinder: (Before using)

- The safety guard must be in place before starting. ✓
- Protective shields must be placed around the object being grinded to protect the people around. ✓
- Use the correct grinding disc for the job. ✓
- Make sure that there are no cracks in the disc before you start. ✓
- Protective clothing and eye protection are essential. ✓
- Check electrical outlets and cord/plugs for any damages. ✓
- Ensure that lockable switch is disengaged. ✓
- Ensure that the disc and the nut are well secured. ✓
- Ensure that the removable handle is secured. ✓
- Remove all flammable material from the area. ✓
- Secure the work piece. ✓

(Any 2 x 1) (2)

### 2.2 Welding goggles:

- To protect your eyes against sparks ✓
- To protect your eyes against heat ✓
- To be able to see where to weld ✓
- To protect your eyes from UV rays / bright light ✓
- To protect your eyes from smoke ✓

(Any 2 x 1) (2)

### 2.3 PPE for Hydraulic press:

- Overall ✓
- Safety shoes ✓
- Safety goggle ✓
- Leather gloves ✓
- Leather apron ✓
- Face shield ✓

(Any 2 x 1) (2)

### 2.4 Workshop layouts:

- Process layout ✓
- Product layout ✓

(2)

### 2.5 Employer's responsibility regarding first-aid:

- Provision of first-aid equipment ✓
- First aid training ✓
- First-aid services by qualified personnel ✓
- Any first aid procedures ✓
- Display first aid safety signs ✓
- First aid personnel must be identified by means of arm bands or relevant personal signage ✓

(Any 2 x 1) (2)

**TOTAL QUESTION 2: [10]**

### QUESTION 3: MATERIALS (GENERIC)

3.1 **Bending test:**

- Ductility ✓✓
- Malleability ✓✓
- Brittleness ✓✓
- Flexibility ✓✓

(Any 1 x 2) (2)

3.2 **Heat-treatment:**

3.2.1 **Annealing:**

- To relieve internal stresses ✓
- To soften the steel ✓
- To make the steel ductile ✓
- To refine the grain structure of the steel ✓
- To reduce the brittleness of the steel ✓

(Any 2 x 1) (2)

3.2.2 **Case hardening:**

- To produce a wear resistant surface ✓ and it must be tough enough internally ✓ at the core to withstand the applied loads.
- Hard case ✓ and tough core. ✓

(Any 1 x 2) (2)

3.3 **Tempering process:**

- To reduce ✓ the brittleness ✓ caused by the hardening process.
- Relieve ✓ strain ✓ caused during hardening process.
- Increase ✓ the toughness ✓ of the steel.

(Any 1 x 2) (2)

3.4 **Factors for heat-treatment processes:**

- Heating temperature / Carbon content ✓
- Soaking (Time period at temperature) / Size of the work piece ✓
- Cooling rate / Quenching rate ✓

(3)

3.5 **Hardening of steel:**

- Steel is heated to 30 – 50°C above the higher critical temperature. (AC<sub>3</sub>) ✓
- It is then kept at that temperature to ensure (soaking) that the whole structure is Austenite. ✓
- The steel is then rapidly cooled by quenching it in clean water, brine or oil. ✓

(3)

**TOTAL QUESTION 3: [14]**

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

- |      |     |     |
|------|-----|-----|
| 4.1  | B ✓ | (1) |
| 4.2  | A ✓ | (1) |
| 4.3  | B ✓ | (1) |
| 4.4  | B ✓ | (1) |
| 4.5  | A ✓ | (1) |
| 4.6  | B ✓ | (1) |
| 4.7  | D ✓ | (1) |
| 4.8  | D ✓ | (1) |
| 4.9  | C ✓ | (1) |
| 4.10 | C ✓ | (1) |
| 4.11 | A ✓ | (1) |
| 4.12 | D ✓ | (1) |
| 4.13 | B ✓ | (1) |
| 4.14 | B ✓ | (1) |

**TOTAL QUESTION 4: [14]**

**QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)**

**5.1 Template loft:**

The template loft is separated from the workshop because...

- it is quieter. ✓
- the lighting is better. ✓
- all equipment is at hand. ✓
- it is a permanent base. ✓
- marking on the floor enhance accuracy. ✓

(Any 2 x 1) (2)

**5.2 Purpose of purlins:**

- The purlins support ✓ the roof covering ✓
- Stabilizes ✓ the trusses. ✓

(Any 1 x 2) (2)

**5.3 A steel ring calculation:**

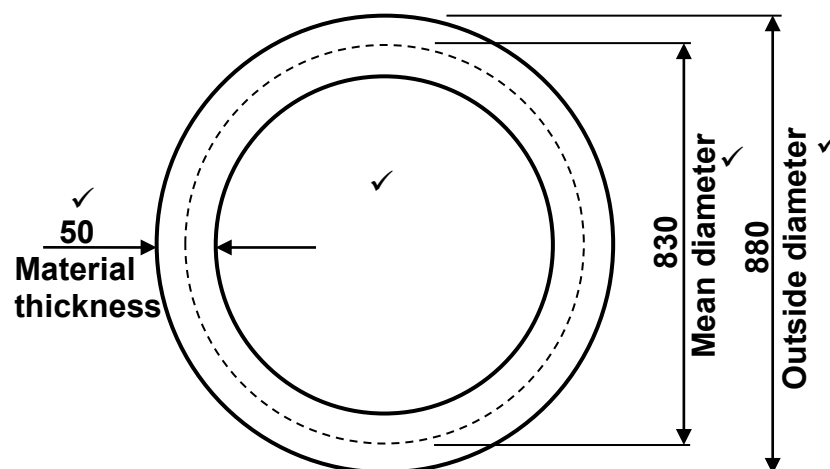
**5.3.1 Dimensions of the required material:**

$$\begin{aligned} \text{Mean diameter} &= \text{Outside diameter} - \text{plate thickness} \quad \checkmark \\ &= 880 - 50 \quad \checkmark \\ &= 830\text{mm} \quad \checkmark \end{aligned}$$

$$\begin{aligned} \text{Mean circumference} &= \pi \times \text{Meandiameter} \quad \checkmark \\ &= \pi \times 830 \quad \checkmark \\ &= 2607,52\text{mm} \quad \checkmark \end{aligned}$$

2608 mm of 50 x 50 mm ✓ square steel bar is required to fabricate the ring. (7)

**5.3.2**



(4)

5.4 **Resistance weld symbols:**

5.4.1 Spot weld ✓ (1)

5.4.2 Seam weld ✓ (1)

5.5 **Welding symbols:**

- A. Tail ✓
- B. Weld symbol (Fillet weld) ✓
- C. Pitch of weld ✓
- D. Site weld ✓
- E. Arrow ✓
- F. Weld all round ✓ (6)

**TOTAL QUESTION 5: [23]**

## QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

### 6.1. Working Principles:

#### 6.1.1 Guillotine:

- A bottom cutting blade is fixed horizontally. ✓
- With a top cutting blade moving downwards. ✓
- It is driven by an electric motor, flywheel, gearbox and axle ✓ by eccentric motion / action / hydraulic action. ✓

**OR**

- It is activated manually by foot ✓ with lever action. ✓ (4)

#### 6.1.2 Bending rolls:

- A bending roll has two fixed rollers next to each other rotating in unison (Manually or Electrical motor). ✓
- A third roller is adjustable, moving in between the two rollers. ✓
- The third roller applies downward pressure onto the metal. ✓
- That causes the metal to deflect and ultimately form the round shape desired. ✓ (4)

### 6.2. Regulators on gas cylinders:

Regulators reduce ✓ the cylinder pressure ✓ to operating or working pressure. ✓ (3)

### 6.3 Press machine:

- The press machine is used for installing ✓ or removing ✓ components on mechanical devices / machines. ✓
- To press ✓ profiles ✓ onto material ✓

(Any 1 x 3) (3)

### 6.4 MIGS/MAGS welding process:

A – Weld pool / weld bead / molten metal ✓

B – Electrode wire / electrode ✓

C – Gas shroud / electrical contact / nozzle / contact tip ✓

D – Shielding gas ✓ (4)

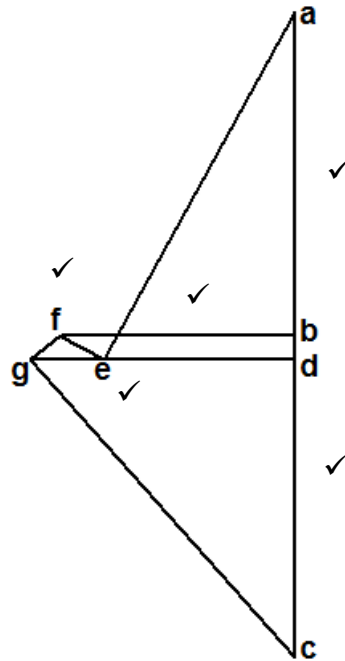
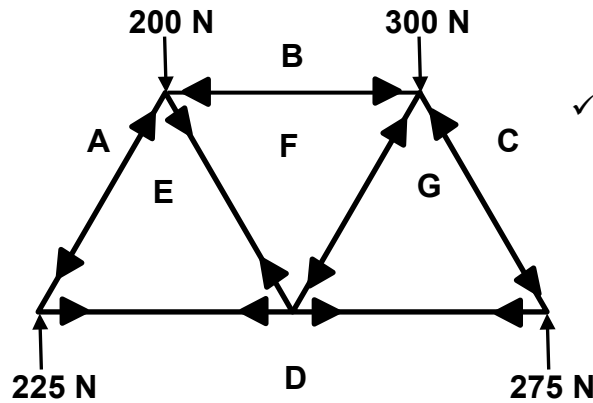
**TOTAL QUESTION 6: [18]**



**QUESTION 7: FORCES (SPECIFIC)**

**7.1 Forces in members:**

SCALE: Vector diagram 1 mm = 5 N



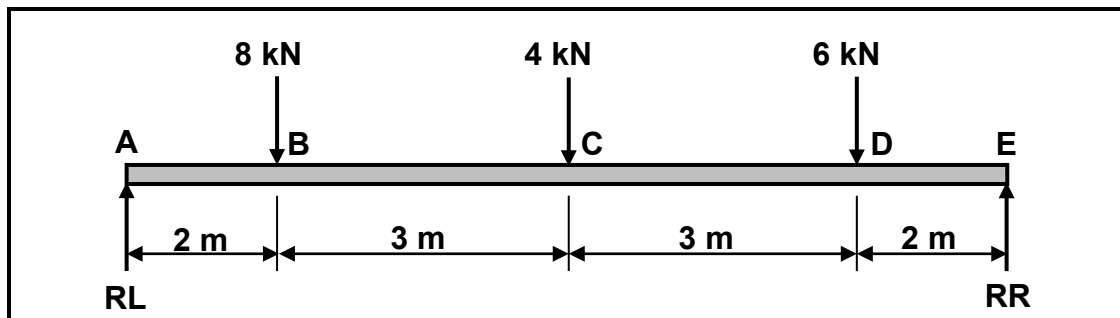
MEMBER	MAGNITUDE	NATURE
AE	260 N ✓	STRUT ✓
BF	135 N ✓	STRUT ✓
CG	317,5 N ✓	STRUT ✓
FG	27,5 N ✓	STRUT ✓
ED	130 N ✓	TIE ✓
EF	27,5 N ✓	TIE ✓
GD	160 N ✓	TIE ✓

(20)

NOTE:

Use a tolerance of 2 mm + and – on the vector diagram.  
 = a tolerance of 10 N + and – on the answer.

7.2 Bending moments:



7.2.1 Moments about RR

$$RL \times 10 = (8 \times 8) + (4 \times 5) + (6 \times 2)$$

$$RL = \frac{96}{10}$$

$$RL = 9,6 \text{ kN}$$

Moments about RL

$$RR \times 10 = (6 \times 8) + (4 \times 5) + (8 \times 2)$$

$$RR = \frac{84}{10}$$

$$RR = 8,4 \text{ kN}$$

(8)

7.2.2 Bending moments at point A, B, C, D and E:

Scale 2 mm = 1 kN.m

Moment at A = 0 kN.m ✓

$$B = RL \times 2 = 19,2 \text{ kN.m} \quad \checkmark$$

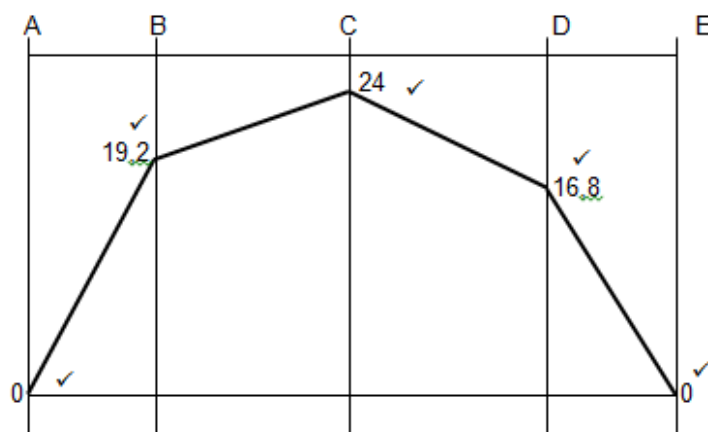
$$C = (RL \times 5) - (8 \times 3) = 24 \text{ kN.m} \quad \checkmark$$

$$D = (RL \times 8) - (8 \times 6) - (4 \times 3) = 16,8 \text{ kN.m} \quad \checkmark$$

$$E = (RL \times 10) - (8 \times 8) - (4 \times 5) - (6 \times 2) = 0 \text{ kN.m} \quad \checkmark$$

(5)

7.2.3



(5)

NOTE:

Use a tolerance of 2 mm + and – on the bending moment diagram.

7.3 **Stress and strain:**

$$A = \frac{\pi}{4} \quad \checkmark$$

$$A = \frac{\pi (0,02)^2}{4} \quad \checkmark$$

$$A = 0,314 \times 10^{-3} \text{ m}^2 \quad \checkmark$$

$$\left. \begin{array}{l} \text{Stress} = \frac{\text{Load}}{\text{Area}} \\ \text{Load} = \text{Stress} \times \text{Area} \end{array} \right\} \quad \checkmark$$

$$\text{Load} = (80 \times 10^6) \times (0,314 \times 10^{-3})$$

$$\text{Load} = 25,133 \text{ kN} \quad \checkmark$$

(7)

**TOTAL QUESTION 7: [45]**

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

**8.1 Factors to be observed during oxy-acetylene welding:**

- Correct flame for the work on hand. ✓
- Correct angle of welding torch and welding rod. ✓
- Depth penetration and amount of fusion. ✓
- The rate of progress along the joint. ✓
- The distance of the nozzle from the parent metal. ✓

**(Any 2 x 1) (2)**

**8.2 Abbreviation 'HAZ':**  
Heat Affected Zone ✓

**(1)**

**8.3 Causes of weld defects:**

**8.3.1 Spatter:**

- Disturbance in the molten weld pool. ✓
- Too low welding voltages. ✓
- Too high welding current / amps. ✓
- Inadequate shielding gas flow. ✓
- Too fast travel speed ✓
- Arc length too long ✓
- Wet electrode ✓
- Wrong polarity ✓
- Arc length too short ✓
- Wrong included electrode angle ✓
- Wrong electrode used ✓
- Arc blow ✓

**(Any 2 x 1) (2)**

**8.3.2 Undercutting:**

- Too fast travel speed ✓
- Rapid solidification ✓
- Too low arc voltage ✓
- Arc length too long ✓
- Excessive welding current ✓
- Too slow movement over weld ✓
- Current / amps too high ✓
- Electrode too big ✓
- Wrong electrode ✓
- Wrong included electrode angle ✓
- Excessive weaving ✓
- Wrong joint design ✓

**(Any 2 x 1) (2)**

8.3.3 **Incomplete penetration:**

- Welding current too low ✓
- Too fast travel speed ✓
- Incorrect electrode angle ✓
- Poor edge preparation ✓
- Insufficient root gap ✓
- Electrode too big ✓
- Wrong electrode ✓
- No pre-heating done ✓
- Wrong shielding gas used ✓
- Too long arc ✓

(Any 2 x 1) (2)

8.4 **Types of cracks:**

8.4.1 **Transverse cracks:**

- Pre-heating the base metal ✓
- Using lower strength consumables / welding rod ✓
- Slow cooling after welding ✓
- Use clamping device. ✓
- Weld toward the unrestrained side of the weld. ✓

(Any 2 x 1) (2)

8.4.2 **Centreline cracks:**

- Ensure that width-to-depth ratio is 1:1. ✓
- Decrease the current to decrease excess penetration. ✓
- Decreasing welding voltage setting or slowing travel speed to achieve a flat to convex weld surface. ✓
- Use clamping device. ✓

(Any 2 x 1) (2)

8.5 **Differences between non-destructive and destructive tests:**

- Non-destructive test does not destroy the welded joint. ✓
- Destructive test destroys the welded joint. ✓

(2)

8.6 **Ultrasonic test:**

- No defects will occur during an ultrasonic test ✓✓
- Detect internal ✓ flaws as well as surface flaws. ✓
- Porosity ✓✓
- Slag inclusions ✓✓
- Cracks ✓✓

(Any 1 x 2) (2)

8.7 **Nick break test for internal defects:**

- Slag inclusion ✓
- Porosity ✓
- Lack of fusing ✓
- Oxidised metal ✓
- Burned metal ✓

(Any 2 x 1) (2)

8.8 **Machinability test:**

- To determine the hardness ✓ and strength ✓ of the welded joint.
- To determine ✓ the machinability. ✓

(Any 1 x 2) (2)

8.9 **Visual requirements of welds:**

- Shape of the profile ✓
- Uniformity of the surface ✓
- Overlap ✓
- Free from any external defects ✓
- Penetration bead ✓
- Root groove ✓

(Any 2 x 1) (2)

**TOTAL QUESTION 8: [23]**

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

- 9.1 **Residual stress:**  
Residual stresses are stresses that exist ✓ in a metal after cooling / welding. ✓ (2)
- 9.2 **Factors affecting grain size:**
- The amount of cold work. ✓
  - The temperature and time of annealing process. ✓
  - The composition and constitution. ✓
  - The recrystallisation temperature of cold worked metal. ✓
  - The melting point. ✓
- (Any 2 x 1) (2)
- 9.3 **Quenching medias:**
- Oil ✓
  - Water ✓
  - Sand ✓
  - Air ✓
  - Brine / Salt water ✓
  - Lime ✓
  - Liquid salts ✓
  - Molten lead ✓
  - Ash ✓
- (Any 2 x 1) (2)
- 9.4 **Weld distortion:**
- Distortion in a weld results from the uneven expansion and contraction (warping) ✓ of the weld metal ✓ and adjacent base metal ✓ during the heating and cooling cycle ✓ of the welding process. (4)
- 9.5 **Factors that affect distortion and residual stress:**
- If the expansion that occurs when metal is heated is resisted ✓ then deformation will occur. ✓
  - When contraction that occurs on cooling is resisted ✓ then a stress will be applied. ✓
  - If this applied stress causes movement ✓ then distortion occurs. ✓
  - If the applied stress does not cause movement ✓ then there will be residual stress in the welded joint. ✓
- (Any 2 x 2) (4)
- 9.6 **Result when metal is cooled rapidly:**
- Rapid cooling of metal results in large temperature differences ✓ between the internal and external areas ✓ of the metal that set up stresses, ✓ which cause cracks ✓ on the surface.
  - It will harden ✓✓ and the grain structure ✓ will change. ✓
- (Any 1 x 4) (4)

**TOTAL QUESTION 9: [18]**

**QUESTION 10: MAINTENANCE (SPECIFIC)**

10.1 **Reasons maintenance:**

- Promote cost saving ✓
- Improves safety ✓
- Increases equipment efficiency ✓
- Fewer equipment failure ✓
- Improves reliability of equipment ✓

(Any 2 x 1) (2)

10.2 **Lockout on machines:**

To ensure that nobody can turn on the machine ✓ while maintenance is being carried out. ✓

(2)

10.3 **Reasons for service records:**

- Assist in the monitoring of the condition of the machines. ✓
- Assist in upholding warranties. ✓
- Assist in keeping a history of maintenance and repairs. ✓

(Any 2 x 1) (2)

10.4 **Methods of reducing friction:**

- By reducing both drill speed and feed speed. ✓
- By applying lubrication. (cutting fluid) ✓
- Use the correct drill bit ✓
- Drill a pilot hole ✓

(Any 2 x 1) (2)

**TOTAL QUESTION 10: [8]**



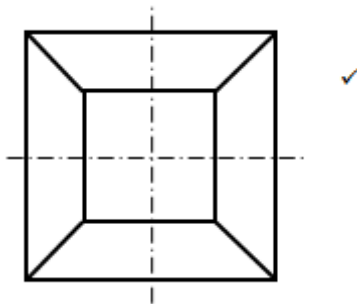
**QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)**

**11.1 Use of transformers:**

Transformers are used to connect ✓ ducting sections of dissimilar ✓ shapes to each other. ✓

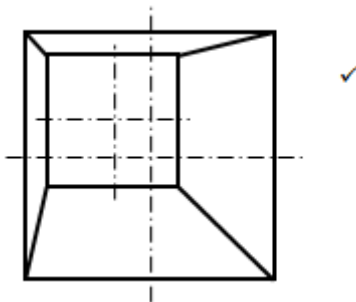
(3)

**11.2 On-centre hopper:**



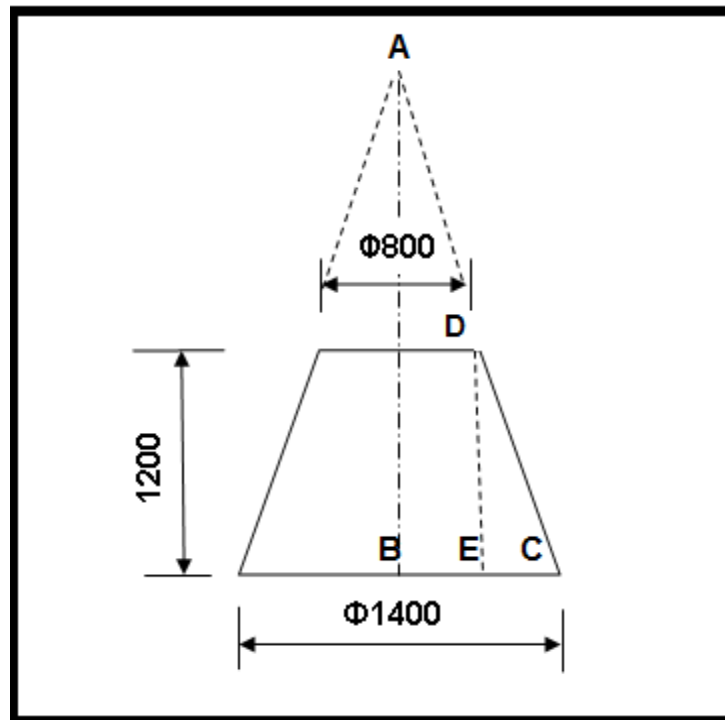
(1)

**Off-centre hopper:**



(1)

11.3 **Truncated cone:**



11.3.1 **Base circumference:**

$$\begin{aligned} \text{Circumference} &= \pi \times \text{Base diameter} \quad \checkmark \\ &= \pi \times 1400 \quad \checkmark \\ &= 4398,23 \text{ mm} \quad \checkmark \end{aligned}$$

(3)

11.3.2 **Main radius (AC):**

Triangles ABC and CED has the same shape:

$$AC : DC = BC : EC$$

$$\text{Thus } \frac{AC}{DC} = \frac{BC}{EC} \quad \checkmark$$

$$\text{From where } AC = \frac{BC \times DC}{EC} \quad \checkmark$$

$$\text{and } CE = \frac{\text{Base Dia} - 800}{2} \quad \checkmark$$

$$= \frac{1400 - 800}{2} \quad \checkmark$$

$$CE = 300 \text{ mm} \quad \checkmark$$

For : DC

$$DC^2 = DE^2 + CE^2 \quad \checkmark$$

$$DC = \sqrt{1200^2 + 300^2} \quad \checkmark$$

$$DC = 1236,93 \text{ mm} \quad \checkmark$$

$$\text{rounded} = 1237 \text{ mm}$$

$$AC = \frac{BC \times DC}{EC}$$

$$= \frac{700 \times 1237}{300} \quad \checkmark$$

$$= 2886,17 \text{ mm} \quad \checkmark$$

$$\text{rounded} = 2886 \text{ mm}$$

(10)

11.3.3 **Small radius (AD):**

$$AD = AC - DC \quad \checkmark$$

$$= 2886 - 1237 \quad \checkmark$$

$$AD = 1649 \text{ mm (1649,24 mm)} \quad \checkmark$$

(3)

**TOTAL QUESTION 11: [21]**

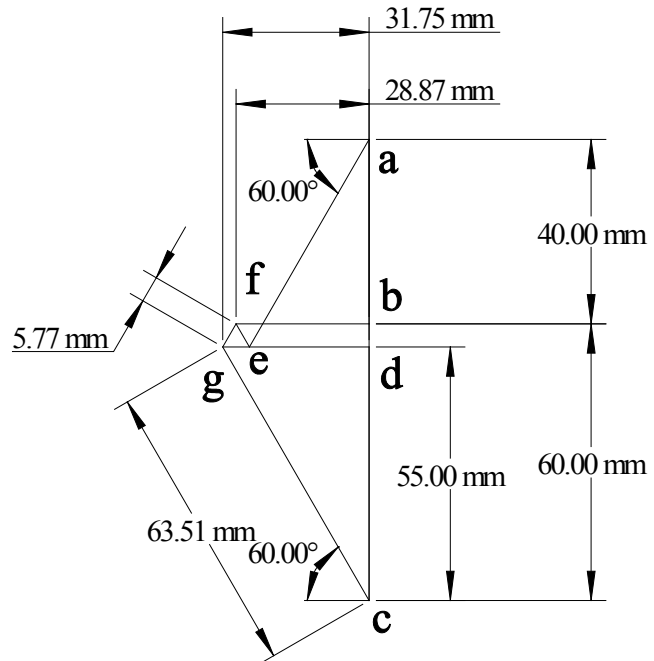
**GRAND TOTAL: 200**

**Annexure A**

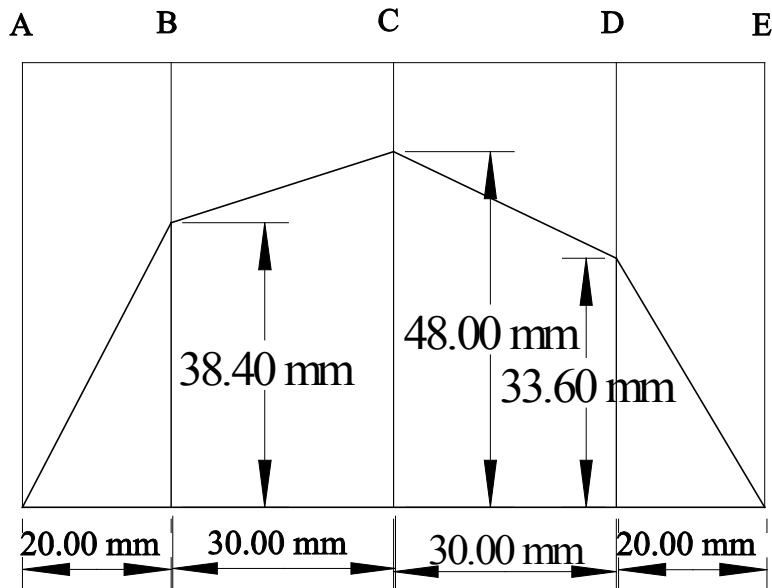
**Question 7.1**

The CM need to redraw to check the scale and to photocopy it to a transparency.

member	mm	N	nature	
AE	52			
BF	29			
CG	63			
FG	6			
ED	25			
EF	6			
GD	32			
AB	40			
BC	60			
CD	55			
AD	45			



**Question 7.2.3**

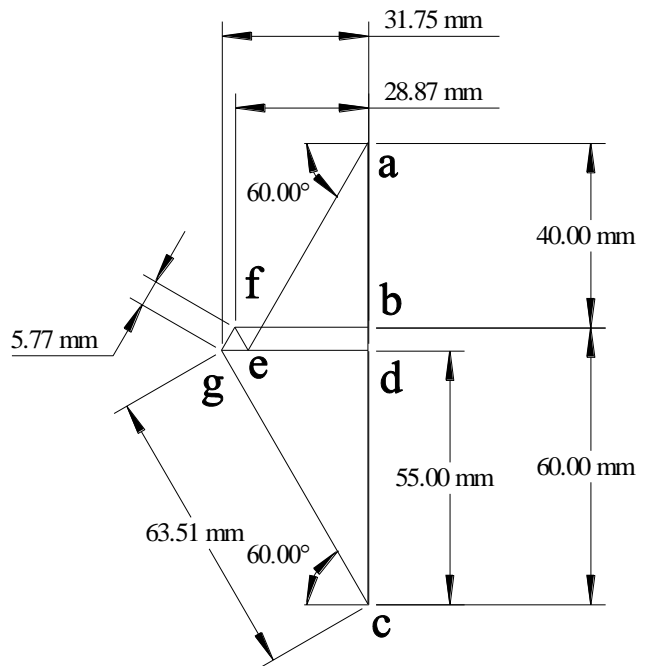


## Annexure A

### Question 7.1

The CM need to redraw to check the scale and to photocopy it to a transparency.

member	mm	N	nature	
AE	52			
BF	29			
CG	63			
FG	6			
ED	25			
EF	6			
GD	32			
AB	40			
BC	60			
CD	55			
AD	45			



### Question 7.2.3

