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basic education

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

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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]

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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)

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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. ✓

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(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_3) ✓
- 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]

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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)

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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:**

$$\text{Mean diameter} = \text{Outside diameter} - \text{plate thickness} \quad ✓$$
$$= 880 - 50 \quad ✓$$
$$= 830\text{mm} \quad ✓$$

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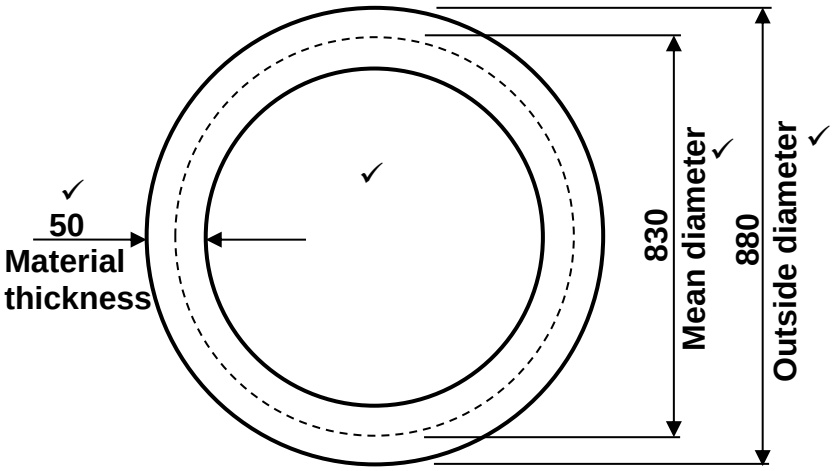
$$\text{Mean circumference} = \pi \times \text{Mean diameter} \quad ✓$$
$$= \pi \times 830 \quad ✓$$
$$= 2607{,}52\text{mm} \quad ✓$$

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

5.3.2



(4)

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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]

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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)

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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]

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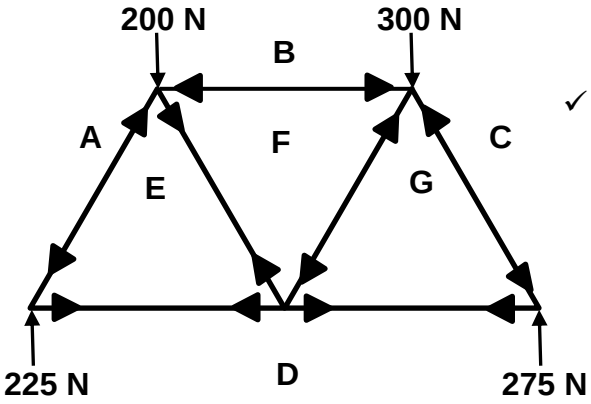
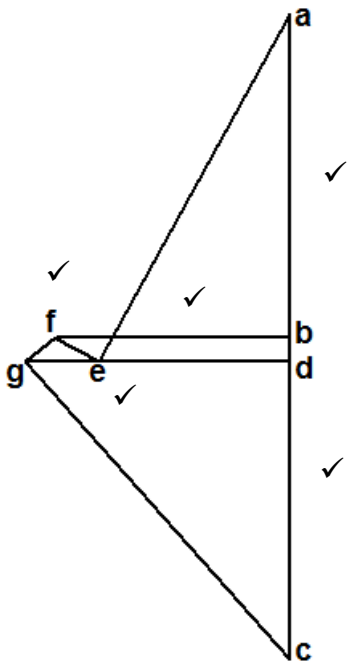
QUESTION 7: FORCES (SPECIFIC)

7.1 **Forces in members:**

SCALE: Vector diagram 1 mm = 5 N



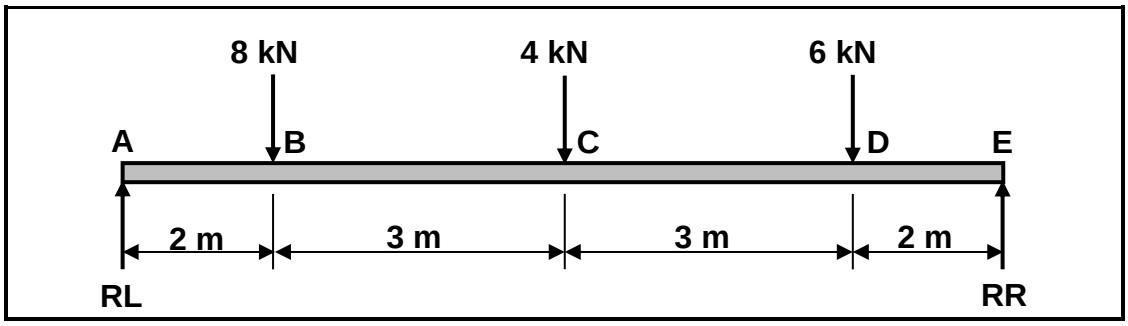


MEMBER	MAGNITUDE	NATURE
AE	260 N ✓	STRUT ✓
BF	135 N ✓	STRUT ✓
CG	317,5 N ✓	STRUT ✓
FG	27,5 N ✓	STRUT ✓
ED	130 N ✓	TIE ✓
EF	27,5 N ✓	TIE ✓
GD	160 N ✓	TIE ✓

(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

✓ ✓

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

$$RL = \frac{96}{10} \quad ✓$$

$$RL = 9{,}6\text{kN} \quad ✓$$

Moments about RL

✓ ✓

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

$$RR = \frac{84}{10} \quad ✓$$

$$RR = 8{,}4\text{kN} \quad ✓$$

(8)

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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 × 2 = 19,2 kN.m ✓

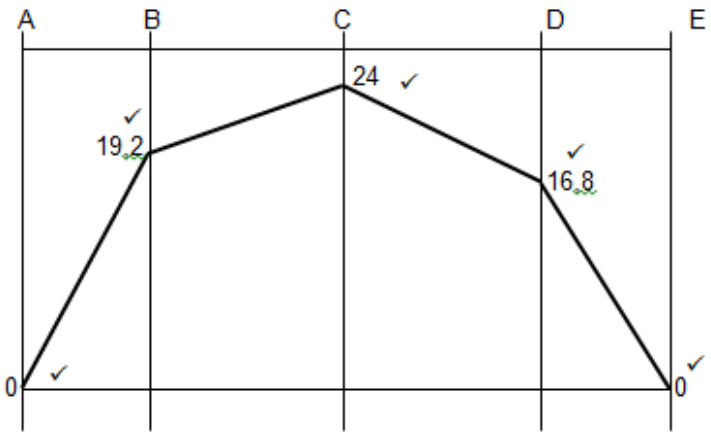
C = (RL × 5) − (8 × 3) = 24 kN.m ✓

D = (RL × 8) − (8 × 6) − (4 × 3) = 16,8 kN.m ✓

E = (RL × 10) − (8 × 8) − (4 × 5) − (6 × 2) = 0 kN.m ✓

(5)

7.2.3



(5)

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

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7.3 **Stress and strain:**

$$A = \frac{\pi d^2}{4} \quad \checkmark$$

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

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

$$\left.\begin{aligned} Stress &= \frac{Load}{Area} \\ Load &= Stress \times Area \end{aligned}\right\} \checkmark$$

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

$$Load = 25,133\,kN \quad \checkmark$$

(7)

TOTAL QUESTION 7: [45]

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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)

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8.3.3 **Incomplete penetration:**

- Welding current too low ✓
- Too fast travel speed ✓
- Incorrect electrode angle ✓
- Poor edge preperation ✓
- 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 occurs during a ultrasonic test ✓✓
- Detect internal ✓ flaws as well as surface flaws. ✓
- Porosity ✓✓
- Slag inclusions ✓✓
- Cracks ✓✓

(Any 1 x 2) (2)

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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]

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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 ✓

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(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 warrantees. ✓
- 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 ✓

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(Any 2 x 1) (2)

TOTAL QUESTION 10: [8]

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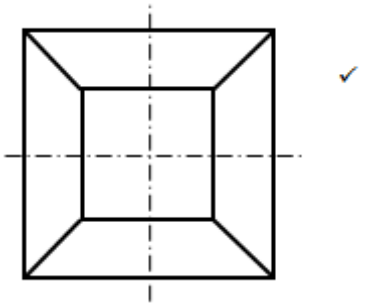
QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

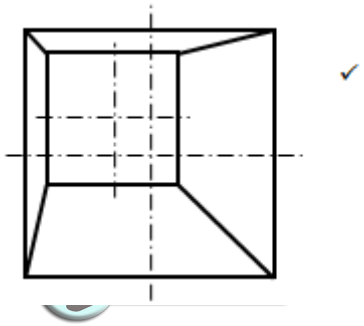
11.1 **Use of transformers:**
Transformers are used to connect ✓ ducting sections of dissimilar ✓ shapes to each other. ✓ (3)

11.2 **On-centre hopper:**



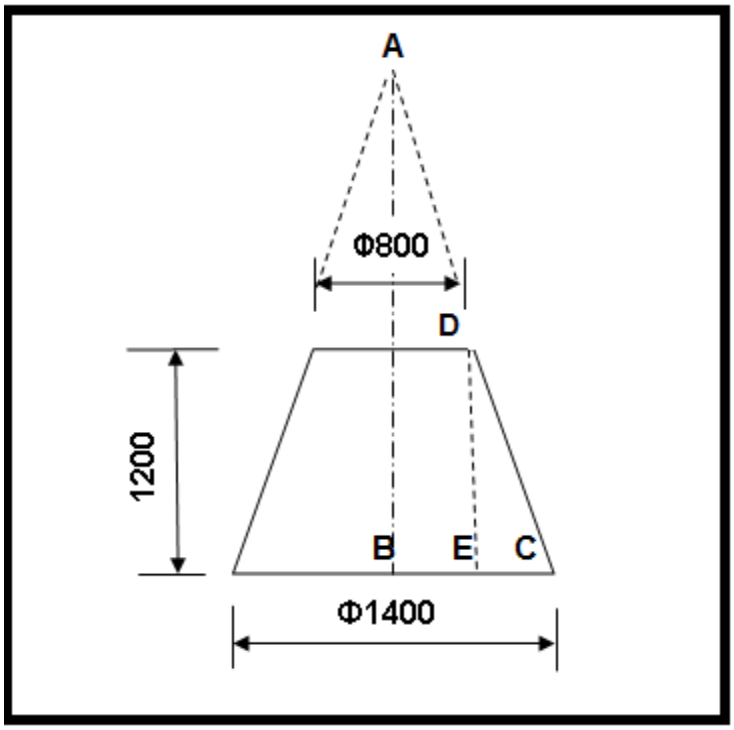
(1)

Off-centre hopper:



(1)

11.3 **Truncated cone:**



11.3.1 **Base circumference:**

$$\text{Circumference} = \pi \times \text{Base diameter} \quad ✓$$
$$= \pi \times 1400 \quad ✓$$
$$= 4398,23 \text{ mm} \quad ✓$$

(3)

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11.3.2 **Main radius (AC):**

Triangles ABC and CED has the same shape:

$$AC : DC = BC : EC$$

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

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

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

$$= \frac{1400 - 800}{2} \quad ✓$$

$$CE = 300\,mm \quad ✓$$

$$\text{For : } DC$$

$$DC^2 = DE^2 + CE^2 \quad ✓$$

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

$$DC = 1236{,}93mm \quad ✓$$

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

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

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

$$= 2886{,}17mm \quad ✓$$

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

(10)

11.3.3 **Small radius (AD):**

$$AD = AC - DC \quad ✓$$

$$= 2886 - 1237 \quad ✓$$

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

(3)

TOTAL QUESTION 11: [21]

GRAND TOTAL: 200

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