basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

2019

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 14 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 B ✓ (1)

1.2 B ✓ (1)

1.3 A ✓ (1)

1.4 A ✓ (1)

1.5 D ✓ (1)

1.6 B ✓ (1)

[6]

QUESTION 2: SAFETY (GENERIC)

2.1 **Angle grinder:**

- Do not use excessive force while grinding ✓
- Ensure that the sparks do not endanger co-workers ✓
- Keep hands clear from grinding disc ✓
- Maintain a firm grip on the angle grinder ✓

(Any 2 x 1) (2)

2.2 **Welding goggles:**

- To protect your eyes from the spatter ✓
- To protect your eyes from the harmful rays ✓
- To ensure proper vision of the process ✓

(Any 2 x 1) (2)

2.3 **PPE – Bench grinder:**

- Overall ✓
- Safety goggles ✓
- Safety shoes ✓

(Any 2 x 1) (2)

2.4 **Process and product workshop layout:**

- The product layout ensures that the machines are arranged in the sequence of the manufacturing process of a product. ✓
- The process layout is based on the type of manufacturing process needed in the making of the product. ✓ (2)

2.5 **Employer's responsibility – equipment:**

- They must provide and maintain equipment ✓
- Ensure that the equipment is safe to use by employees ✓
- Provide safe storage for equipment ✓
- Provide proper training of employees in the use of the equipment ✓
- Enforce safety measures ✓

(Any 2 x 1) (2)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 **Tests to distinguish between metals:**

- Bending test: ✓ hit with hammer✓
- Filing test ✓file material(colour and ease) ✓
- Machining test ✓ machine material (type of shaving, ease and colour) ✓
- Sound ✓ drop on floor(high or low frequency) ✓ (8)

3.2 **Heat-treatment:**

3.2.1 **Tempering:**
After hardening, the steel must be tempered

- To relieve ✓ the strains ✓ induced.
- To reduce ✓ brittleness. ✓

(Any 1 x 2) (2)

3.2.2 **Normalising:**

- To relieve ✓ the internal stresses ✓ produced by forging and machining. (2)

3.2.3 **Hardening:**

- To produce extremely hard steel ✓ to enable it to resist wear and tear ✓ or to use as cutting tools. (2)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

4.1 C ✓ (1)

4.2 D ✓ (1)

4.3 B ✓ (1)

4.4 C ✓ (1)

4.5 A ✓ (1)

4.6 D ✓ (1)

4.7 B ✓ (1)

4.8 A ✓ (1)

4.9 D ✓ (1)

4.10 D ✓ (1)

4.11 A ✓ (1)

4.12 A ✓ (1)

4.13 C ✓ (1)

4.14 B ✓ (1)

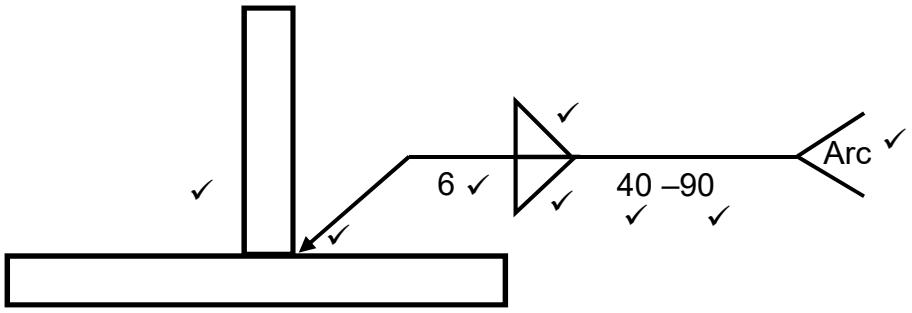
[14]

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 **Roof truss:**

A – Purlin ✓
B – Rafter ✓
C – Incline tie ✓
D – Tie beam ✓
E – Shoe plate/Gusset plate ✓ (5)

5.2 **Fillet weld on T-joint:**



(8)

5.3 **Dimensions of the material:**

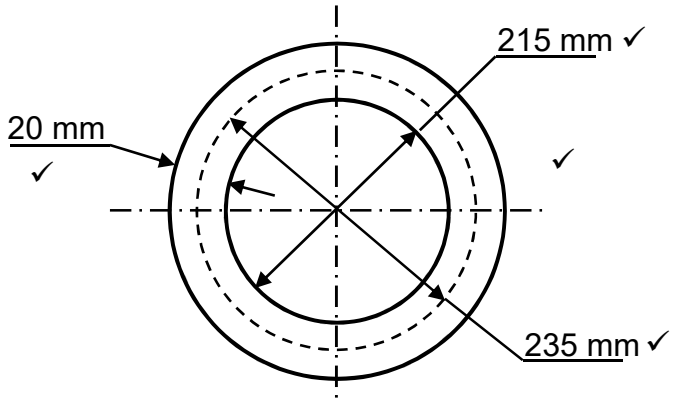
5.3.1

$$\text{Mean}\,\phi = \text{Inside}\,\phi + \text{Thickness} \quad ✓$$
$$= 215 + 20 \quad ✓$$
$$= 235 \text{ mm} \quad ✓$$

$$\text{Mean circumferance} = \pi \times \text{Mean}\,\phi \quad ✓$$
$$= \pi \times 235 \quad ✓$$
$$= 738{,}27 \text{ mm}$$

Round off to 740 mm ✓ (6)

5.3.2



(4)
[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 **Punch and shear machine:**

- A shear and punch machine is a heavy-duty machine for cutting steel profiles and punching holes into steel plates. ✓
- Croppers are electrically driven ✓ and make use of a heavy flywheel and clutches to engage various shearing blades to shear/punch different profiles. ✓
- Punches and corresponding dies need to be set to the desired size before punching ✓
- They do not require cooling fluid because the shearing action does not develop a great deal of heat ✓ (5)

6.2 **Plasma cutter:**

- The basic cutting process involves creating an electrical channel of ionised gas; that is plasma, ✓ from the plasma cutter itself through the work piece that is being cut. Thus forming a completed electric circuit back to the plasma cutter via a grounding clamp. ✓
- This is accomplished by compressed air that is blown toward the work piece through a focused nozzle at high speed. ✓
- A high frequency, electrical arc is then formed within the gas between an electrode near or integrated into the gas nozzle and the work piece itself. ✓ (4)

6.3 **Internal Thread cutting process:**

- Drill the required core diameter ✓
- Use the three taps in order – taper / intermediate / plug ✓
- Check thread with gauge/bolt when complete ✓ (3)

6.4 **Brinell hardness test:**

- The Brinell hardness tester makes an indentation into the test material with a 10 mm hardened steel or carbide ball.
- A load of 3000 kg is used for harder metals, while 1500 kg is used for softer metals. ✓
- The diameter of the indentation is measured with a microscope. ✓
- The diameter is then used in a formula to determine the Brinell reading. (4)

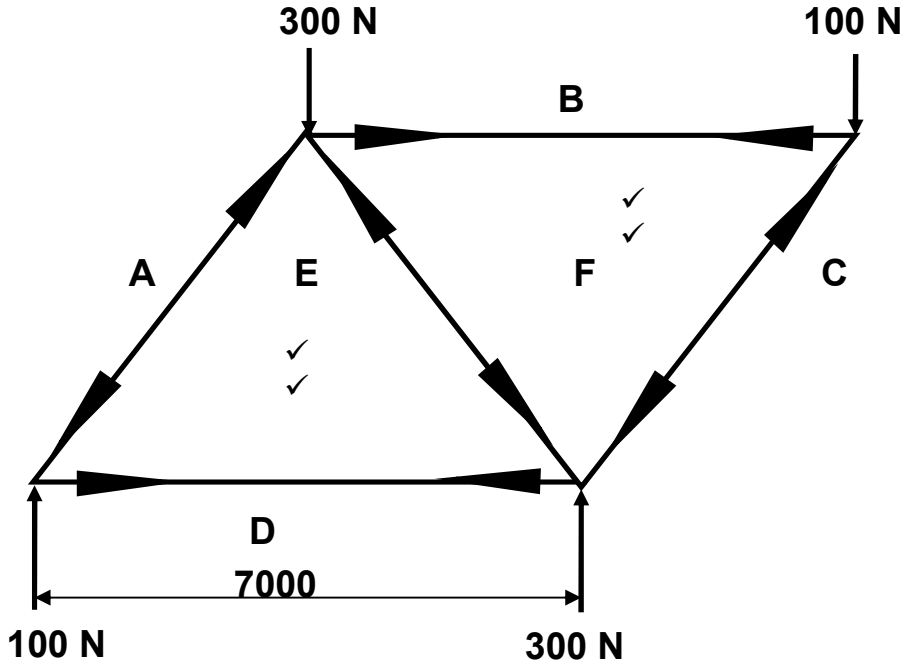
6.5 **Rockwell hardness testing over Brinell hardness testing:**

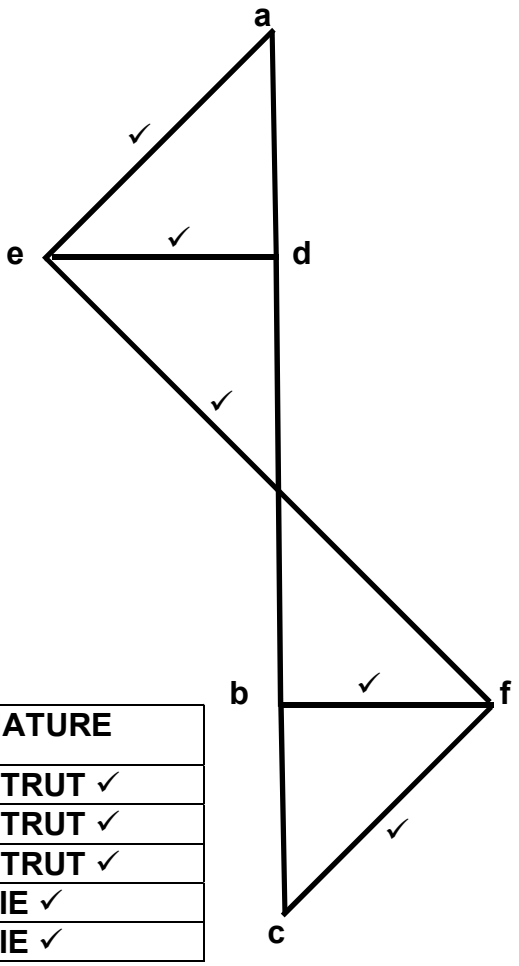
The advantages of the Rockwell Hardness method include the direct readout of the Rockwell Hardness number ✓ and rapid testing time ✓ (2)

[18]

QUESTION 7: FORCES (SPECIFIC)

7.1





MEMBER	FORCE (N)	NATURE
AE	140 N ✓	STRUT ✓
EF	285 N ✓	STRUT ✓
FC	140 N ✓	STRUT ✓
BF	100 N ✓	TIE ✓
ED	100 N ✓	TIE ✓

(19)

7.2 **Beams:**

7.2.1 **Reactions at the supports RL and RR:**

$R_L \times 12 = (3\times3)+(5\times6)+(4\times9)$ ✓

$R_L = 6{,}25\text{N}$ ✓

$R_R \times 12 = (4\times3)+(5\times6)+(3\times9)$ ✓

$R_R = 5{,}75\text{ N}$ ✓ (4)

7.2.2 **Bending moments:**

$BM_B = (6{,}25\times3)$ ✓

$= 18{,}75\text{ N.m}$ ✓

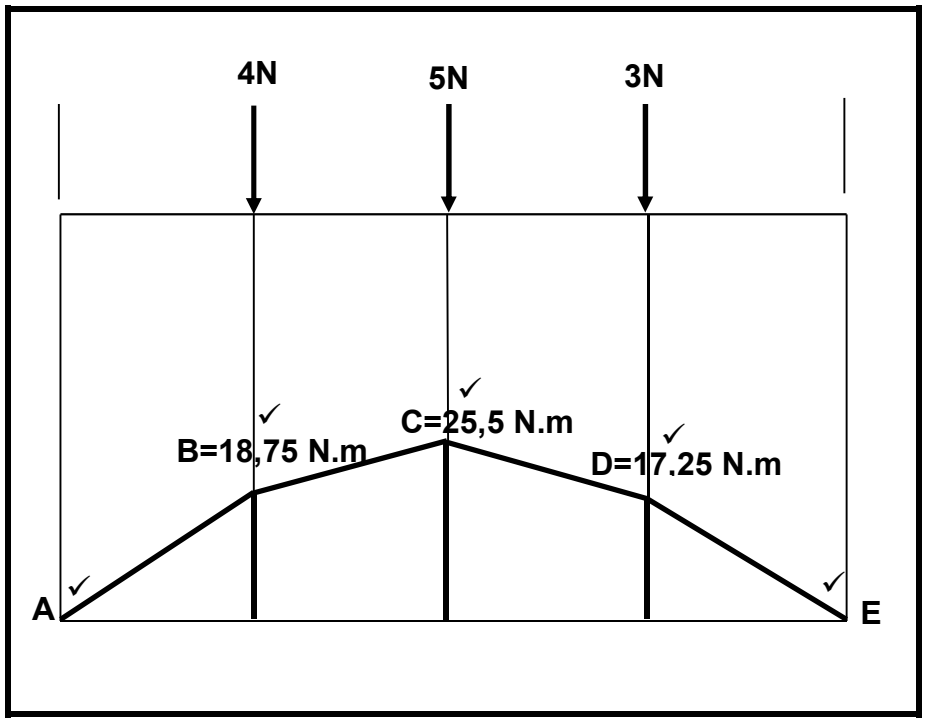
$BM_C = (6{,}25\times6)-(4\times3)$ ✓

$= 25{,}5\text{ N.m}$ ✓

$BM_D = (6{,}25\times9)-(4\times6)-(5\times3)$ ✓

$= 17{,}25\text{ N.m}$ ✓ (6)

7.2.3 **Bending moments diagram:**



(5)

SCALES: Space diagram: 10 mm = 1 m
Bending moment diagram: 5 mm = 1 N.m

7.3 Stress and Strain:

7.3.1 Stress in the shaft:

$$\text{Area} = \frac{\pi D^2}{4} \quad \checkmark$$

$$= \frac{\pi \times \left(32 \times 10^{-3}\right)^2}{4}$$

$$= 0{,}8 \times 10^{-3}\, m^2 \quad \checkmark$$

$$\sigma = \frac{\text{Load}}{\text{Area}} \quad \checkmark$$

$$= \frac{100 \times 10^3}{0{,}8 \times 10^{-3}} \quad \checkmark$$

$$= 125 \times 10^6 \text{ Pa} \quad \checkmark$$

$$= 125 \text{ MPa} \qquad (5)$$

7.3.2 Strain in the steel:

$$\varepsilon = \frac{\Delta L}{oL} \quad \checkmark$$

$$= \frac{0{,}5}{120} \quad \checkmark$$

$$= 4{,}17 \times 10^{-3} \quad \checkmark \qquad (3)$$

7.3.3 Young's modulus of elasticity:

$$E = \frac{\sigma}{\varepsilon} \quad \checkmark$$

$$= \frac{125 \times 10^6}{4{,}17 \times 10^{-3}} \quad \checkmark$$

$$= 29{,}98 \times 10^9 \text{ Pa} \quad \checkmark$$

$$= 29{,}98 \text{ GPa} \qquad (3)$$

[45]

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

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

- Correct flame for the work at hand ✓
- Correct angle of welding torch and rod ✓
- Depth of fusion ✓
- The welding rate ✓

(Any 2 x 1) (2)

8.2 **Welding defects:**

Incomplete penetration:

- Welding current too low ✓
- Welding speed too fast ✓
- Incorrect welding angle ✓
- Poor joint preparation ✓
- Insufficient root gap ✓

(Any 2 x 1) (2)

8.3 **Methods reducing of welding defects:**

8.3.1 **Slag inclusion:**

- Using well-maintained consumables ✓
- Ensure adequate shielding gas ✓
- Clean the joint properly ✓
- Slag must be removed before welding the next bead ✓

(Any 2 x 1) (2)

8.3.2 **Centreline cracks:**

- Aiming for a width-to-depth ratio of 1:1 ✓
- Decreasing the current to reduce excess penetration ✓
- Decreasing welding voltage ✓
- Slowing travel speed ✓

(Any 2 x 1) (2)

8.4 **Porosity:**
Porosity refers to cavity-type pores ✓ (bubbles or gas pockets) formed by gas ✓ during the solidification ✓ of molten weld metal. (3)

8.5 **Non-destructive test:**
The welded joint is not ✓ destroyed ✓ in the process of testing. (2)

8.6 **Ultrasonic test:**

- To detect internal flaws ✓
- To detect surface flaws ✓

(2)

8.7 **Visual inspection:**

- Shape of profile ✓
- Uniformity of surface ✓
- Overlap ✓
- Undercutting ✓
- Penetration bead ✓
- Root groove ✓

(Any 3 x 1) (3)

8.8 **Nick break test:**

- Make a hacksaw cut at both edges, through the centre of the weld. ✓
- Place specimen on two steel supports. ✓
- Use a sledge hammer to break the specimen in the area of the cuts. ✓
- Inspect the exposed weld metal in the break ✓ for incomplete fusion, slag inclusion etc. ✓ (5)

[23]

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

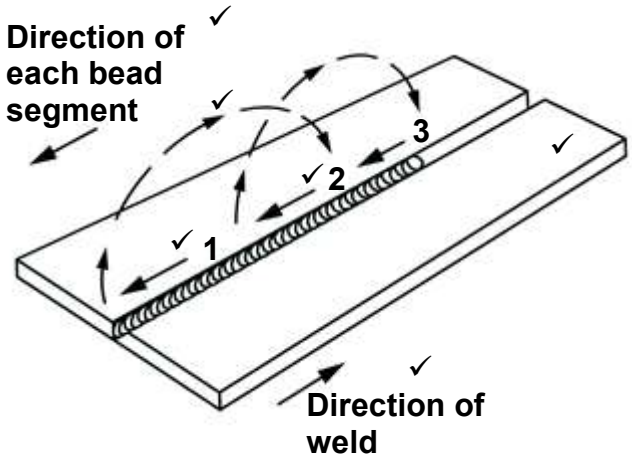
9.1 **Shrinkage in welding:**

Shrinkage is a form of plastic deformation ✓ where the metal has deformed as a result ✓ of contraction ✓ on cooling. ✓ (4)

9.2 **Factors affecting 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 that 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. ✓ (4)

9.3 **Back-step welding:**



(6)

9.4 **Factors affecting the temperature of cold worked steel for recrystallisation:**

- The prior amount of cold work ✓
- The temperature and time of annealing process ✓
- Composition of the metal. ✓
- The melting point ✓ (4)

[18]

QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 **Effect of overloading:**

10.1.1 **Power saw:**

- Driving motor will be damaged. ✓
- The cutting blade will be damaged. ✓
- The blade may deflect and result in a skew cut. ✓

(Any 1 x 1) (1)

10.1.2 **Bench grinder:**

- Result in malfunction due to excessive loads on the spindle bearings, grinding wheel and machine motor. ✓
- Overloading will wear the grinding wheel excessively and unevenly. ✓
- It shortens the life span of the spindle bearings and motor. ✓

(Any 1 x 1) (1)

10.2 **Effect of friction:**

10.2.1 **Drill bit of a pedestal drill:**

- Due to the heat caused by friction the cutting edge of the drill bit softens. ✓
- Lifespan of the drill bit will be reduced. ✓

(Any 1 x 1) (1)

10.2.2 **Rolling machine's bearings:**

- Journals and bearings will wear out. ✓ (1)

10.3 **A punch and a shearing machine:**

- Check the condition of the switch gear, wiring and isolation. ✓
- Ensure that the isolator is lockable. ✓
- Check the condition of the stop/start equipment. ✓
- Check the operation of emergency stop where fitted. ✓
- Check connections of electrical wiring. ✓

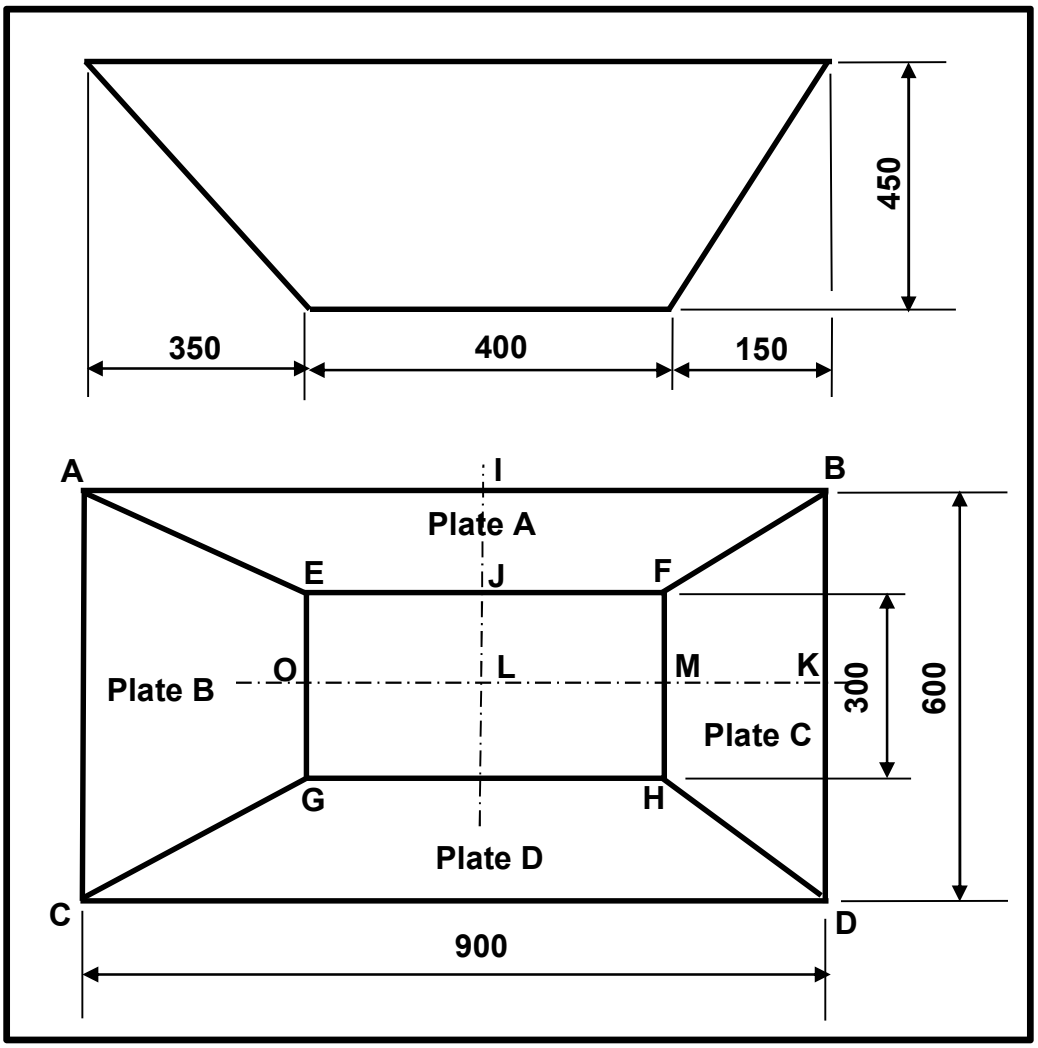
(Any 2 x 1) (2)

10.4 **Record keeping:**

- Monitoring of the machine's condition. ✓
- Monitoring of the maintenance costs on the machines. ✓
- Upholding the warranties and guarantees. ✓

(Any 2 x 1) (2)
[8]

QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)



11.1.1 **Length of IJ:**
Plates A and D.

$IJ = IL - JL$ ✓
$IJ = 300 - 150$ ✓
$IJ = 150\,mm$ ✓ (3)

11.1.2 **True length of A-E:**

$True\ Length\ A\text{-}E = \sqrt{IE^2 + AI^2 + VH^2}$ ✓✓
$A\text{-}E = \sqrt{150^2 + 350^2 + 450^2}$ ✓✓
$A\text{-}E = 589.49\,mm$ ✓
$= 590\ mm$ ✓ (6)

11.1.3 **Length of MK:**

$MK = LK - LM$ ✓
$MK = 350 - 200$
$MK = 150 \text{ mm}$ ✓

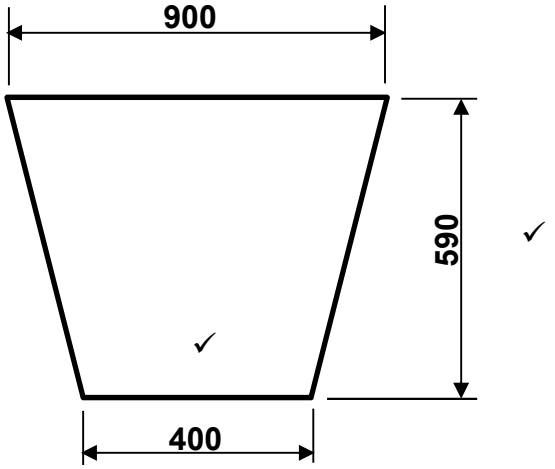
(2)

11.1.4 **The True length of D-H:**

$\text{True length } D\text{-}H = \sqrt{HK^2 + KD^2 + VH^2}$ ✓✓
$D - H = \sqrt{150^2 + 150^2 + 450^2}$ ✓✓
$D\text{-}H = 497.49 \text{ mm}$ ✓
$\text{SAY } 498 \text{ mm}$ ✓

(6)

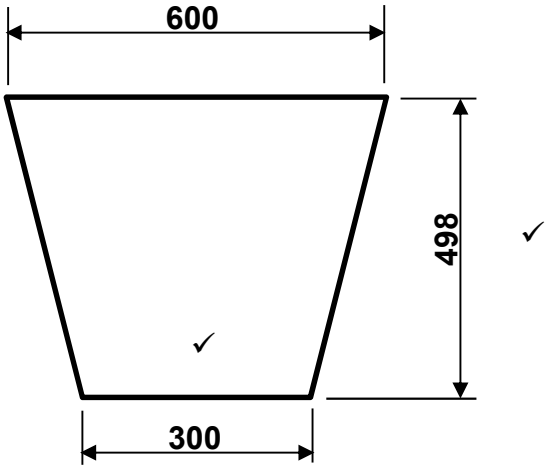
11.1.5 **Pattern for plates A:**



✓ ✓

(2)

11.1.6 **Pattern for Plate C:**



✓ ✓

(2)

[21]

TOTAL: 200