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 16 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. ✓
- Grinding disc fitted will not turn faster than the manufactures recommendation. ✓
- Make sure that there is no cracks or chips on the grinding disc
- Safety guard must be in place. ✓
- PPE must be worn. ✓
- Beware of lockable switches in the on position when the machine is plugged in and switched on. ✓
- Check for defective cables. ✓
- Secure work piece properly. ✓
- Grinding angle to be away from body to prevent sparks directly on clothing. ✓
- Make sure disc does not wobble during cutting. ✓

(Any 2 x 1) (2)

2.2 **Welding goggles:**

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

(Any 2 x 1) (2)

2.3 **PPE – Bench grinder:**

- Overall ✓
- Safety goggles / face shield ✓
- Safety shoes ✓
- Safety gloves ✓

(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/ OHS acts and Regulations. ✓
- Employer must provide proper personal protective equipment (PPE) for the specific machines. ✓

(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) ✓
- Spark test. ✓ Shape and colour of sparks. ✓

(Any 4 x 2) (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. ✓✓ (2)

3.2.3 **Hardening:**

- To produce extremely hard steel. ✓✓
- To enable it to resist wear and tear. ✓✓

(Any 1 x 2) (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)

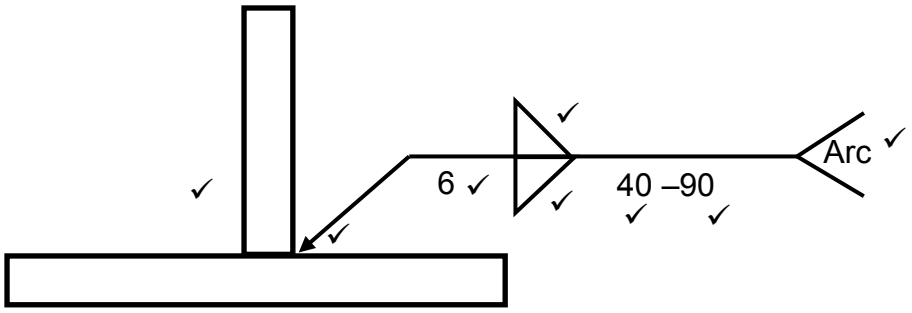
[14]

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:**

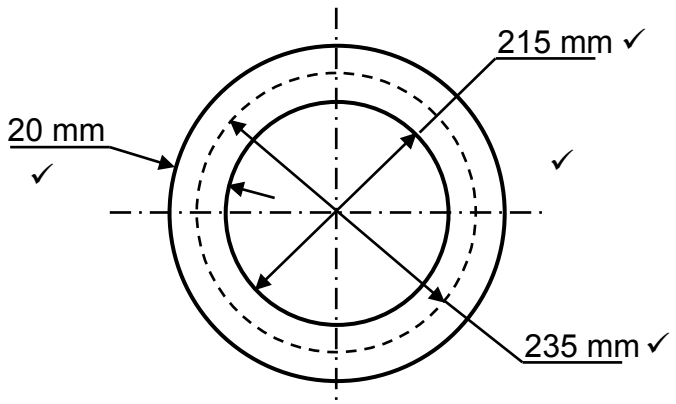
5.3.1

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

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

Round off to 740 mm ✓ (6)

5.3.2



(4)
[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 **Punch and shear machine:**

- Croppers are activated by hand or by foot. ✓
- A shear and punch machine is a heavy-duty machine for cutting steel profiles and punching holes into steel plates. ✓
- Croppers are electrically / hydraulically driven engaging 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 / root / inside diameter. ✓
- Use the three taps in order. ✓
- Check thread with gauge / bolt when complete. ✓ (3)

6.4 **Brinell hardness test:**

- The Brinell hardness tester makes use of a steel ball as indenter. ✓
- A load is applied to the test piece. ✓
- The diameter of the indentation is measured with a microscope. ✓
- The diameter is used to determine the Brinell reading. ✓ (4)

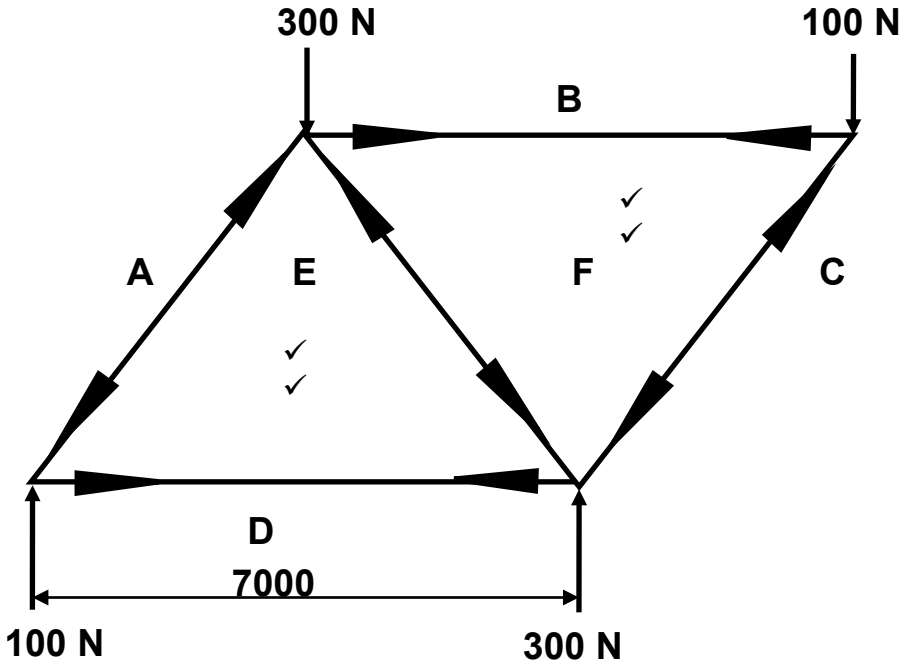
6.5 **Rockwell hardness testing over Brinell hardness testing:**

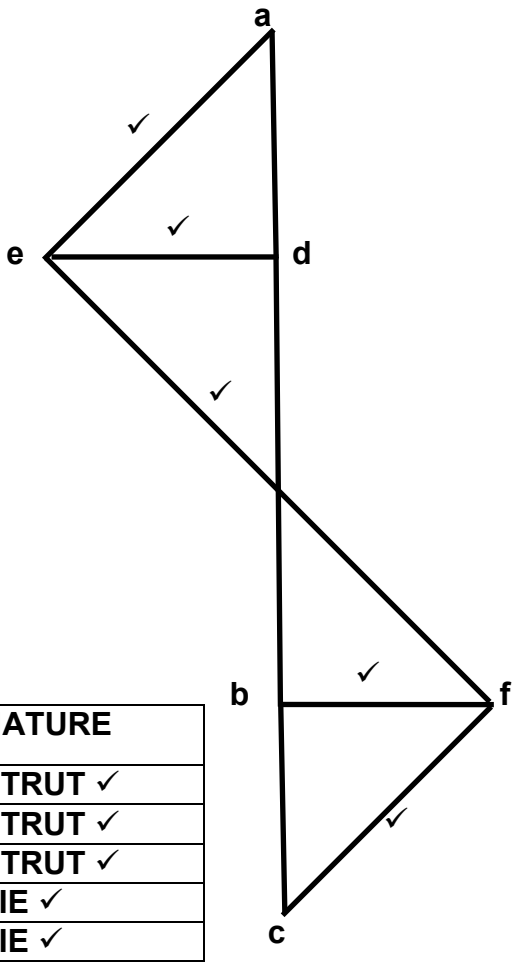
- The advantages of the Rockwell Hardness method include the direct readout of the Rockwell Hardness number. ✓✓
- Rapid testing time. ✓✓

(Any 1 x 2) (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 ✓

NOTE: (Tolerance: ±2 mm) (2 mm = 10 N) (19)

7.2 **Beams:**

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

$R_L \times 12 = (3\times 3)+(5\times 6)+(4\times 9)$ ✓

$R_L = 6{,}25\text{N}$ ✓

$R_R \times 12 = (4\times 3)+(5\times 6)+(3\times 9)$ ✓

$R_R = 5{,}75\text{ N}$ ✓ (4)

7.2.2 **Bending moments:**

$BM_B = (6{,}25\times 3)$ ✓

$= 18{,}75\text{ N.m}$ ✓

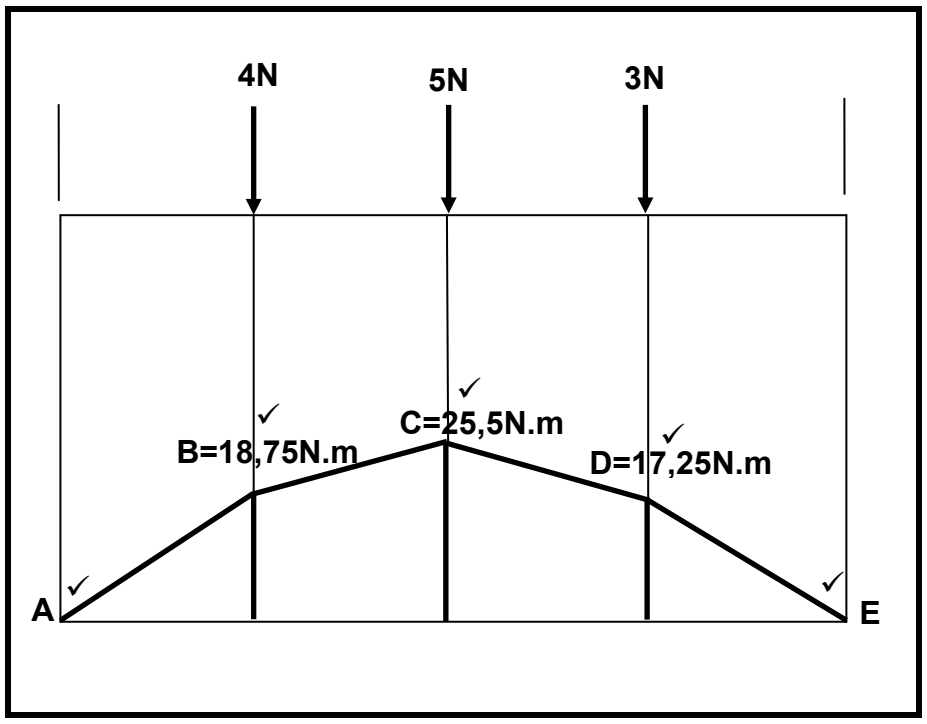
$BM_C = (6{,}25\times 6)-(4\times 3)$ ✓

$= 25{,}5\text{ N.m}$ ✓

$BM_D = (6{,}25\times 9)-(4\times 6)-(5\times 3)$ ✓

$= 17{,}25\text{ N.m}$ ✓ (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:**

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

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

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

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

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

$$= 125 \times 10^6\,\text{Pa} \quad \text{or} \quad 125\,\text{MPa} \quad \checkmark$$ (5)

7.3.2 **Strain in the steel:**

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

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

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

7.3.3 **Young's modulus of elasticity:**

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

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

$$= 29{,}98 \times 10^9\,\text{Pa} \quad \text{or} \quad 29{,}98\,\text{GPa} \quad \checkmark$$ (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. ✓
- Wrong polarity. ✓
- Arc length too short. ✓
- Wrong electrode used. ✓

(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. ✓
- Too slow welding movements. ✓
- Electrode too big. ✓
- Wrong or too big weaving action. ✓

(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 / current. ✓
- Slowing travel speed. ✓
- Reduce high carbon content in weld. ✓
- Welding while joint is under stress due to joint design, use clamping devices. ✓

(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)

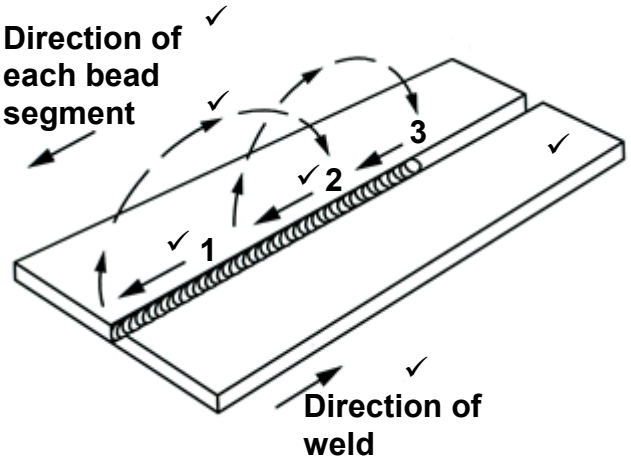
9.1 **Shrinkage in welding:**

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 re-crystallisation:**

- 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. ✓
- Excessive strain on the driving system. ✓
- 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 / blunt. ✓
- Lifespan of the drill bit will be reduced. ✓

(Any 1 x 1) (1)

10.2.2 **Rolling machine's bearings:**

- Journals and bearings will prematurely 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. ✓

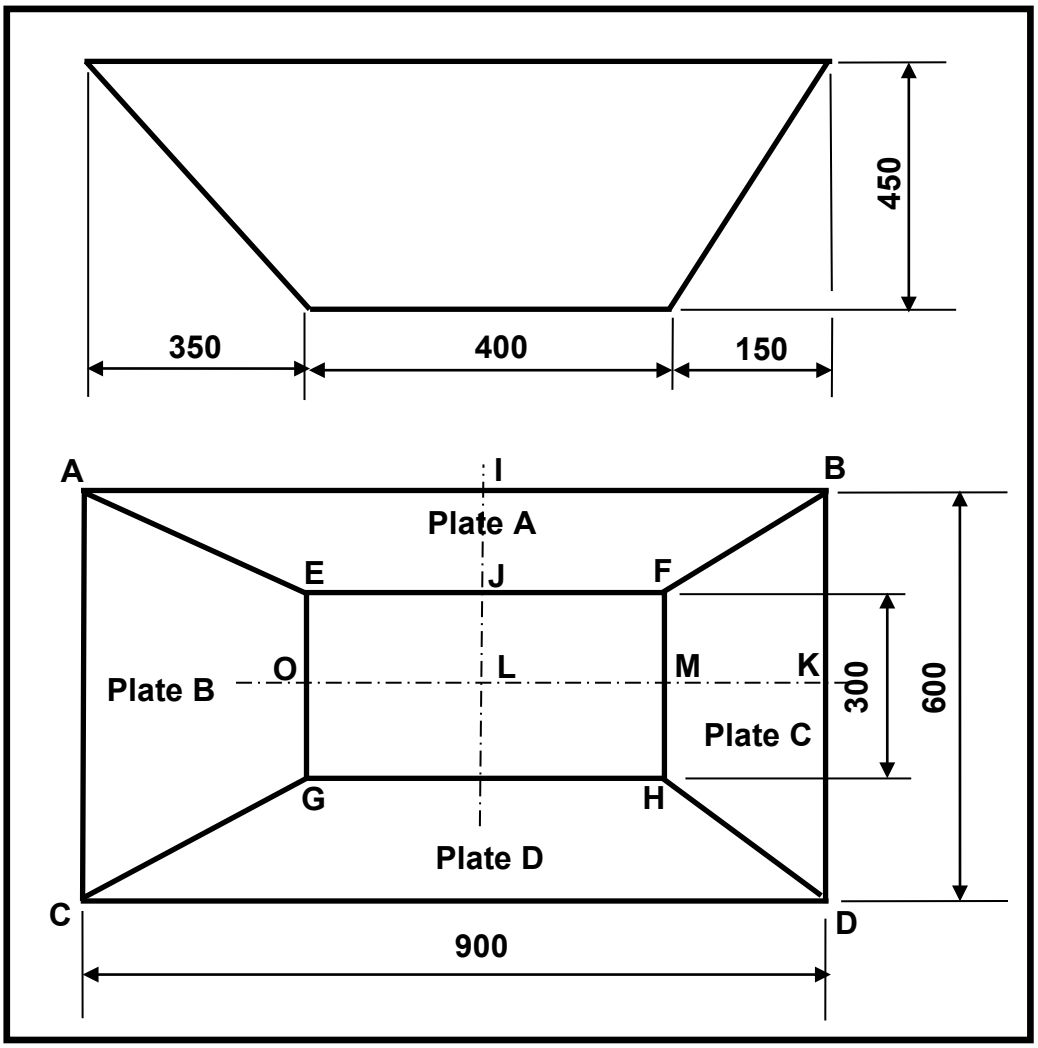
(Any 2 x 1) (2)

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 AE:**

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

11.1.3 **Length of MK:**

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

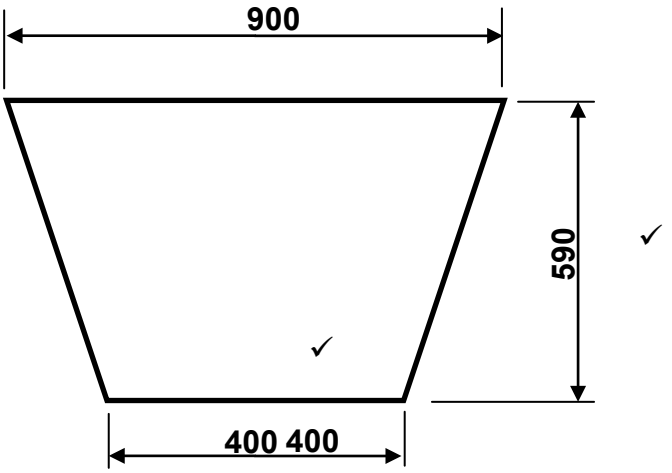
(2)

11.1.4 **The True length of DH:**

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

(6)

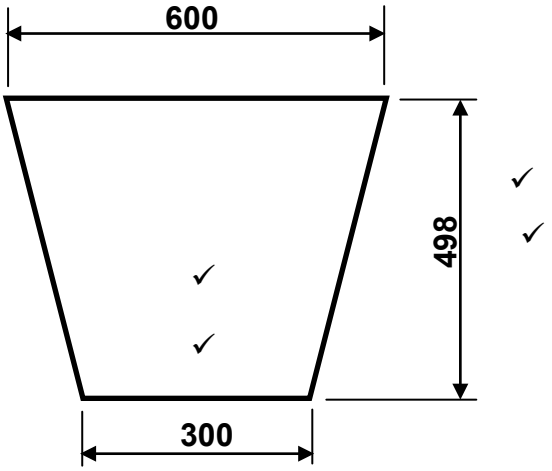
11.1.5 **Pattern for plates A:**



✓ ✓

(2)

11.1.6 **Pattern for Plate C:**



✓ ✓ ✓ ✓

(2)

[21]

TOTAL: 200