

# Soek jy 'n fantastiese tutor?

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# 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)        |
|     |     | <b>[6]</b> |

**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]

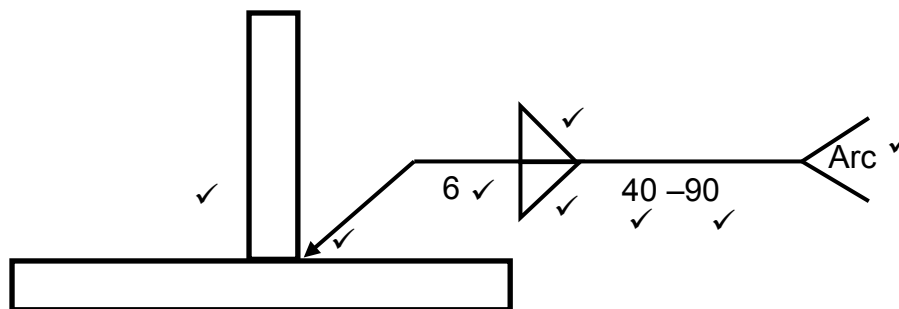
**QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)**

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)
		<b>[14]</b>

**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)

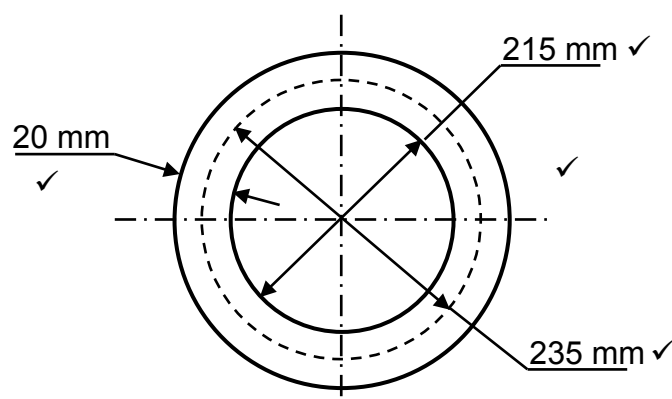
**5.3 Dimensions of the material:**

$$\begin{aligned}
 5.3.1 \quad \text{Mean } \phi &= \text{Inside } \phi + \text{Thickness} \quad \checkmark \\
 &= 215 + 20 \quad \checkmark \\
 &= 235 \text{ mm} \quad \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \text{Meancircumference} &= \pi \times \text{Mean } \phi \\
 &= \pi \times 235 \quad \checkmark \\
 &= 738,27 \text{ mm} \quad \checkmark
 \end{aligned}$$

$$\text{Round off to } 740 \text{ mm} \quad \checkmark$$

(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)

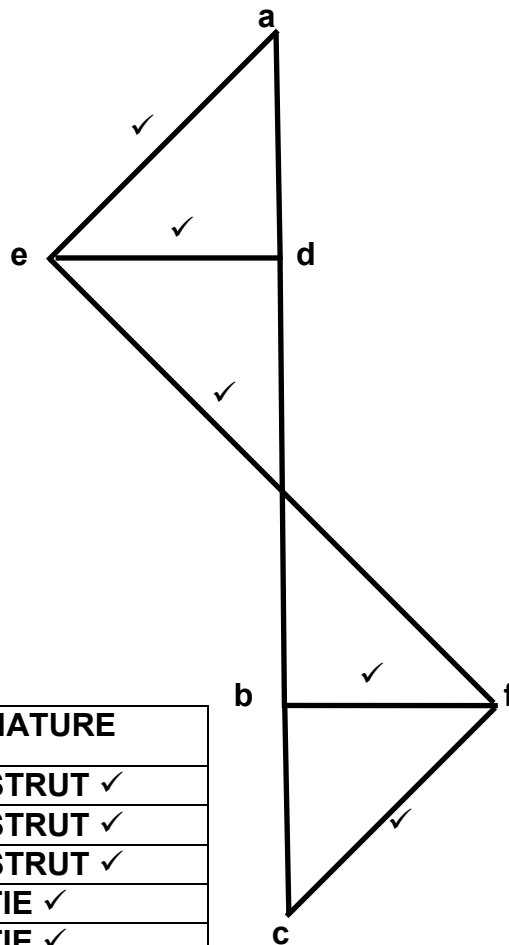
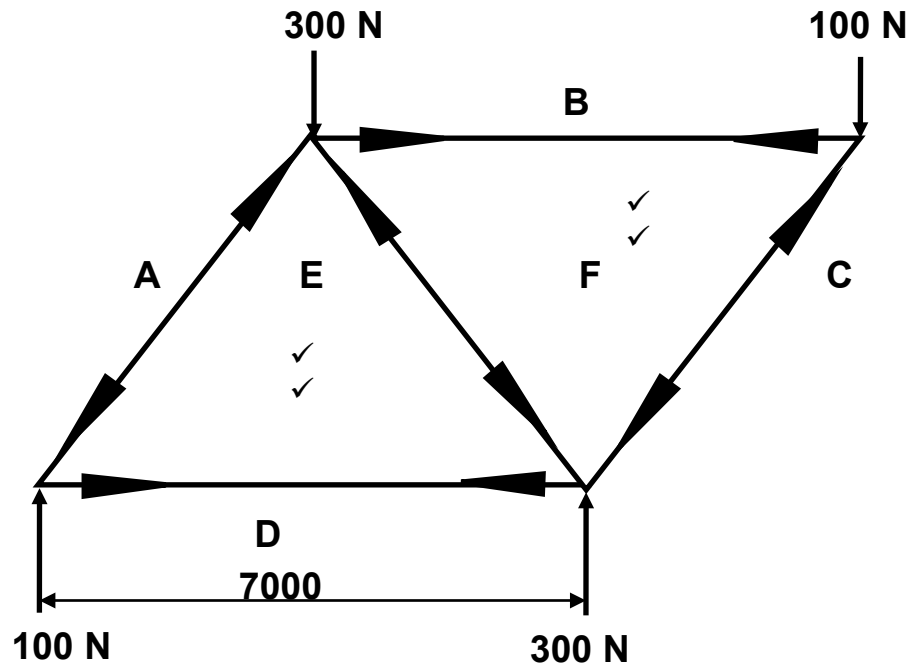
(2)

[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:  $\pm 2$  mm) (2 mm = 10 N)

(19)

## 7.2 Beams:

## 7.2.1 Reactions at the supports RL and RR:

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

$$R_L = 6,25\text{N} \quad \checkmark$$

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

$$R_R = 5,75\text{ N} \quad \checkmark$$

(4)

## 7.2.2 Bending moments:

$$BM_B = (6,25 \times 3) \quad \checkmark$$

$$= 18,75\text{ N.m} \quad \checkmark$$

$$BM_C = (6,25 \times 6) - (4 \times 3) \quad \checkmark$$

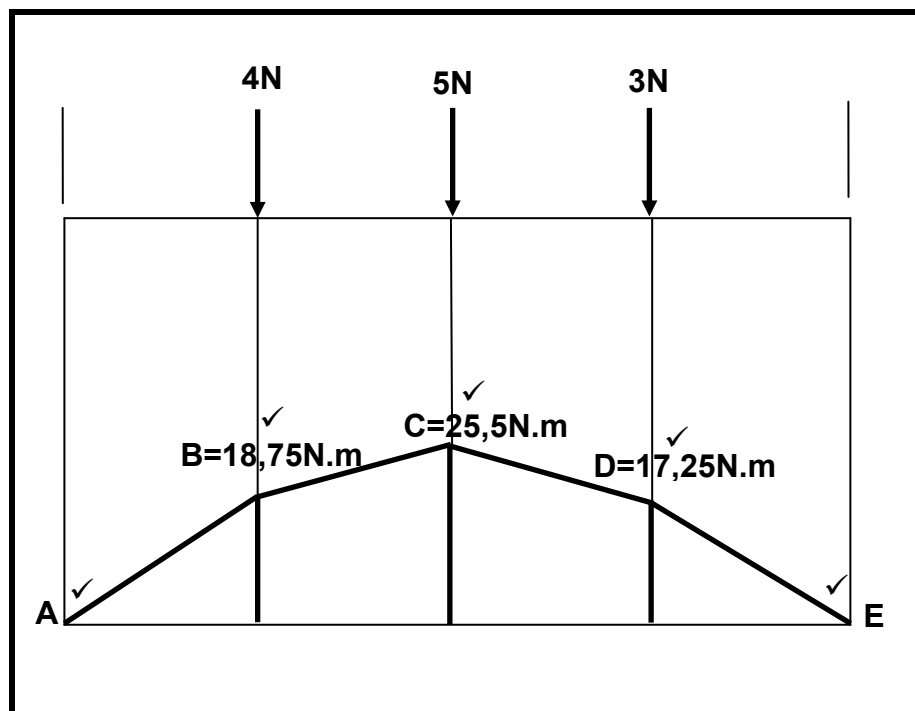
$$= 25,5\text{ N.m} \quad \checkmark$$

$$BM_D = (6,25 \times 9) - (4 \times 6) - (5 \times 3) \quad \checkmark$$

$$= 17,25\text{ N.m} \quad \checkmark$$

(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:**

$$\begin{aligned}
 \text{Area} &= \frac{\pi D^2}{4} \\
 &= \frac{\pi \times (32 \times 10^{-3})^2}{4} \quad \checkmark \\
 &= 0,8 \times 10^{-3} \text{ m}^2 \quad \checkmark \\
 \sigma &= \frac{\text{Load}}{\text{Area}} \\
 &= \frac{100 \times 10^3}{0,8 \times 10^{-3}} \quad \checkmark \\
 &= 125 \times 10^6 \text{ Pa} \quad \text{or} \quad 125 \text{ MPa} \quad \checkmark \quad (5)
 \end{aligned}$$

**7.3.2 Strain in the steel:**

$$\begin{aligned}
 \epsilon &= \frac{\Delta L}{oL} \\
 &= \frac{0,5}{120} \quad \checkmark \\
 &= 4,17 \times 10^{-3} \quad \checkmark \quad (3)
 \end{aligned}$$

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

$$\begin{aligned}
 E &= \frac{\sigma}{\epsilon} \\
 &= \frac{125 \times 10^6}{4,17 \times 10^{-3}} \quad \checkmark \\
 &= 29,98 \times 10^9 \text{ Pa} \quad \text{or} \quad 29,98 \text{ GPa} \quad \checkmark \quad (3) \\
 &\quad [45]
 \end{aligned}$$

**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:**

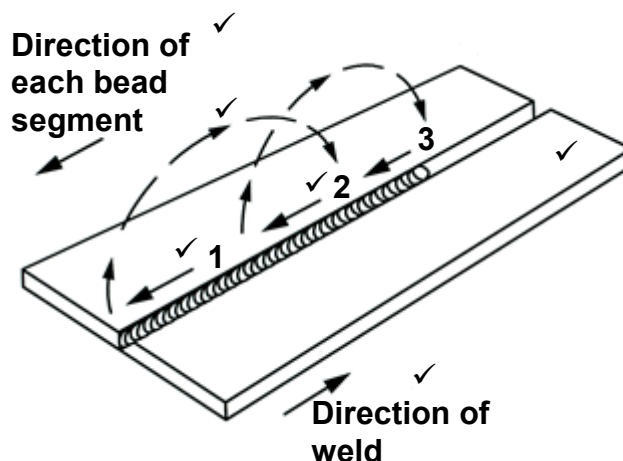
Shrinkage is a form of plastic deformation ✓ where the metal has deformed as a result ✓ of contraction ✓ on cooling. ✓

(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]**





**11.1.3 Length of MK:**

$$MK = LK - LM$$

$$MK = 350 - 200 \quad \checkmark$$

$$MK = 150 \text{ mm} \quad \checkmark$$

(2)

**11.1.4 The True length of DH:**

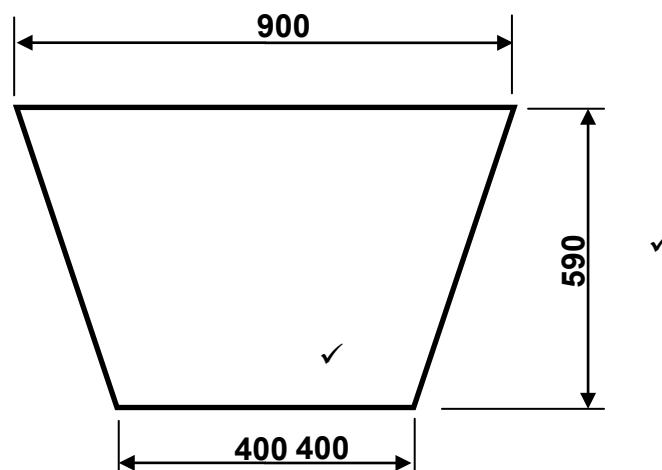
$$\text{True length DH} = \sqrt{HK^2 + KD^2 + VH^2} \quad \checkmark \checkmark$$

$$DH = \sqrt{150^2 + 150^2 + 450^2} \quad \checkmark \checkmark$$

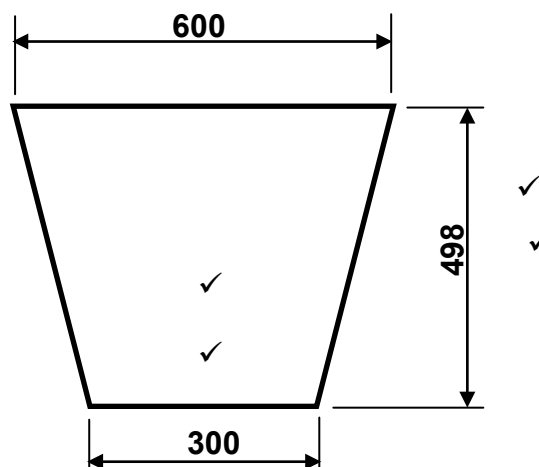
$$DH = 497.49 \text{ mm} \quad \checkmark$$

$$\text{SAY } 498 \text{ mm} \quad \checkmark$$

(6)

**11.1.5 Pattern for plates A:**

(2)

**11.1.6 Pattern for Plate C:**

(2)

[21]

**TOTAL: 200**