



Province of the  
**EASTERN CAPE**  
EDUCATION

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# **NATIONAL SENIOR CERTIFICATE**

**GRADE 12**

**SEPTEMBER 2024**

## **MECHANICAL TECHNOLOGY: WELDING AND METALWORK MARKING GUIDELINE**

**MARKS: 200**

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This marking guideline consists of 14 pages.

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

- 1.1 B ✓ (1)
- 1.2 A ✓ (1)
- 1.3 C ✓ (1)
- 1.4 C ✓ (1)
- 1.5 A ✓ (1)
- 1.6 D ✓ (1)
- [6]**

**QUESTION 2: SAFETY (GENERIC)****2.1 Gas cylinder safety precautions:**

- Always store and use gas cylinders in an upright position. ✓
- Never stack cylinders on top of one another. ✓
- Do not bang or work on the cylinders. ✓
- Never allow cylinders to fall. ✓
- No oil and grease should come into contact with gas cylinders or fittings. ✓
- Keep the caps on the cylinders for protection. ✓ (Any 2 x 1) (2)

**2.2 Employers' responsibility regarding safety:**

- Provide and maintain working systems, work area, equipment and tools in a safe condition. ✓
- Eliminate or reduce any hazard or potential hazard. ✓
- Produce, handle, store and transport goods safely. ✓
- Ensure that every person employed complies with the requirements of this Act. ✓
- Enforce measures, if necessary, in the interest of health and safety. ✓
- Appoint a person who is trained and who have the authority to ensure that employee take precautionary measures. ✓ (Any 2 x 1) (2)

**2.3 Safety precautions before switching on the angle grinder:**

- Make sure that there are no cracks or chips on the disc. ✓
- Make sure that there are no flammable materials nearby. ✓
- Ensure that guards are in place. ✓
- Wear the appropriate PPE especially eye protection. ✓ (Any 2 x 1) (2)

**2.4 Welding goggles:**

- To protect your eyes against sparks. ✓
- To protect your eyes against heat. ✓
- To see where to weld. ✓ (Any 2 x 1) (2)

**2.5 Disadvantages of process layout:**

- Production is not always continuous. ✓
- Transportation costs between process departments may be high. ✓
- Additional time is spent in testing and sorting as the product moves to the different departments. ✓
- Damage to fragile goods may result from extra handling. ✓ (Any 2 x 1) (2)

**[10]**

**QUESTION 3: MATERIALS (GENERIC)****3.1 Reason to cut from the unmarked end:**

- Marking does not get lost ✓
- Be able to identify the material ✓

(Any 1 x 1) (1)

**3.2 Heat-treatment processes properties:**

	PROCESS	PROPERTY
3.2.1	Hardening	Very hard, high tensile strength and brittle ✓
3.2.2	Tempering	Tough, hard ✓
3.2.3	Annealing	Soft, ductile, low tensile strength ✓
3.2.4	Normalising	Tough and machinable ✓

(4)

**3.3 Heat-treatment process steps:**

- Heat the metal slowly to a temperature below the critical temperature. ✓
- Soak it at that temperature for a period. ✓
- Quench / cool in an appropriate quenching medium. ✓

(3)

**3.4 Quenching media:**

- Water ✓
- Brine ✓
- Oil ✓

(3)

**3.5 Types of tests:**

3.5.1 Filing test ✓

(1)

3.5.2 Spark test ✓

(1)

3.5.3 Bending test ✓

(1)

**[14]**

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

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

**[14]**

**QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)****5.1 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 3 x 1) (3)

**5.2 5.2.1 OSU ✓**

(1)

**5.2.2 Galvanised ✓**

(1)

**5.2.3 This side up ✓**

(1)

**5.3 Dimensions of the required material:**

5.3.1 Mean diameter = Outside diameter – plate thickness  
= 600 – 20 ✓  
= 580 mm ✓

(2)

5.3.2 Mean circumference =  $\pi$  x mean diameter ✓  
=  $\pi$  x 580 ✓  
= 1 822,13 mm  
= 1 822 mm ✓

(3)

**5.4 Welding elements:**

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

(6)

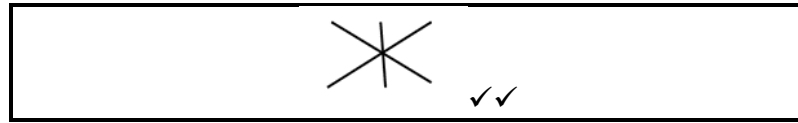
**5.5 Template loft machine tools:**

- Circular saw ✓
- Planer ✓
- Drilling machine ✓
- Jig saw ✓
- Sanding machine ✓
- Shears for cutting cardboard ✓
- Welding machine ✓
- Angle grinder ✓
- Bench grinder ✓
- Guillotine ✓
- Cut-off power saw ✓

(Any 2 x 1) (2)

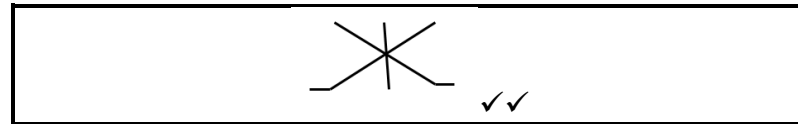
## 5.6 Resistance welding symbols:

### 5.6.1 Spot weld symbol:



(2)

### 5.6.2 Projection weld symbol:



(2)

**[23]**

## QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

### 6.1 Workshop machines and their functions:

#### 6.1.1 Pedestal drill press ✓

##### **Function:**

- Used to drill a wide variety of materials including ferrous and non-ferrous metals and composite plastics. ✓

(2)

#### 6.1.2 Hydraulic press ✓

##### **Function:**

- To install or remove components, such as bearings or bushes, in mechanical devices. ✓

(2)

#### 6.1.3 Bench grinder ✓

##### **Function:**

- Used for grinding, sharpening tools and removing excess material. ✓

(2)

### 6.2 Gas welding equipment:

#### 6.2.1 Regulator ✓

(1)

#### 6.2.2 A – Gauge ✓

##### B – Outlet ✓

##### C – Inlet ✓

##### D – Pressure adjusting knob ✓

(4)

### 6.3 Operating principle of a power-driven guillotine:

#### **Power driven guillotine:**

- A bottom cutting blade is fixed horizontally. ✓
- A top cutting blade moves downwards. ✓
- It is driven by an electric motor activated by a foot pedal. ✓
- It is driven by a flywheel, gearbox, and axle. ✓
- It lowers the blade by eccentric motion or action. ✓

(4)

### 6.4 Manual guillotine labels:

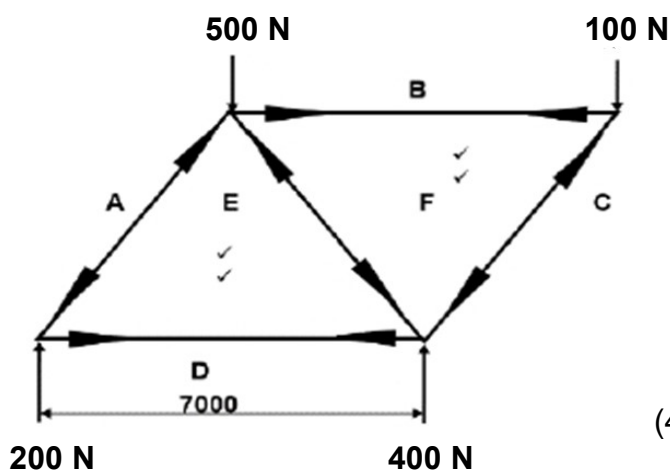
#### A – Spring-loaded down pedal/foot pedal ✓

#### B – Cutting table ✓

#### C – Pressure plate/Blade guard ✓

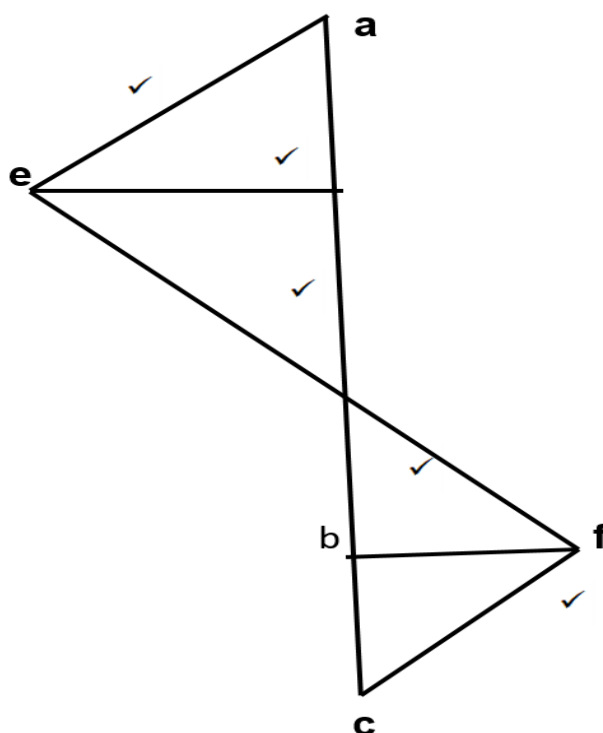
(3)

**[18]**

**QUESTION 7: FORCES (SPECIFIC)****7.1 Space diagram:****Scale 1 : 100**

(4 marks)

**Force diagram (NOTE: Diagram is NOT according to scale; markers must redraw the diagram.)**

**Scale: 1 mm = 5N**

(5 marks)

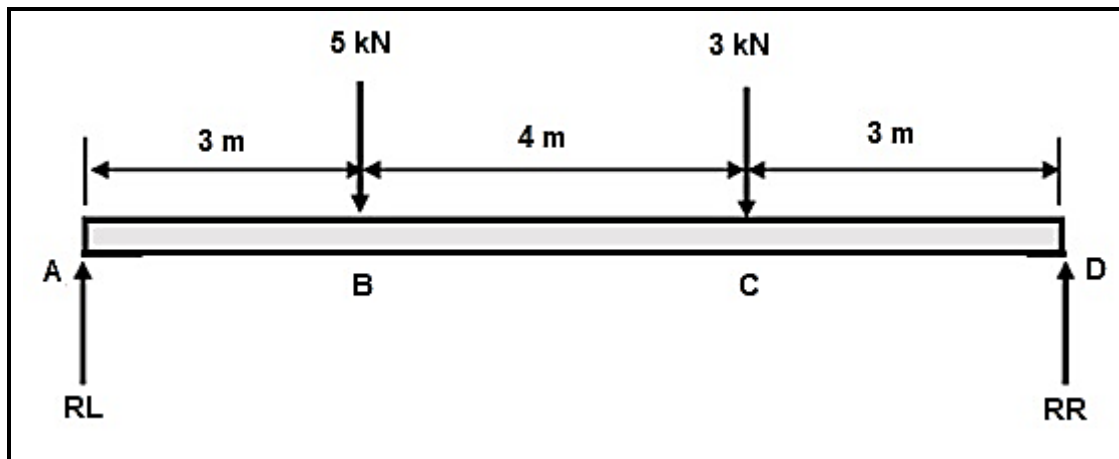
MEMBER	FORCE(N)	NATURE
AE	275 N ✓	STRUT ✓
EF	425 N ✓	STRUT ✓
FC	300 N ✓	STRUT ✓
BF	200 N ✓	TIE ✓
ED	200 N ✓	TIE ✓

(10 marks)

**NOTE: (Tolerance:  $\pm 2$  mm) (2 mm = 10 N)**

(19)

## 7.2 Calculating reaction forces:



### 7.2.1 Take moments about RL:

$$(5 \times 3) + (3 \times 7) = RR \times 10 \quad \checkmark$$

$$15 + 21 = 10 RR$$

$$36 = 10 RR \quad \checkmark$$

$$\frac{36}{10} = RR$$

$$3,6 \text{ KN} = RR \quad \checkmark$$

### Take moments about RR:

$$(3 \times 3) + (5 \times 7) = 10 \times RL \quad \checkmark$$

$$9 + 35 = 10 RL$$

$$44 = 10 RL \quad \checkmark$$

$$\frac{44}{10} = RL$$

$$4,4 \text{ KN} = RL \quad \checkmark$$

(6)

### 7.2.2 Calculating Bending Moments:

$$BM_A = (4,4 \times 0) = 0 \text{ KN.m} \quad \checkmark$$

$$BM_B = (4,4 \times 3) = 13,2 \text{ KN.m} \quad \checkmark$$

$$BM_C = (4,4 \times 7) - (5 \times 4) - (3 \times 0)$$

$$= 30,8 - 20 - 0$$

$$= 10,8 \text{ KN.m} \quad \checkmark$$

$$BM_D = (4,4 \times 10) - (5 \times 7) - (3 \times 3)$$

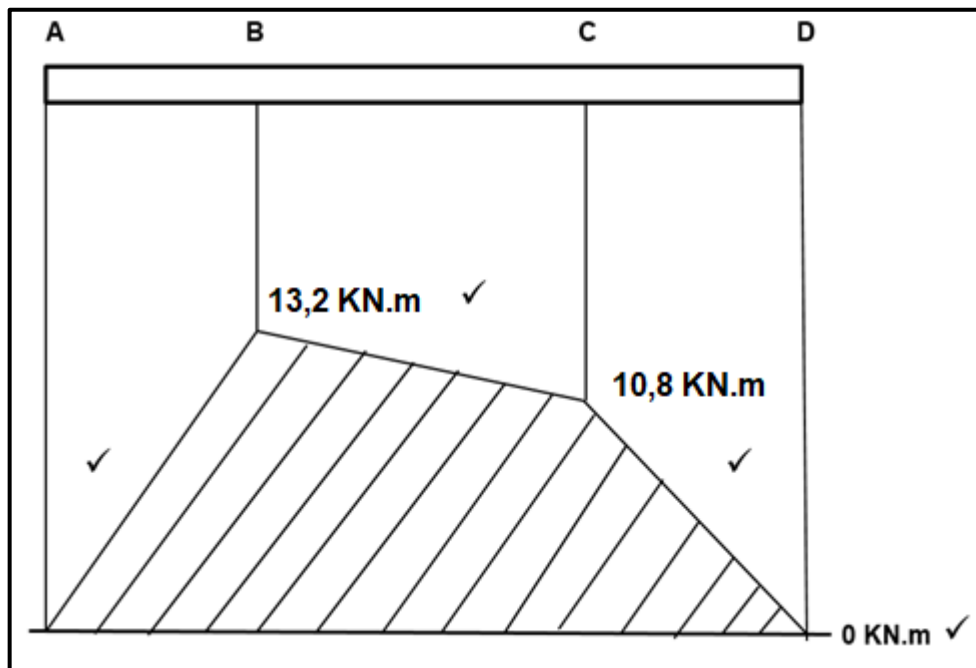
$$= 44 - 35 - 9$$

$$= 0 \text{ KN.m} \quad \checkmark$$

(4)



7.2.3 Bending moment diagram:  
NOTE: Diagram NOT drawn to scale.



(4)

7.3 Stress and Strain:

7.3.1 Stress

$$\text{stress} = \frac{\text{Force}}{\text{Area}} \quad \checkmark \quad \text{Area} = \frac{\pi \times (38)^2}{10^6} \quad \checkmark$$

$$= 4,536459792 \times 10^{-3} \quad \checkmark$$

$$\text{stress} = \frac{100 \times 10^3}{\frac{\pi(38)^2}{10^6}} \quad \checkmark$$

$$= 22\,043\,620,93 \text{ Pa} \quad \checkmark$$

$$= 22,04 \text{ MPa} \quad \checkmark$$

(6)

7.3.2 Strain

$$\text{strain} = \frac{\Delta l}{l} \quad \checkmark$$

$$\text{strain} = \frac{0,5}{150} \quad \checkmark$$

$$= 3,333333333 \times 10^{-3} \quad \checkmark$$

$$= 3,33 \times 10^{-3}$$

(3)

7.3.3 Young's modulus of elasticity

$$\text{Young's modulus of elasticity} = \frac{\text{Stress}}{\text{Strain}} \quad \checkmark$$

$$= \frac{22043620,93}{3,333333333 \times 10^{-3}} \quad \checkmark$$

$$= 6\,613,09 \text{ Pa} \quad \checkmark$$

(3)

[45]

**QUESTION 8: JOINING METHODS (INSPECTION OF WELD) (SPECIFIC)****8.1 Visual inspection process:**

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

(Any 3 x 1) (3)

**8.2 Heat affected zone ✓**

(1)

**8.3 Inspection during oxy-acetylene welding:**

- Correct flame for the work on hand. ✓
- Correct angle of blowpipe and rod, depending on the method being used. ✓
- Depth of fusion and amount of penetration. ✓
- The rate of progress along the joint. ✓

(Any 3 x 1) (3)

**8.4 Weld gauge:**

- Angle of preparation ✓
- Misalignment ✓
- Fillet weld leg length/excess weld metal ✓
- Fillet weld throat ✓
- Undercut ✓

(Any 3 x 1) (3)

**8.5 Nick break test:**

- Make a hacksaw cut at both edges, through the centre of the weld. ✓
- Place specimen on two supports/bench vice. ✓
- Use a sledgework hammer to break the specimen in the area of the cuts. ✓
- Inspect the exposed weld metal in the break ✓ for incomplete fusion, slag inclusion (or other welding defects). ✓

(5)

**8.6 Welding defects:****8.6.1 Slag inclusion:**

- Included angle too narrow ✓
- Rapid chilling ✓
- Welding temperature too low / current too low ✓
- High viscosity of molten metal ✓
- Slag not removed from previous weld run ✓
- Incorrect welding technique ✓
- Surface contamination ✓
- Too big weaving action ✓
- Too slow speed along the weld joint ✓
- Too short arc length ✓

(Any 2 x 1) (2)

**8.6.2 Incomplete penetration:**

- Welding current is too low ✓
- Travel speed is too fast ✓
- Incorrect electrode angle ✓
- Poor edge preparation ✓
- Insufficient root gap ✓
- Gas flow too low (gas welding) ✓

(Any 2 x 1) (2)

**8.7 Disadvantages of using liquid dye penetrant:**

- Might miss problems below the surface. ✓
- Cannot work on porous materials. ✓

(2)

**8.8 Welding defects:**

8.8.1 Spatter ✓

(1)

8.8.2 Undercut ✓

(1)

**[23]****QUESTION 9: JOINING METHODS (STRESSES AND DISTORTION) (SPECIFIC)****9.1 Distortion:**

- Weld distortion is the warping of the base metal ✓ caused by heat from the welding arc/flame. ✓

(2)

**9.2 Quenching mediums:**

- Oil ✓
- Water ✓
- Brine/ salt water ✓
- Liquid salts ✓
- Molten lead ✓

(3)

**9.3 Iron-carbon equilibrium diagram:**

- A – Ferrite and pearlite ✓
- B – Ferrite and austenite ✓
- C – Austenite ✓
- D – Cementite and austenite ✓
- E – Pearlite and cementite ✓

(5)

**9.4 Definition of terms:**

9.4.1 **Elastic deformation** – occurs when the joint recovers to its original ✓ position, once the stresses have been relieved. ✓

(2)

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

(2)

9.5 **Methods to reduce distortion:**

- Do not over weld ✓
- Apply intermittent welding ✓
- Place welds near the neutral axis ✓
- Use as few passes as possible ✓
- Use back-step welding ✓
- Anticipate the shrinkage forces ✓
- Plan the welding sequence ✓
- Use strong backs ✓
- Use clamps, jigs and fixtures ✓

(Any 2 x 1) (2)

9.6 **Types of shrinkage:**

9.6.1 Transverse shrinkage ✓

(1)

9.6.2 Longitudinal shrinkage ✓

(1)

**[18]****QUESTION 10: MAINTENANCE (SPECIFIC)**10.1 **Effects of overloading the following machines:**

10.1.1 Overloading a punch and shearing machine:

- Dulling or breaking blades/punches. ✓
- Putting strain on the motor and drive mechanism. ✓ (Any 1 x 1) (1)

10.1.2 Rolling machine:

- Limit the lifespan of bearings, gearbox and motor. ✓ (1)

10.2 **Locking out large machines before maintenance:**

- Due to the dangers associated with large machines. ✓
- To ensure that isolation switches are switched off. ✓
- To ensure that nobody can turn on the machine while maintenance is being done. ✓ (Any 2 x 1) (2)

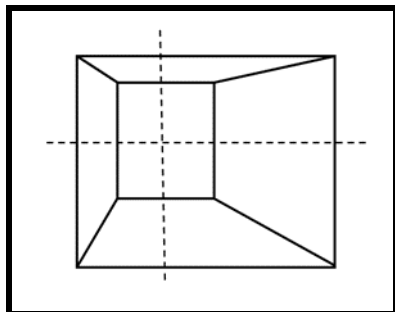
10.3 **Purpose of keeping service records:**

- Assist in the monitoring of the condition of the machines. ✓
- Assist in upholding warranties. ✓
- Assist in keeping a history of maintenance and repairs. ✓ (2)

10.4 **Lubrication** is not applicable to bench grinders because the bearings on the spindle shaft are factory lubricated ✓ and sealed with an oil seal to prevent leakage. ✓

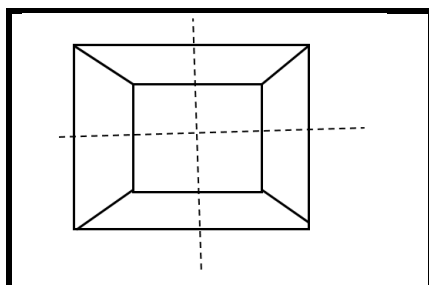
(2)

**[8]**

**QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)****11.1 Transition pieces:****11.1.1 Off-Centre hopper sketch**

✓✓

(2)

**11.1.2 On-Centre hopper sketch**

✓✓

(2)

**11.2 Conical hopper****11.2.1 Vertical height (DE):**

$$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$DE = \tan 70^\circ \times EC \quad \checkmark$$

$$= 2,75 \times 1$$

$$= 2,75 \text{ m} \quad \checkmark$$

(2)

**11.2.2 Main radius (AC):**

$$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$AC = \frac{BC}{\cos 70^\circ} \quad \checkmark$$

$$= \frac{2,5}{0,34} \quad \checkmark$$

$$= 7,35 \text{ m} \quad \checkmark$$

(3)

## 11.2.3 Small radius (AD):

$$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$DC = \frac{EC}{\cos 70^\circ} \checkmark$$

$$= \frac{1}{0,34}$$

$$= 2,94 \text{ m } \checkmark$$

$$\begin{aligned} \text{Now AD} &= AC - DC \\ &= 7,35 - 2,94 \checkmark \\ &= 4,41 \text{ m } \checkmark \end{aligned}$$

(4)

11.2.4 Circumference =  $\pi \times MD$ 

$$= \pi \times 5 \checkmark$$

$$= 15,71 \text{ m } \checkmark$$

(2)

## 11.3 Calculating True Lengths:

$$11.3.1 \quad \mathbf{A-1} = \sqrt{125^2 + 100^2 + 450^2} \checkmark$$

$$= 477,62 \checkmark$$

(2)

$$11.3.2 \quad \mathbf{A-2} = \sqrt{500^2 + 125^2 + 450^2} \checkmark$$

$$= 684,2 \checkmark$$

(2)

$$11.3.3 \quad \mathbf{B-3} = \sqrt{475^2 + 100^2 + 450^2} \checkmark$$

$$= 661,91 \checkmark$$

(2)

**[21]****TOTAL: 200**

