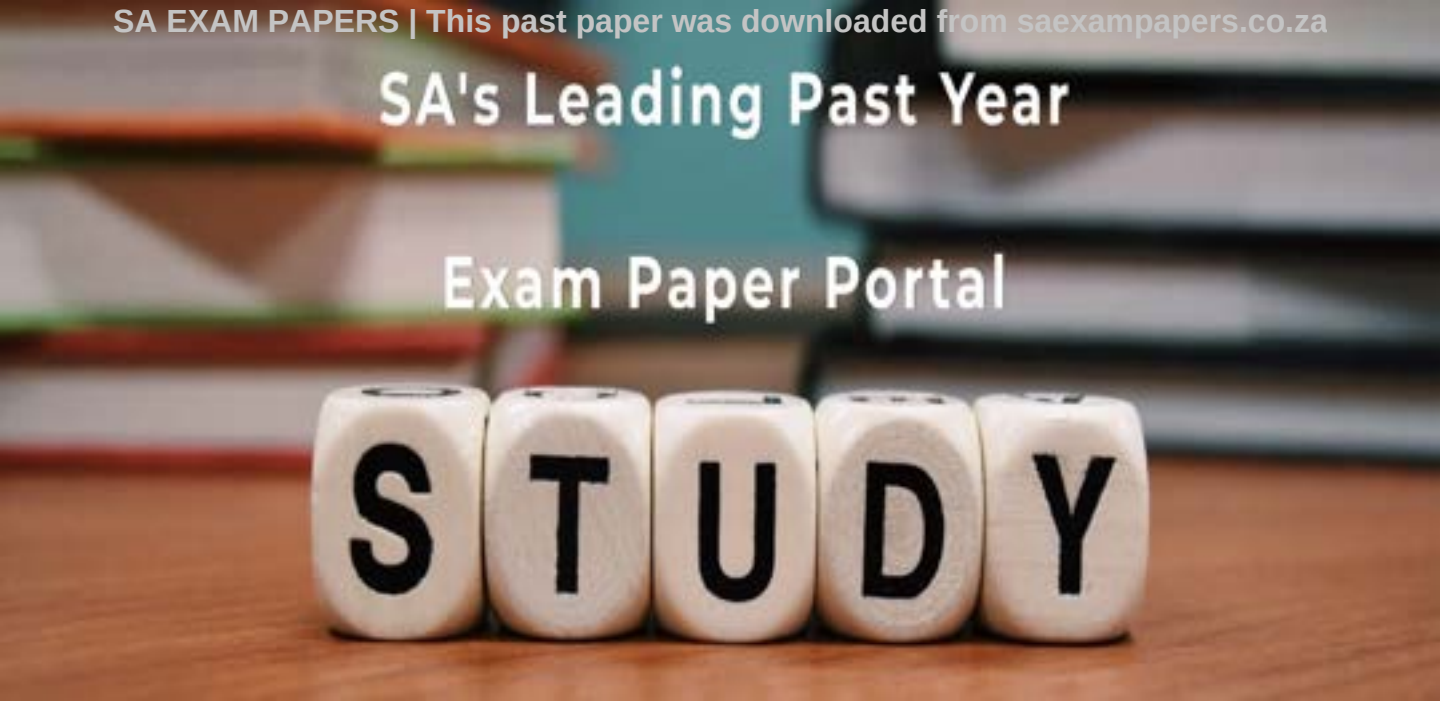


basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

NOVEMBER 2024

MARKING GUIDELINES

MARKS: 200

These marking guidelines consists of 19 pages.

QUESTION 1: MULTIPLE-CHOICE (GENERIC)

1.1 A ✓ (1)

1.2 D ✓ (1)

1.3 A ✓ (1)

1.4 B ✓ (1)

1.5 D ✓ (1)

1.6 C ✓ (1)
[6]

QUESTION 2: SAFETY (GENERIC)

2.1 **Horizontal band saw (Already been switched on):**

- Never leave the band saw unattended while in motion. ✓
- Switch off the band saw when leaving. ✓
- Use a brush or wooden rod to remove chips/swarf/filings. ✓
- When reaching around a revolving band saw, be careful that your clothes do not get caught in the blade. ✓
- Don't stop a revolving bandsaw blade with your hand. ✓
- Don't adjust the band saw while working. ✓
- Don't open any guard while in motion. ✓
- Keep hands away from action points. ✓
- Do not force the band saw blade into the material. ✓
- Apply cutting fluid if required. ✓
- Avoid overcrowding of persons around the machine. ✓
- Do not lean on the machine. ✓
- Check if the machine is running smoothly. ✓

(Any 2 x 1) (2)

2.2 **First aid basic treatment:**

- Examination ✓
- Diagnosis ✓
- Treatment ✓ (3)

2.3 **Oxygen fittings with oil and grease:**

It forms a flammable mixture. ✓ (1)

2.4 **Disadvantages of the 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)

2.5 **Advantages of the product layout:**

- Handling of material is limited to a minimum. ✓
- Time period of manufacturing cycle is less. ✓
- Production control is almost automatic. ✓
- Control over operations is easier. ✓
- Greater use of unskilled labour is possible. ✓
- Less total inspection is required. ✓
- Less total floor space is needed per unit of production. ✓

(Any 2 x 1) (2)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 **Filing test:**

3.1.1 Files easily ✓ (1)

3.1.2 Hard to file ✓ (1)

3.1.3 Files easily ✓ (1)

3.2 **Heat treatment:**

It is the heating ✓ and cooling ✓ of metals under controlled conditions / as to change their properties. ✓ (3)

3.3 **Heating of metal:**

If metal is heated too fast, the outside of the metal becomes hotter ✓ than the inside, ✓ then it is very difficult ✓ to achieve a uniform structure. ✓ (4)

3.4 **Case hardening:**

- Low-carbon steel / Mild steel ✓
- Low-alloy steel ✓ (2)

3.5 **Tempering:**

- It is to relieve the strains✓ induced during the hardening process. ✓
- Increase toughness. ✓✓
- Decrease brittleness. ✓✓
- Achieve a finer grain structure. ✓✓

(Any 1 x 2) (2)
[14]

QUESTION 4: MULTIPLE-CHOICE (SPECIFIC)

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

[14]

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 **Template loft separation:**

- It is quieter. ✓✓
- The lighting is better. ✓✓
- All equipment is readily available. ✓✓
- It is a permanent base. ✓✓
- Marking on the floor enhances accuracy. ✓✓
- Specialists works in the template loft. / More specialised work is done in the template loft. ✓✓

(Any 1 x 2) (2)

5.2 **Template loft tools: (*Due to the large number of alternatives, marker discretion must be used - discuss with IM*).**

- Hand saws ✓
- Chisels ✓
- Plane ✓
- Drill and drill bits ✓
- Steel tape ✓
- Straight edge ✓
- Compass ✓
- Trammel pins ✓
- Carpenter's square ✓
- Protractor ✓
- Chalk line ✓
- Clamps. ✓

(Any 3 x 1) (3)

5.3 **Steel ring calculations:**

5.3.1 Mean Ø = Outside Ø – Plate thickness
= 980 – 25 ✓
= 955 mm ✓ (2)

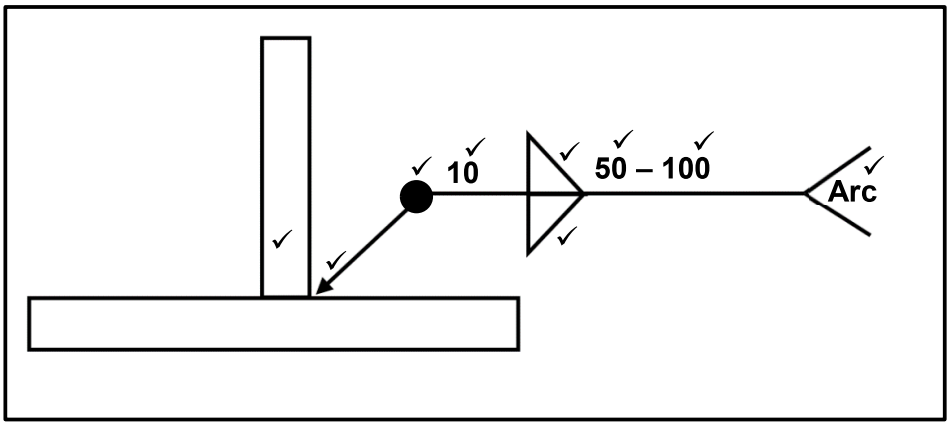
5.3.2 Mean circumference = $\pi \times$ Mean Ø
= $\pi \times 955$ ✓
= 3000,22 ✓
= 3000 mm ✓ (3)

5.4 **Factors for selecting materials for templates:**

- Durability ✓
- Cost effective ✓
- Light weight ✓
- Moisture resistant ✓
- Flexible ✓
- Size ✓
- Accuracy required ✓

(Any 2 x 1) (2)

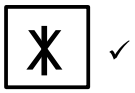
5.5 **Fillet weld on T–joint:**



(9)

5.6 **Welding symbols:**

5.6.1 Spot weld:



(1)

5.6.2 Seam weld:

(1)
[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 **Working principles of:**

6.1.1 **Punch and cropping machine**:

- Cropping machines are electrically driven. ✓
- Uses a heavy fly wheel/hydraulics and clutch system. ✓
- It engages various blades/punches. ✓
- Uses shearing/punching motion to cut the various profiles. ✓ (4)

6.1.2 **Resistance welding machine**:

- Current flows through a resistance to fuse plates together. ✓
- Two copper electrodes are pressed against the plates. ✓
- Heavy current is passed between the electrodes. ✓
- The two plates melt and fuse together, forming a weld nugget or spot weld. ✓ (4)

6.2 **Uses of the drill press:**

- Drilling ✓
- Ream work ✓
- Countersinking ✓
- Sawing – hole saw ✓
- Sanding ✓
- Wire brushing ✓
- Buffing/Polishing ✓
- Boring ✓
- Tapping ✓
- Spot facing ✓
- Honing ✓

(Any 3 x 1) (3)

6.3 **Types of taps:**

- Taper tap/starting tap/first tap ✓
- Intermediate/second tap ✓
- Plug or bottoming tap ✓ (3)

6.4 **Brinell hardness test procedure:**

- 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)

[18]

QUESTION 7: FORCES (SPECIFIC)

7.1 **Beams:**

7.1.1 **Calculate the reaction left (RL):**

Take moments about RR:

$$RL \times 10 = (50 \overset{\checkmark}{\times} 2) + (75 \overset{\checkmark}{\times} 5) + (60 \overset{\checkmark}{\times} 8)$$
$$= 100 + 375 + 480$$
$$RL = \frac{955}{10}$$
$$= 95{,}5 \text{ N } \checkmark$$

Calculate the reaction right (RR):

Take moments about RL:

$$RR \times 10 = (60 \overset{\checkmark}{\times} 2) + (75 \overset{\checkmark}{\times} 5) + (50 \overset{\checkmark}{\times} 8)$$
$$= 120 + 375 + 400$$
$$RR = \frac{895}{10}$$
$$= 89{,}5 \text{ N } \checkmark$$ (8)

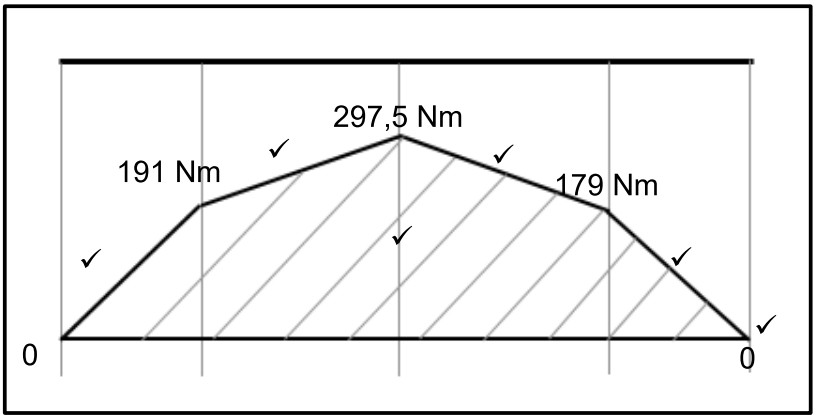
7.1.2 **Bending moments:**

$$BM_B = (95{,}5 \times 2) - (60 \times 0)$$
$$= 191 \text{ Nm } \checkmark$$

$$BM_C = (95{,}5 \times 5) - (60 \times 3) - (75 \times 0) \checkmark$$
$$= 297{,}5 \text{ Nm } \checkmark$$

$$BM_D = (95{,}5 \times 8) - (60 \times 6) - (75 \times 3) - (50 \times 0) \checkmark$$
$$= 179 \text{ Nm } \checkmark$$ (5)

7.1.3 **Bending moment diagram:**



Note to marker:

Marker must redraw the bending moment diagram according to given scales for marking purposes.

(6)

7.2 **Stress and Strain:**

7.2.1 **Area:**

$$A = \frac{\pi D^2}{4}$$
$$= \frac{\pi(0,038)^2}{4} \checkmark$$
$$= 1,13 \times 10^{-3}\ m^2 \checkmark$$

(2)

7.2.2 **Stress:**

$$\text{Stress} = \frac{F}{A}$$
$$= \frac{120 \times 10^3 \checkmark}{1,13 \times 10^{-3} m^2} \checkmark$$
$$= 106,19\ MPa \checkmark$$

(3)

7.2.3 **Strain:**

$$\varepsilon = \frac{\Delta l}{ol}$$

$$\varepsilon = \frac{0,55}{125} \checkmark\checkmark$$

$$= 0,0044 \quad \text{or} \quad 4,4 \times 10^{-3} \checkmark \qquad (3)$$

7.2.4 **Calculation of Young's Modulus:**

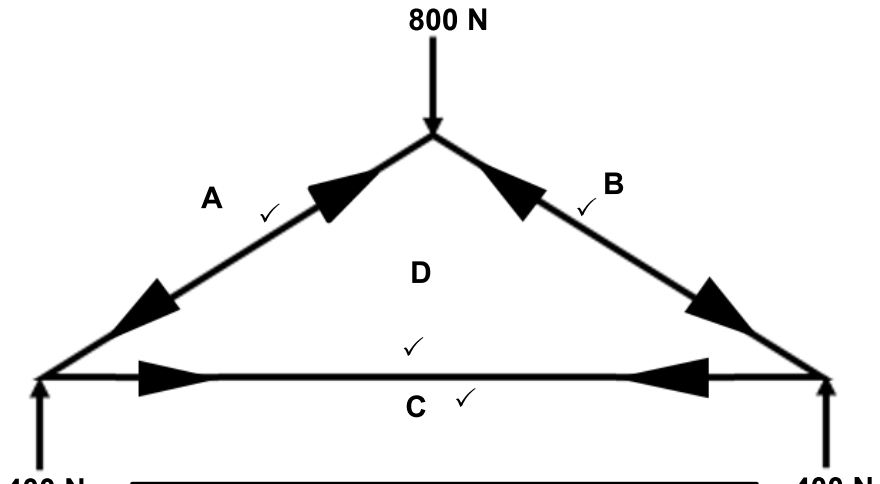
$$E = \frac{\text{stress}}{\text{strain}}$$

$$= \frac{106,19}{4,4 \times 10^{-3}} \checkmark\checkmark$$

$$= 24,13 \text{ GPa} \checkmark \qquad (3)$$

7.3 **Simple frame:**

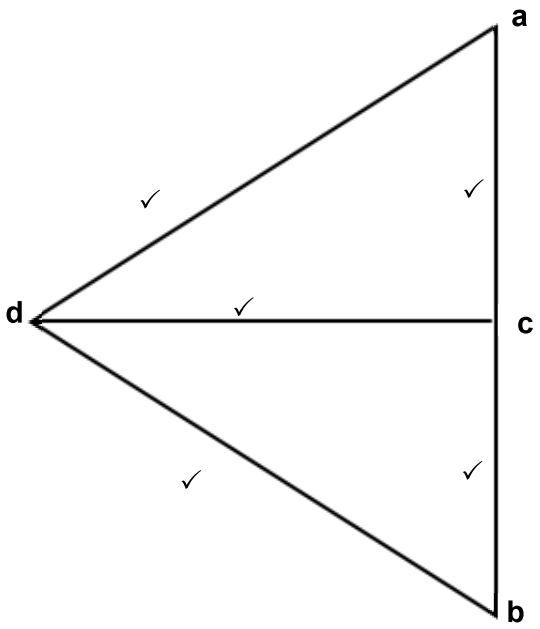
7.3.1 **Space diagram:**



3 MARKS FOR ARROWS
1 MARK FOR DRAWING TO SCALE ✓

(4)

7.3.2 **Vector diagram:**



NOTE: Draw to scale on transparency for marking purpose
Tolerance of 2 mm.

(5)

7.3.3 **Magnitude and nature of force:**

Member	**Force**	**Nature**
AD	810 N(790-830) ✓	Strut ✓
BD	810 N(790-830) ✓	Strut ✓
CD	700 N(680-720) ✓	Tie ✓

(6)
[45]

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

8.1 **Factors to consider during the inspection of welds:**

- Bead ✓
- Width
- Height ✓
- Fusion
- Penetration ✓
- Pits ✓
- Undercutting ✓
- Distortion ✓
- Cracks ✓
- Spatter ✓
- No Slag inclusion ✓
- Proper start of weld ✓
- Termination of weld ✓

(Any 2 x 1) (2)

8.2 **Welding defects:**

8.2.1 **Weld spatter:**

- Too low welding voltages. ✓
- Too high welding current. ✓
- Arc length too long. ✓
- Not applying anti-spatter spray. ✓
- Electrode angle too small. ✓
- Welding speed incorrect. ✓
- Wrong polarity (DC). ✓
- Contaminated surface. ✓
- Wet electrodes. ✓
- Inadequate consumables. (e.g wrong electrodes, not enough shielding gas, etc.) ✓

(Any 2 x 1) (2)

8.2.2 **Cracks:**

- Wrong selection of electrode. ✓
- A restrained welded joint. ✓
- Fast cooling. ✓
- Improper welding technique. ✓
- Absence of preheating and post-heating of the joint. ✓
- Parent metal of poor weldability/High carbon content. ✓
- High residual stress on the base metal. ✓

(Any 2 x 1) (2)

8.3 **Preventions for welding defects:**

8.3.1 **Incomplete penetration:**

- Use correct arc length. ✓
- Use correct electrode angle. ✓
- Use correct current setting. ✓
- Use correct travel speed. ✓
- Use correct joint preparation/Remove mould scale/Clean joint. ✓

(Any 2 x 1) (2)

8.3.2 **Undercutting:**

- Decrease arc travel speed. ✓
- By raising arc voltage. ✓
- By lowering arc voltage. ✓
- By lowering the current. ✓
- Ensure proper joint preparation/Remove mould scale/Clean joint. ✓
- Use correct electrode angle. ✓

(Any 2 x 1) (2)

8.4 **Label weld dimension:**

A. Penetration ✓
B. Width ✓
C. Height/Reinforcement/Cap height/Overfill ✓
D. Weld bead/Deposited metal ✓
E. Base metal/Work-piece/Test piece/Parent metal ✓ (5)

8.5 **Machinability test for welded joints:**

- To evaluate the surface finish. ✓
- To evaluate the integrity of the weld. ✓
- To evaluate defects such as porosity, inclusions or excessive hardness. ✓
- To determine the ease of machining. ✓

(Any 2 x 1) (2)

8.6 **Free-bend test on a welded joint:**

- To determine the percentage elongation of a welded metal. ✓
- It measures the ductility of the weld deposit. ✓
- It measures the heat affected area adjacent to the weld. ✓

(Any 2 x 1) (2)

8.7 **Label X-ray test:**

A. Gamma ray/X-rays ✓
B. Radioactive source/X-ray machine ✓
C. Test piece/Work piece ✓
D. Photographic film/Film ✓

(4)
(23)

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

9.1 **Factors affecting grain size of steel:**

- The prior amount of cold work. ✓
- The temperature and time of the annealing process. ✓
- The composition/Type of steel. ✓
- The melting point. ✓ (4)

9.2 **Factors that affect distortion and residual stress:**

- Welding current ✓
- Type/Size of electrode ✓
- Cooling rate ✓
- Size/Thickness of the material ✓

(Any 3 x 1) (3)

9.3 **Label iron-carbon equilibrium diagram:**

A. Carbon percentage ✓
B. Temperature in degrees Celsius ✓
C. AC_3 / Higher critical temperature ✓
D. AC_1 / Lower critical temperature ✓ (4)

9.4 **Quenching media:**

- Oil ✓
- Water ✓
- Brine ✓
- Air ✓
- Liquid salts ✓
- Sand ✓
- Ash ✓
- Lime ✓
- Molten lead ✓
- Nitrogen air-infused air ✓

(Any 2 x 1) (2)

9.5 **Stress relieving:**

- Annealing ✓
- Tempering ✓
- Normalising ✓

(Any 1 x 1) (1)

9.6 **Definition of terms:**

9.6.1 **Distortion:**
Distortion is the warping ✓ of the base plate caused by heat. ✓ (2)

9.6.2 **Elastic deformation:**
Is the ability of a material to regain its shape ✓ after the stresses have been relieved. ✓ (2)

[18]

QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 **Maintenance in operating systems:**

- It helps prolong the lifespan of hardware. ✓
- Minimizes downtime. ✓
- Improves system security. ✓
- Ensures efficient operation. ✓
- Improves safety. ✓

(Any 2 x 1) (2)

10.2 **Lack of lubrication:**

- It causes increased friction between moving parts. ✓
- It causes excessive heat. ✓
- It causes wear. ✓
- Potential damage to components. ✓

(Any 2 x 1) (2)

10.3 **Overloading machine:**

- Premature failure of machine components. ✓
- Decreased lifespan. ✓
- It can create a safety hazard. ✓

(Any 2 x 1) (2)

10.4 **Maintenance guidelines for a power saw:**

- Visual checks of electrical wiring. ✓
- Clearing the workspace. ✓
- Lubricating moving parts. ✓
- Monitor wheel bearings. ✓
- Checking hydraulic oil. ✓
- Repairing any existing leaks. ✓
- Check blade tension. ✓
- Check for proper alignment. ✓
- Inspect belts for wear. ✓
- Daily inspect the chip removal system/band guides. ✓
- Align vice to blade. ✓
- Check that guards are in place. ✓
- Blade condition. ✓

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

QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

11.1 **Gravity flow:**
To discharge ✓ its content at the bottom. ✓ (2)

11.2 **Value of X:**

$$X = \sqrt{40^2 + 30^2}\ \checkmark$$
$$= \sqrt{1600 + 900}$$
$$= \sqrt{2500}\ \checkmark$$
$$= 50\ \text{mm}\ \checkmark$$

(3)

11.3 **Square to square off centre hopper:**

11.3.1 **B-3:**

$$B-3 = \sqrt{300^2 + 600^2 + 850^2}\ \ \checkmark\ \ \checkmark\ \ \checkmark$$
$$= \sqrt{90000 + 360000 + 722500}$$
$$= \sqrt{1172500}\ \checkmark$$
$$= 1082{,}82\ \text{mm}\checkmark$$

(5)

11.3.2 **X-Y:**

$$X-Y = \sqrt{250^2 + 850^2}\ \ \checkmark\ \ \checkmark$$
$$= \sqrt{62500 + 722500}$$
$$= \sqrt{785000}\ \checkmark$$
$$= 886\ \text{mm}\ \checkmark$$

(4)

11.3.3 **C- 4:**

$$C-4 = \sqrt{700^2 + 350^2 + 850^2}\ \ \checkmark\ \ \checkmark\ \ \checkmark$$
$$= \sqrt{490000 + 122500 + 722500}$$
$$= \sqrt{1335000}\ \checkmark$$
$$= 1155{,}42\ \text{mm}\ \checkmark$$

(5)

11.4 Square to square ✓ hopper on centre. ✓ (2)

[21]

TOTAL: 200