



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

MAY/JUNE 2025

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 22 pages.

Instructions to marker: Mechanical Technology – Welding and Metalwork

1. General marking instructions:

- 1.1 During the marking of multiple-choice questions, only ONE possible answer can be accepted. If the candidate indicated two or more responses, ONLY the first response will be recognised/acknowledged and marked according to the marking guidelines.
- 1.2 Where the number of responses of the candidate exceeds the required number stated in the question, ONLY the first number of responses will be accepted. For example, if the question states, 'Name THREE ...' and the candidate stated four different responses, ONLY the first three will be accepted and recognised.
- 1.3 If question numbering of sub questions is not correct according to the question paper sequence, the responses can be accepted if a sequence pattern can be identified.
- 1.4 Attention must be given to mark allocation in questions where two (2) marks were allocated for one response, e.g (**Any 1 x 2**).
- 1.5 There must be ONE tick allocated for each mark awarded.
- 1.6 An unanswered question must be indicated with a cross (X).
- 1.7 All blank pages in an ANSWER BOOK must be crossed out to indicate that the pages have been seen by the marker.
- 1.8 Attention must be given to questions where the candidate did not complete the question and continued answer(s) on subsequent pages in the ANSWER BOOK. Continue marking such questions and award marks, if applicable.
- 1.9 During calculation marking, pay attention to the position of the tick mark(s).
- 1.10 If a candidate skipped a step where a tick mark is allocated in the marking guidelines and the final answer is correct, the total amount of tick marks must be indicated by the marker to indicate full marks awarded for the question correctly answered, so that the examination assistant can verify marks awarded.

- 1.11 If the unit required for calculations is specified in the question, the final answer can be considered correct without explicitly stating the unit, provided that the numerical value matches the unit specified or used in the question.
- 1.12 If an incorrect unit is stated in the candidate's answer during calculations, the answer will be marked incorrect even if the value itself is correct.
- 1.13 Attention must be given to calculation type questions when different methods are used by candidates to obtain the correct answer.
- 1.14 Attention must be given to special marking instructions to the marker which are stated for specific questions in the marking guidelines.
- 1.15 A red line must be drawn by the marker to indicate the end of each question.
- 1.16 Marks of sub question totals must be indicated on the outside margins of the ANSWER BOOK pages and NOT on the inside margins.
- 1.17 Marks of sub question totals, when indicated on the outside margins, must be in line with the sub questions and must NOT be circled.
- 1.18 Total marks of a question must be indicated on the red line drawn by the marker and circled as to indicate marks for particular questions.
- 1.19 The marker must transfer the marks to the cover page and ensure the correctness of the transfer.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

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

QUESTION 2: SAFETY (GENERIC)

2.1 Manual guillotine:

- Care must therefore be taken to never bring the operator's hands near the shearing blade. ✓
- Blade guard or back of the machine to catch the cut material must be fitted. ✓
- Cut material must be allowed to fall to the floor to be collected when safe to do so. ✓
- The guillotine must never be adjusted during operation. ✓
- The guillotine must never be lubricated during operation. ✓
- The guillotine must never be serviced during operation. ✓
- Care must be taken not to cut material that is thicker than the specified limit or harder materials. ✓
- Do not lean on the machine while operating. ✓

(Any 3 x 1) (3)

2.2 Examination procedures for First Aid:

- Environmental observation ✓
- Visible signs ✓
- Visible symptoms ✓
- Indicators to diagnosis ✓
- Vital functions ✓

(Any 3 x 1) (3)

2.3 Acetylene cylinders key:

So that the valve can be quickly closed./In case of an emergency. ✓ (1)

2.4 Product layout or a process layout:

2.4.1 Process layout ✓ (1)

2.4.2 Process layout ✓ (1)

2.4.3 Product layout ✓ (1)

[10]

QUESTION 3: MATERIALS (GENERIC)

- 3.1 **Heat treatment:**
- Work piece size ✓
 - Quenching rate ✓
 - Carbon content ✓
- (3)
- 3.2 **Machining test:**
- 3.2.1 Easy to cut ✓ (1)
- 3.2.2 Hard/Difficult to cut ✓ (1)
- 3.2.3 Easy to cut ✓ (1)
- 3.3 **Annealing:**
- To relieve internal stresses of the steel ✓
 - Soften steel to allow for easy machining ✓
 - Make steel ductile ✓
 - Refine grain structure ✓
 - Reduce brittleness ✓
- (Any 1 x 1) (1)
- 3.4 **Normalising:**
- 3.4.1 above ✓ (1)
- 3.4.2 soaking ✓ (1)
- 3.4.3 cooling ✓ (1)
- 3.4.4 room ✓ (1)
- 3.5 **Rapid cooling:**
- To increase the hardness of the metal. ✓
 - To produce fine grain structure. ✓
 - To maximise tensile strength. ✓
 - To minimise ductility. ✓
- (Any 1 x 1) (1)
- 3.6 **Processes which cause internal stress:**
- Machining ✓
 - Forging ✓
 - Welding ✓
 - Bending/Rolling ✓
 - Twisting ✓
 - Extreme/rapid heating ✓
 - Flame/plasma cutting ✓
 - Hardening ✓
 - Rapid/uneven cooling ✓
- (Any 2 x 1) (2)
- [14]

QUESTION 4: MULTIPLE-CHOICE (SPECIFIC)

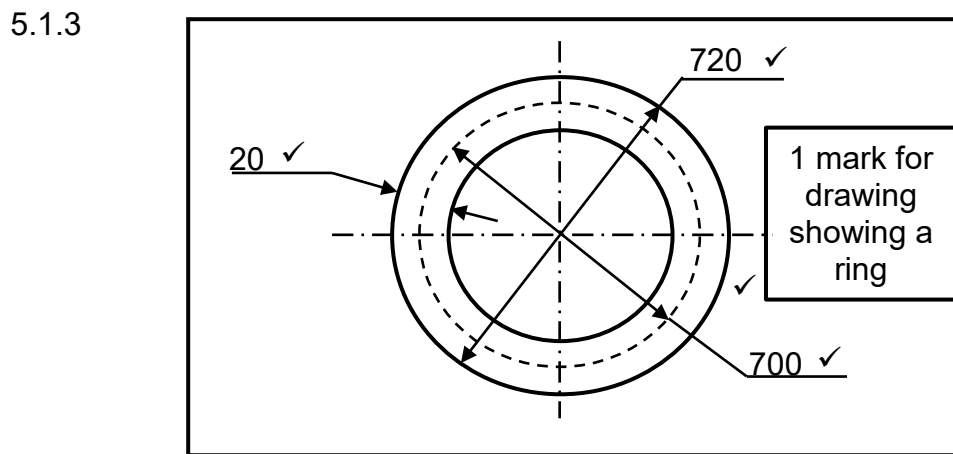
4.1	A ✓	(1)
4.2	D ✓	(1)
4.3	D ✓	(1)
4.4	B ✓	(1)
4.5	A ✓	(1)
4.6	D ✓	(1)
4.7	A ✓	(1)
4.8	A ✓	(1)
4.9	C ✓	(1)
4.10	C ✓	(1)
4.11	B ✓	(1)
4.12	C ✓	(1)
4.13	C ✓	(1)
4.14	B ✓	(1)
		[14]

QUESTION 5: TERMINOLOGY(TEMPLATES) (SPECIFIC)

5.1 Aluminium ring calculations:

5.1.1 Mean \varnothing = Outside \varnothing – plate thickness
 $= 720 - 20 \checkmark$
 $= 700 \text{ mm} \checkmark$ (2)

5.1.2 Mean circumference = $\pi \times \text{Mean } \varnothing$
 $= \pi \times 700 \checkmark$
 $= 2199,11 \checkmark$
 $= 2199 \text{ mm} \checkmark$ (3)



(4)

5.2 Resistance weld methods:

- Spot weld \checkmark
- Projection \checkmark
- Seam weld \checkmark
- Foil seam welding/Foil butt seam welding \checkmark
- Flash welding \checkmark
- Friction welding \checkmark

(Any 3 x 1) (3)

5.3 Welding symbol:

- 5.3.1 MIG welding \checkmark (1)
- 5.3.2 Square butt weld \checkmark (1)
- 5.3.3 Bevel half V weld \checkmark (1)
- 5.3.4 50 \checkmark (1)
- 5.3.5 100 \checkmark (1)
- 5.3.6 Grind \checkmark (1)

5.4 **Cutting machines:**

- Circular saw ✓
- Jig saw ✓
- Band saw ✓
- Bench shears / Shearing machine ✓
- Guillotine ✓
- Cut-off saw ✓
- Power saw ✓
- Drill press/machine ✓
- Punch and cropper ✓
- Angle grinder ✓

(Any 4 x 1) (4)

5.5 **Roof truss:**

Ridging ✓

(1)
[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 Parts of the drill press:

- A – Adjustable table/Table/Machine table ✓
- B – Chuck ✓
- C – Operating handles/Feed lever ✓
- D – Motor/Electric motor ✓
- E – Column ✓
- F – Base ✓

(6)

6.2 Operating principles of spot welding machine:

- Two copper electrodes are pressed against the plates. ✓
- Heavy current is passed between the electrodes. ✓
- Current flows through a resistance. ✓
- High resistance causes intense heat at the point. ✓
- The two plates melt and fuse together, forming a weld nugget or spot weld. ✓

(5)

6.3 Uses of the bench grinder:

- To sharpen cutting tools and drill bits. ✓
- To remove rough edges/burr. ✓
- To remove excess material. ✓
- To shape metal. ✓

(Any 3 x 1) (3)

6.4. MIG welding parts:

- A – Gas cylinder/Argon gas/MAG mix ✓
- B – MIG welder/MIG welding machine/Welding machine/Power source ✓
- C – Earth cable ✓
- D – Welding gun ✓

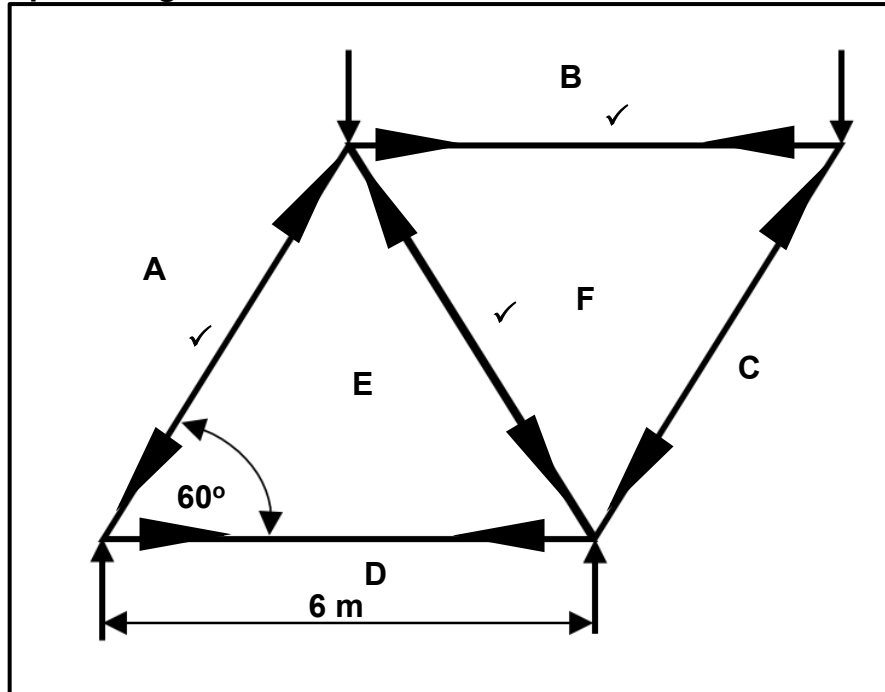
(4)

[18]

QUESTION 7: FORCES (SPECIFIC)

7.1 Steel frameworks:

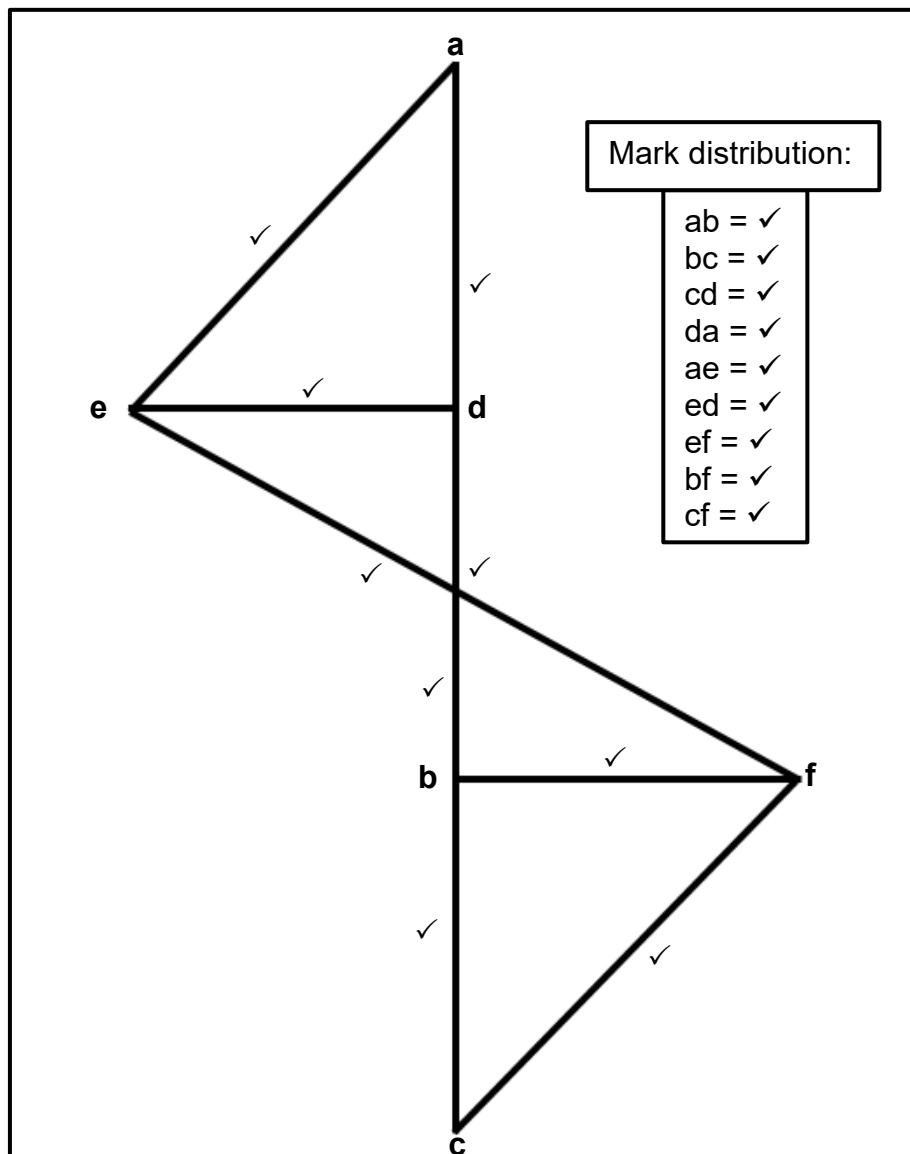
7.1.1 Space diagram:



1 mark to be awarded for correct drawing and 3 marks for the arrows on **AE**, **EF** and **BF**. ✓

(4)

7.1.2 **Vector diagram:**



NOTE: Draw to scale on transparency for marking purpose

(9)

7.1.3 **Magnitude and nature of force:**

MEMBER	FORCE	NATURE
AE	1,7 N (1,5 – 1,9 N) ✓	STRUT ✓
EF	5,2 N (5 – 5,4 N) ✓	STRUT ✓
BF	1,8 N (1,6 – 2 N) ✓	TIE ✓

(6)

7.2 **Beam:**

7.2.1 **Calculate RL:**

Take moments about (RR):

$$\begin{aligned} RL \times 12 &= (4 \times 3) + (5 \times 6) + (3 \times 9) \\ &= 12 + 30 + 27 \\ RL &= \frac{69}{12} \\ &= 5,75 \text{ N} \checkmark \end{aligned}$$

Calculate RR:

Take moments about (RL):

$$\begin{aligned} RR \times 12 &= (3 \times 3) + (5 \times 6) + (4 \times 9) \\ &= 9 + 30 + 36 \\ RR &= \frac{75}{12} \\ &= 6,25 \text{ N} \checkmark \end{aligned}$$

(8)

7.2.2 **Shear force:**

$$\begin{aligned} SF_A &= (5,75 - 3) \checkmark \\ &= 2,75 \text{ N} \checkmark \end{aligned}$$

$$\begin{aligned} SF_B &= (2,75 - 5) \checkmark \\ &= -2,25 \text{ N} \checkmark \end{aligned}$$

$$\begin{aligned} SF_C &= (-2,25 - 4) \checkmark \\ &= -6,25 \text{ N} \checkmark \end{aligned}$$

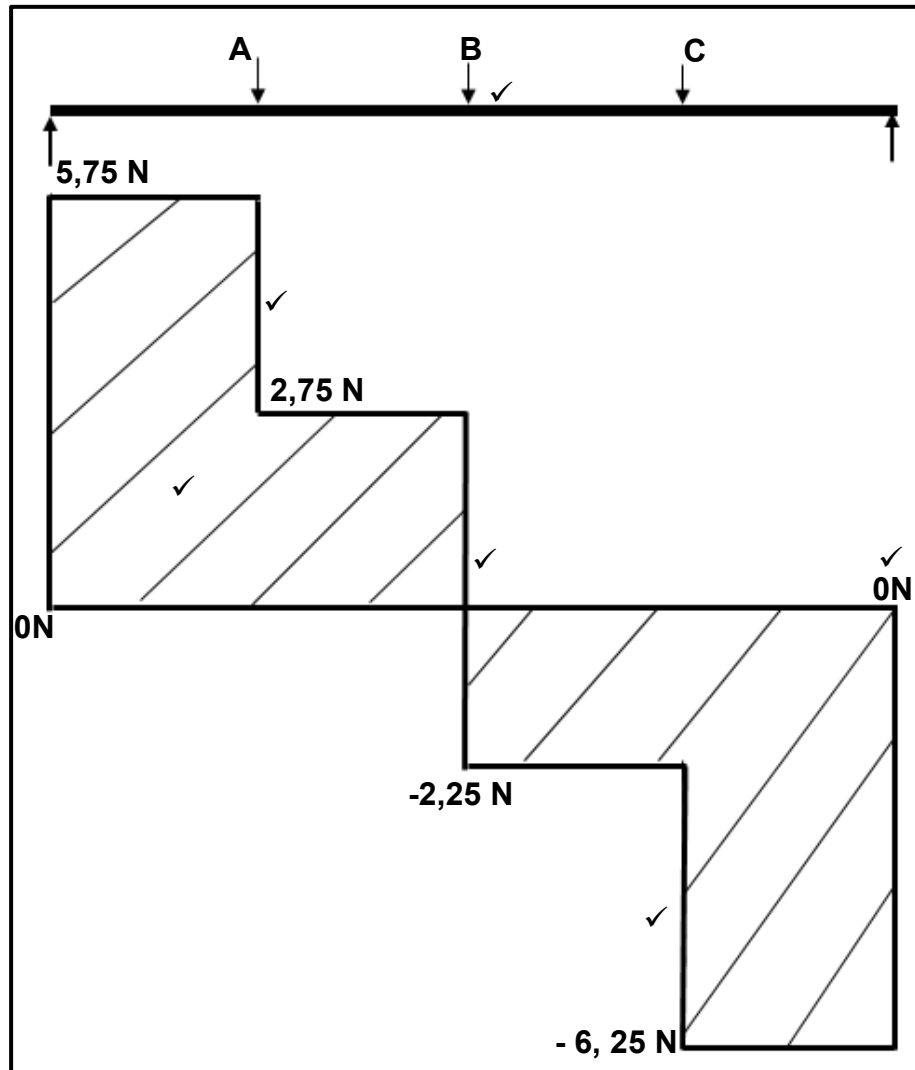
$$\begin{aligned} SF_B &= RL - 3\text{N} - 5\text{N} \checkmark \\ \text{OR} \quad &= 5,75\text{N} - 3\text{N} - 5\text{N} \\ &= -2,25 \text{ N} \checkmark \end{aligned}$$

$$\begin{aligned} SF_C &= RL - 3\text{N} - 5\text{N} - 4\text{N} \checkmark \\ \text{OR} \quad &= 5,75\text{N} - 3\text{N} - 5\text{N} - 4\text{N} \\ &= -6,25 \text{ N} \checkmark \end{aligned}$$

(6)

7.2.3 Shear force diagram:

Scale: 1 m = 10 mm and 1N = 10 mm.



Note to marker:

Marker must redraw the shear force diagram according to given scales for marking purposes. 1 mark for cross hatching.

(6)

7.3 **Stress and Strain:**

7.3.1 **Cross sectional area:**

$$\begin{aligned}\text{Area} &= \frac{\pi D^2}{4} \\ &= \frac{\pi (0,04)^2}{4} \checkmark \\ &= 1,26 \times 10^{-3} \text{ m}^2 \checkmark\end{aligned}\quad (2)$$

7.3.2 **Stress:**

$$\begin{aligned}\text{Stress} &= \frac{F}{A} \\ &= \frac{120 \times 10^3}{1,26 \times 10^{-3}} \checkmark \\ &= 95238095,24 \text{ Pa} \\ &= 95,24 \text{ MPa} \checkmark\end{aligned}\quad (2)$$

7.3.3 **Strain:**

$$\begin{aligned}\epsilon &= \frac{\Delta L}{OL} \\ \epsilon &= \frac{0,6}{120} \checkmark \\ &= 0,005 \checkmark\end{aligned}\quad (2)$$

[45]

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

8.1 Uses of weld gauges:

To check:

- angle of preparation. ✓
- weld misalignment. ✓
- fillet weld leg length. ✓
- fillet weld throat. ✓
- weld defects (undercutting/porosity). ✓
- excess weld metal. ✓

(Any 2 x 1) (2)

8.2 Causes of weld defects:

8.2.1 Lack of fusion:

- Poor welding technique ✓
- Poor joint preparation ✓
- Low travel speed ✓
- Low welding voltage ✓
- Electrode size ✓
- Low welding current ✓
- Too short arc length ✓
- Insufficient gas flow ✓

(Any 2 x 1) (2)

8.2.2 Incomplete penetration:

- Too low welding current ✓
- Too slow travel speed ✓
- Poor edge preparation ✓
- Incorrect root gap ✓
- Electrode size ✓
- Too fast travel speed ✓
- Too long arc length ✓
- Insufficient gas flow ✓

(Any 2 x 1) (2)

8.3 Cracks reductions:

8.3.1 Transverse cracks:

- Preheat the base metal. ✓
- Using lower strength consumables (electrodes/ filler rod/wire). ✓
- Slow cooling after weld. ✓

(Any 2 x 1) (2)

8.3.2 Centre line cracks:

- Aim for width to depth ratio 1:1. ✓
- Decrease current to decrease penetration. ✓
- Decrease welding voltage. ✓
- Slowing travel speed. ✓

(Any 2 x 1) (2)

8.4 **Types of flames:**

8.4.1 Oxidising flame ✓ (1)

8.4.2 Neutral flame ✓ (1)

8.4.3 Carburizing flame ✓ (1)

8.5 **Definition:**

Spatter comprises of droplets of molten material ✓ that are generated at or near the welding arc. ✓ (2)

8.6 **Nick break test:**

- Make hacksaw cuts at both edges of the weld. ✓
- Place on solid supports/in a bench vice. ✓
- Break the weld by hitting with a hammer. ✓
- Check for defects. ✓ (4)

8.7 **Inspection of welds:**

To check:

- for specification. ✓
- for weld quality. ✓
- for weld defects. ✓

(Any 2 x 1) (2)

8.8 **Disadvantages of using liquid dye penetrant testing:**

- Might miss problems below the surface/Can only detect surface defects. ✓
 - Cannot work on porous materials. ✓ (2)
- [23]

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

9.1 Causes of residual stress in welds:

- Heat present in the weld. ✓
- Qualities/type of parent metal. ✓
- Qualities/type of filler rods. ✓
- Qualities/type of electrode. ✓
- Shape and size of weld. ✓
- Number of successive weld runs. ✓
- Difference in thickness of weld metal and parent metal. ✓
- Type of welding joint used. ✓
- Welding method used to mitigate stress and distortion. ✓
- Type of structure of adjacent joints. ✓
- Freeness of joint to be able to expand and contract. ✓
- Rate of cooling. ✓
- Stresses already present in the parent metal. ✓
- Clamping of the work piece. ✓

(Any 2 x 1) (2)

9.2 Cooling rate:

- Size of work piece. ✓
- Weld thickness. ✓
- Thermal conductive properties of parent metal. ✓

(Any 2 x 1) (2)

9.3 Definition:

9.3.1 Distortion:

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

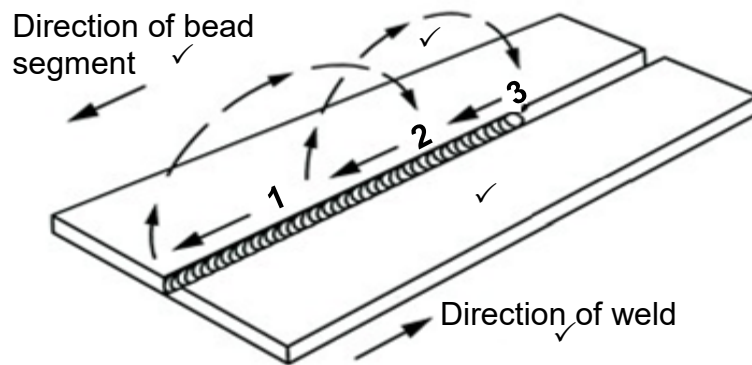
(2)

9.3.2 Shrinkage:

It is a form of plastic deformation ✓ as a result of contraction on cooling. ✓

(2)

9.4 **Back-step welding:**



(4)

9.5 **Main steel groups of materials:**

- Low carbon steel ✓ - (0,15 – 0,30%) ✓
- Medium carbon steel ✓ - (0,31 – 0,70%) ✓
- High carbon steel ✓ - (0,71 – 1,5%) ✓

(6)
[18]

QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 Life span of equipment:

- Regular maintenance ✓
- Report damaged or unsafe equipment ✓
- Do not ignore faulty equipment ✓
- Regular inspections ✓
- Use equipment according to manufacturer's instructions ✓

(Any 2 x 1) (2)

10.2 Friction:

10.2.1 Power driven guillotine:

- Excessive wear/damage to moving parts (bearing blocks/shafts/pulleys/levers). ✓
- Damage to the cutting blade. ✓
- Overheating of motor. ✓

(Any 1 x 1) (1)

10.2.2 Horizontal band saw:

- Overheating of the cutting blade. ✓
- Damage to the cutting blade. ✓
- Excessive wear to moving parts (bearings/shafts/pulleys/levers). ✓

(Any 1 x 1) (1)

10.3 Reasons for 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. ✓
- Assist in planning of maintenance. ✓

(Any 2 x 1) (2)

10.4 Factors to be considered when selecting the cutting speed:

- Type of material ✓
- Diameter of the drill bit ✓
- Material of which the drill bit is made of ✓
- Condition of the machine ✓
- Use of cutting fluid ✓
- Rate of feed ✓

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

QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

11.1 Truncated cone:

11.1.1 Base circumference:

$$\begin{aligned}\text{Circumference} &= \pi \times D \\ &= \pi \times 400 \checkmark \\ &= 1256,64 \text{ mm } \checkmark\end{aligned}\quad (2)$$

11.1.2 True length of A–D:

$$\begin{aligned}A-D &= \frac{\pi \times D}{4} \checkmark \\ &= \frac{\pi \times 400}{4} \checkmark \\ &= 314,16 \text{ mm } \checkmark\end{aligned}\quad (3)$$

11.1.3 Top circumference:

$$\begin{aligned}\text{Circumference} &= \pi \times D \\ &= \pi \times 300 \checkmark \\ &= 942,48 \text{ mm } \checkmark\end{aligned}\quad (2)$$

11.1.4 True length of 1–2:

$$\begin{aligned}1-2 &= \frac{\pi \times D}{12} \checkmark \\ &= \frac{\pi \times 300}{12} \checkmark \\ &= 78,54 \text{ mm } \checkmark\end{aligned}\quad (3)$$

11.2 **Square to square on centre hopper:**

11.2.1 **True length A-1:**

$$\begin{aligned} A-1 &= \sqrt{\overset{\checkmark}{100^2} + \overset{\checkmark}{100^2} + \overset{\checkmark}{600^2}} \\ &= \sqrt{10\,000 + 10\,000 + 360\,000} \\ &= 616,44 \text{ mm } \checkmark \end{aligned} \quad (4)$$

11.2.2 **True length A-2:**

$$\begin{aligned} A-2 &= \sqrt{\overset{\checkmark}{300^2} + \overset{\checkmark}{100^2} + \overset{\checkmark}{600^2}} \\ &= \sqrt{90\,000 + 10\,000 + 360\,000} \\ &= 678,23 \text{ mm } \checkmark \end{aligned} \quad (4)$$

11.2.3 **True length X-Y:**

$$\begin{aligned} X-Y &= \sqrt{\overset{\checkmark}{100^2} + \overset{\checkmark}{600^2}} \\ &= \sqrt{10\,000 + 360\,000} \\ &= 608,28 \text{ mm } \checkmark \end{aligned} \quad \begin{array}{l} (3) \\ [21] \end{array}$$

TOTAL: 200