



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

NOVEMBER 2025

MARKING GUIDELINES

MARKS: 200

These marking guidelines consists of 21 pages.

Instructions to marker: Mechanical Technology – Welding and Metalwork

1. General marking instructions:

- 1.1 During 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 marking guideline.
- 1.2 Where the number of responses of the candidate exceeds the required number stated in the question, only the first required number of responses will be accepted. E.g. if the question states, 'Name THREE ...' and the candidate stated four different responses, ONLY the first three will be accepted. The remaining responses must be ignored with a line drawn through it.
- 1.3 When the question clearly indicates what is expected of the candidate:
 - (a) If the candidate is required to describe a process step by step (e.g., a process in four steps), only the first four responses should be considered.
 - (b) However, if the candidate is required to explain a process, it should be noted that the response may be lengthy and not necessarily well organized. In such cases, the marker must evaluate the entire response to determine whether the candidate has explained the required outcome satisfactorily and allocate marks on merit.
- 1.4 If question numbering of sub-questions is not correct according to question paper sequence, the responses can be accepted if a sequence pattern can be identified or followed.
- 1.5 Attention must be given to mark allocation in questions where two (2) marks were allocated to one response, e.g. (**Any 1 x 2**).
- 1.6 ONE tick must be allocated for each mark awarded and no global marking is allowed.
- 1.7 Unanswered and incorrect responses of questions must be indicated with a cross (X).
- 1.8 All blank pages in an ANSWER BOOK must be crossed out to indicate that the pages have been seen by the marker.
- 1.9 Attention must be given to questions where the candidate did not complete the answer and continued answer(s) on subsequent pages in the answer book. Continue marking such answers and award marks, if applicable. If a question is answered twice, mark the first response.

- 1.10 During calculation marking, pay attention to the position of the tick mark(s) in the marking guideline.
- 1.11 If a candidate skipped a step where a tick mark is allocated in the marking guideline 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 assistants can verify marks awarded.
- 1.12 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.
- 1.13 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.
- 1.14 Attention must be given to calculation type questions when different methods are used by candidates to obtain the correct answer. Consider answers where candidates have rounded off in sub-questions and it affects the final answer.
- 1.15 Attention must be given to special marking instructions to the marker which are stated for specific questions in the marking guideline.
- 1.16 A red line must be drawn by the marker to indicate the end of each question.
- 1.17 Marks of sub-questions must be indicated in the outside margins of the ANSWER BOOK pages and NOT in the inside margins.
- 1.18 When sub-question marks are allocated in the outside margins they must be in line with the sub-question and NOT be circled.
- 1.19 The total marks awarded for the question must be written on the red line drawn by the marker and circled to clearly indicate the marks awarded for that particular question.
- 1.20 Marker must transfer marks to cover page and ensure correctness of transfer.
- 1.21 Markers should familiarise themselves with the question and answer before evaluating the responses of candidates.
- 1.22 Always interpret the responses of the candidates within the context of the question.

- 1.23 Mark what the candidate wrote and do not make assumptions about or predict intended responses.
- 1.24 Accept incorrect spelling in answers unless the spelling changes the meaning of the answer.
- 1.25 Pencil work is normally acknowledged as rough work and should not be considered/marked.
- 1.26 As a rule, marks are not awarded for formulas that are found in the attached formula sheet. If a formula was correctly manipulated, then only can a mark be awarded. Marks will also be awarded for correct formulas given by candidates if the particular formula is not found in formula sheet. Marks are awarded for correct substitution.
- 1.27 Incorrect values from previous calculations substituted at the right place in the formula will be awarded marks.
- 1.28 Markers must pay attention to calculations where an incorrect answer from a previous step was correctly substituted in the next calculation. In such cases, they must write “*sub*” next to the tick mark on the script to indicate that the mark was awarded for correct substitution only.
- 1.29 If during the calculations of a candidate, the formula that appear on the formula page was not indicated correctly but calculations and steps were done correctly, full marks may be awarded.
- 1.30 If, during a candidate’s calculations, the formula from the formula sheet was transferred incorrectly, no marks should be awarded for the values substituted in that calculation, as it renders the solution mathematically incorrect.

2. Specific marking instructions:

- 2.1 Markers to draw answers to scale on a transparency for marking purposes: QUESTIONS 7.2.4 and 7.3.2.
- 2.2 Question 7.2.4
This question must be marked using a mask or transparency that the marker draws to scale. Full marks should be awarded when the candidate’s response matches the required fit or shape. Additionally, part of the marks should be awarded when the candidate’s response is partially correct according to the fit of the mask or transparency, as outlined in the marking guideline.

QUESTION 1: MULTIPLE-CHOICE (GENERIC)

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

QUESTION 2: SAFETY (GENERIC)

2.1 Examination procedures:

- Breathing irregularities. ✓
- Abnormal position of limbs that indicate breakages. ✓
- Any visible signs of bleeding. ✓
- Level of consciousness. ✓

(Any 2 x 1) (2)

2.2 Arc welding safety:

- An operator must be adequately trained. ✓
- A workplace must be effectively partitioned off. ✓
- An operator uses protective equipment. ✓
- Ensure that all equipment is in safe working conditions. ✓
- Keep proper housekeeping to avoid fire hazards and electric shocks. ✓

(Any 2 x 1) (2)

2.3 Portable angle grinder (PPE excluded):

- Safety guard must be in place. ✓
- Protective shields must be placed around the area where grinding is taking place. ✓
- Use the correct disc. ✓
- Ensure the grinder is in good and safe working order.
- Make sure there are no cracks on the disc. ✓
- Ensure the lockable switch is in the off position. ✓
- Check electrical cables for any defects. ✓
- Ensure that the surrounding area is dry. ✓
- Ensure the grinder is in good and safe working order. ✓
- Ensure the disc is securely fastened. ✓
- Clamp work piece firmly. ✓

(Any 2 x 1) (2)

2.4 Handling gas cylinders:

- Never stack cylinders on top of one another. ✓
- Cylinders must not be stored in direct sunlight. ✓
- Chain/handle cylinders in upright position. ✓
- Valve guards must be on cylinders. ✓
- Don't work or bang on cylinders. ✓
- Never allow cylinders to fall. ✓
- Do not allow oil or grease to come into contact with oxygen fittings. ✓
- Do not interfere with the structure (no modification) of the gas cylinders. ✓
- Store full and empty cylinders separately. ✓
- Store acetylene and oxygen cylinders separately. ✓
- Keep cylinders away from flammable substances. ✓
- Do not drag/roll cylinders. ✓
- Cylinders' valves should be closed properly. ✓

(Any 2 x 1) (2)

2.5 **Disadvantage of product layout:**

- Lack of flexibility. ✓
- Optimum use of equipment is not possible. ✓

(Any 1 x 1) (1)

2.6 **Employee responsibilities:**

- Take reasonable care of the health and safety of himself and others. ✓
- To cooperate with employer to comply with any duty or responsibility. ✓
- Carry out any lawful order to him/her as to obey the health and safety rules. ✓
- Report any unsafe conditions. ✓
- Report any unhealthy conditions. ✓
- Report any incident immediately. ✓
- Report any injury immediately if possible. ✓

(Any 1 x 1) (1)
[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 Bend test:

3.1.1 Bends easily ✓ (1)

- 3.1.2
- Hard to bend ✓
 - It will snap/break easily ✓
 - Tends to crack/fracture easily ✓

(Any 1 x 1) (1)

3.2 Heat treatment:

To change the properties ✓ of metals. (1)

3.3 Quenching media:

- Water ✓
- Brine (salt and water) ✓
- Oil ✓
- Molten metal salts ✓
- Nitrogen ✓
- Air ✓
- Sand ✓
- Molten lead ✓
- Ash ✓

(Any 3 x 1) (3)

3.4 Sound test:

- Tap with a hammer ✓
 - Drop on the floor ✓
- (2)

3.5 Purpose of case hardening:

It is to produce a hard case ✓ over a tough core. ✓ (2)

3.6 Case hardening methods:

- Carburising ✓
- Nitriding ✓
- Cyaniding ✓

(Any 2 x 1) (2)

3.7 Normalising:

It is to relieve the internal stresses ✓ caused by machining/forging/welding. ✓ (2)

[14]

QUESTION 4: MULTIPLE-CHOICE (SPECIFIC)

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

QUESTION 5: TERMINOLOGY(TEMPLATES) (SPECIFIC)

5.1 Brass ring calculations:

5.1.1 Mean \varnothing = Inside \varnothing + Plate thickness
= 950 + 30 ✓
= 980 mm ✓ (2)

5.1.2 Mean circumference = $\pi \times$ Mean \varnothing
= $\pi \times 980$ ✓
= 3078,76 ✓
= 3079 mm ✓ (3)

5.2 Fusion welding symbol:

5.2.1 V-butt on the arrow side:

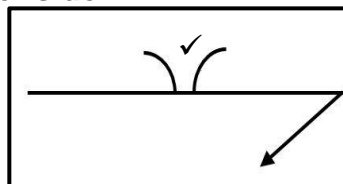
Symbol position ✓



(2)

5.2.2 Flare-V on the other side:

Symbol position ✓



(2)

5.3 Template maker's measuring tools:

- Steel measuring tape ✓
- Carpenters square ✓
- Protractor ✓
- Vernier calliper ✓
- Micrometer ✓
- Steel ruler ✓
- Combination square ✓
- Compasses ✓ (in conjunction with steel rulers)
- Set square ✓
- Lazer ✓
- Engineer's Square ✓

(Any 3 x 1) (3)

5.4 Types of templates:

- Web template ✓
- Flange template ✓
- Strip template ✓

(3)

5.5 Labels of welding symbols:

- A. Arrow ✓
- B. Weld all around ✓
- C. Site weld ✓
- D. Square butt/groove weld ✓ on both sides
- E. Tail ✓
- F. Pitch of weld ✓
- G. Length of weld ✓
- H. Root gap ✓

(8)
[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1. Parts of angle grinder:

- A. Disc ✓
- B. Electrical cord ✓
- C. Handle ✓
- D. Safety guard ✓

(4)

6.2 Difference between *power saw* and *vertical band saw*:

Power saw is used to rough cut large sections of metal ✓ and the vertical band saw is used to cut straight cuts/curves. ✓

(2)

6.3 Arc welding setup:

6.3.1 Parts of an arc welding setup:

- A. Negative cable/Earth cable ✓
- B. Earth clamp ✓
- C. Electrode ✓
- D. Electrode holder ✓
- E. Positive cable/Electrode cable ✓

(5)

6.3.2 Function of an electrode holder:

- To support/hold the electrode. ✓
- Guaranteeing a good electrical contact for current passage. ✓
- It also guarantees sufficient electrical insulation for the welding operator. ✓

(Any 1 x 1) (1)

6.4 Operating principle of a manual guillotine:

- This guillotine is operated by a foot/hand pedal/lever that activates a pressure plate. ✓
- The blade cuts the material. ✓
- The cut material is ejected at the back of the machine. ✓

(3)

6.5 Uses of a press machine:

- Installing components. ✓
- Removing components. ✓
- Press/form profiles. ✓

(3)

[18]

QUESTION 7: FORCES (SPECIFIC)

7.1 Stress and strain:

7.1.1 Stress:

$$\begin{aligned}\text{Stress} &= \frac{\text{Force}}{\text{Area}} \\ &= \frac{85 \times 10^3 \text{ N}}{0,0962 \text{ m}^2} \checkmark \\ &= 883575,88 \text{ Pa} \checkmark\end{aligned}\quad (2)$$

7.1.2 Strain:

$$\begin{aligned}\text{Strain} &= \frac{\Delta L}{oL} \\ &= \frac{0,05}{2000} \checkmark \\ &= 2,5 \times 10^{-5} \checkmark\end{aligned}$$

(If any unit indicated, then NO mark awarded for final answer) (2)

7.2 Beams:

7.2.1 Convert UDL to point load:

$$\begin{aligned}\text{UDL} &= 10 \times 3 \checkmark \\ &= 30 \text{ N} \checkmark\end{aligned}\quad (2)$$

7.2.2 Calculate RL:

Taking moment about right reaction (RR)

$$\begin{aligned}\text{RL} \times 10 &= (40 \times 2) + (30 \times 6,5) + (20 \times 8) \\ &= 80 + 195 + 160 \\ &= \frac{435}{10} \\ \text{RL} &= 43,5 \text{ N} \checkmark\end{aligned}\quad (4)$$

Calculate RR:

Taking moment about left reaction (RL)

$$\begin{aligned}\text{RR} \times 10 &= (20 \times 2) + (30 \times 3,5) + (40 \times 8) \\ &= 40 + 105 + 320 \\ &= \frac{465}{10} \\ \text{RR} &= 46,5 \text{ N} \checkmark\end{aligned}\quad (4)$$

7.2.3 **Bending moments at point A, B and C:**

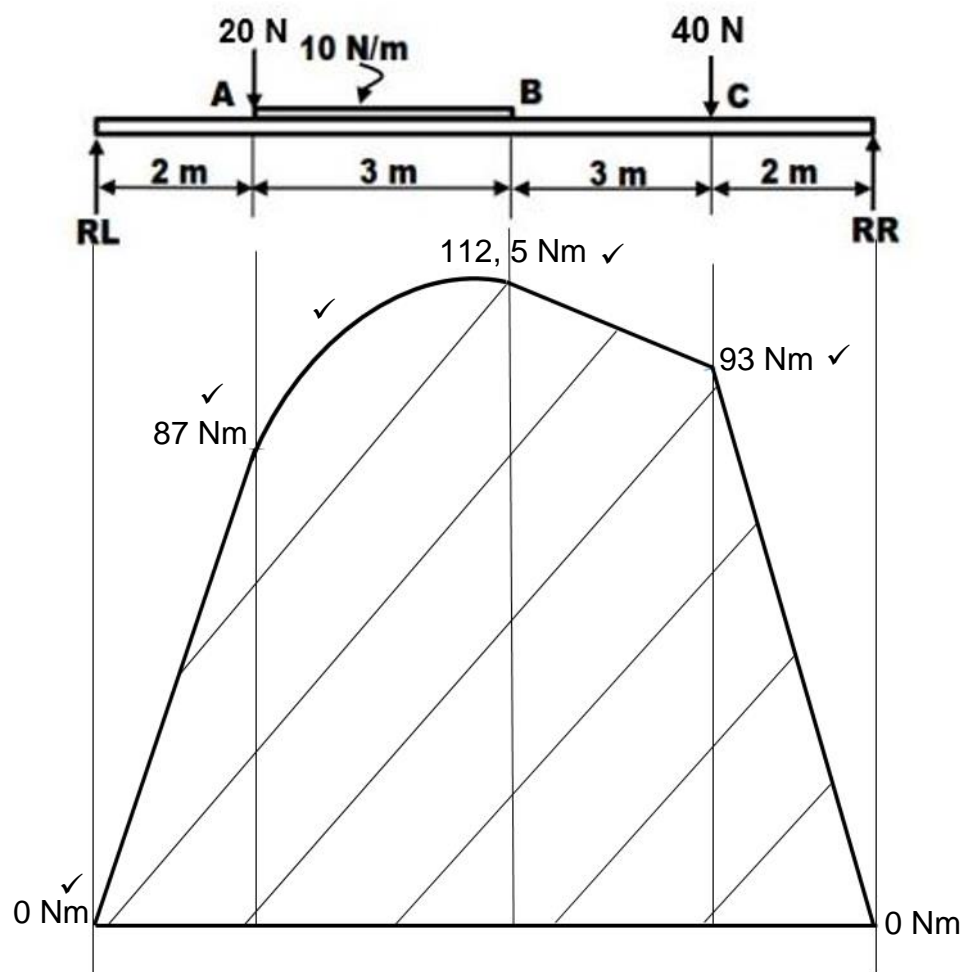
$$\begin{aligned} BM_A &= (43,5 \times 2) - (20 \times 0) \\ &= 87 \text{ Nm} \checkmark \end{aligned}$$

$$\begin{aligned} BM_B &= (43,5 \times 5) - (20 \times 3) - (30 \times 1,5) \checkmark \\ &= 112,5 \text{ Nm} \checkmark \end{aligned}$$

$$\begin{aligned} BM_C &= (43,5 \times 8) - (20 \times 6) - (30 \times 4,5) \checkmark \\ &= 93 \text{ Nm} \checkmark \end{aligned}$$

(5)

7.2.4 **Bending moment diagram:**



NOTE:

Redraw bending moment diagram according to given scale for marking purpose.
1 mark for a curved line between A & B.

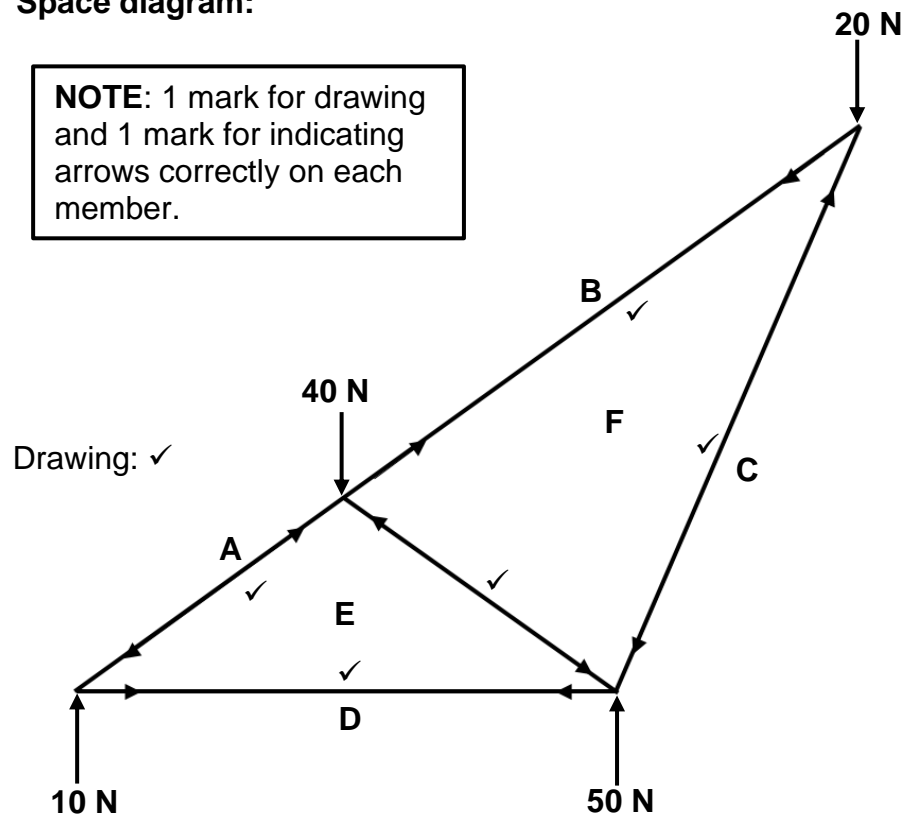
(5)

7.3

7.3.1

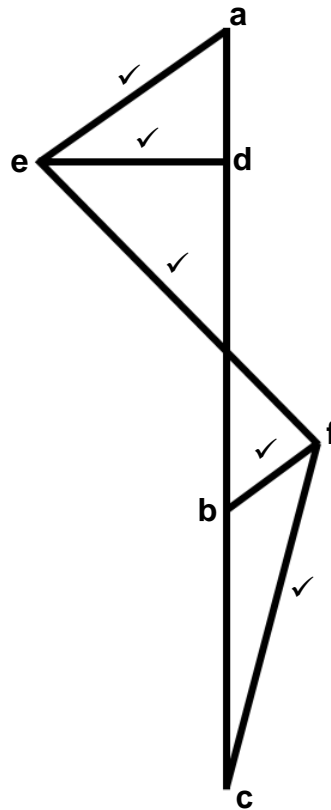
Space diagram:

NOTE: 1 mark for drawing and 1 mark for indicating arrows correctly on each member.



(6)

7.3.2 **Vector diagram:**



NOTE: Draw to scale on transparency for marking purposes.

(5)

7.3.3 **Members:**

MEMBER	MAGNITUDE	NATURE
AE	20 N (19-21) ✓	Strut ✓
BF	20 N (19-21) ✓	Tie ✓
CF	35 N (34-36) ✓	Strut ✓
DE	17 N (16-18) ✓	Tie ✓
EF	40 N (39-48) ✓	Strut ✓

NOTE: allow ± 2 mm variation.

(10)
[45]

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

8.1 Prevention of slag inclusion:

- Use correct electrode. ✓
- Remove slag from previous run before doing the next run. ✓
- Use adequate shielding gas flow. ✓
- Ensure that the surface is clean. ✓
- Correct the arc length. ✓
- Increase weaving action. ✓
- Correct welding speed. ✓
- Correct the welding current. ✓
- Don't use contaminated electrodes. ✓

(Any 3 x 1) (3)

8.2 Welding cracks:

- Centre line/Longitudinal cracks ✓
- Crater cracks ✓
- Transverse cracks ✓
- HAZ-cracks ✓

(Any 3 x 1) (3)

8.3 Causes of undercutting:

- Current too high. ✓
- Wrong electrode angle. ✓
- Arc length too long. ✓
- Weld speed too fast. ✓
- Too low arc voltage. ✓
- Faulty electrode manipulation. ✓
- Wrong electrode. ✓

(Any 2 x 1) (2)

8.4 Machinability test for welded joints:

- The form and colour of the shavings. ✓
- The form and colour of the sparks. ✓
- The ease of machining. ✓

(Any 2 x 1) (2)

8.5 Nick break test on a welded joint:

- Slag inclusion ✓
- Porosity ✓
- Lack of fusion ✓
- Oxidised/Burnt metal ✓
- Incomplete penetration ✓

(Any 2 x 1) (2)

8.6 **Blow holes in porosity:**

- Presence of contaminants/impurities on the job surface. ✓
- Presence of contaminants/impurities on electrode flux. ✓
- Welding in windy conditions. ✓
- Lack of shielding gas. ✓

(Any 3 x 1) (3)

8.7 **Disadvantages of dye penetrant test:**

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

(2)

8.8 **Procedure to conduct X-ray test:**

- The X-ray or gamma ray source is placed in front of the object being tested. ✓
- The tester must stand behind lead shields and far away from possible harmful exposure. ✓
- The source is activated for a brief moment and then the X-rays penetrate the test piece. ✓
- As they pass through the areas of lower density, the rays expose the film as lighter on the negative, ✓ indicating a weld defect. ✓
- Photographic films provide a permanent record of the shadow which can be carefully studied. ✓

(6)
[23]

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

9.1 Visual inspection:

- Shape of the profile ✓
- Uniformity of the surface ✓
- Overlap ✓
- Undercutting ✓
- Penetration bead ✓
- Root groove ✓
- Spatter ✓
- Overcapping ✓
- Cracks (Cratercracks) ✓
- Slag/slag inclusion ✓

(Any 4 x 1) (4)

9.2 Aspects that affect the rate of cooling:

- The size of the work piece. ✓
- Weld thickness. ✓
- Thermal conductive properties of parent metal. ✓
- Type of quenching media. ✓
- Carbon content/Type of material. ✓

(Any 3 x 1) (3)

9.3 Cold working and hot working:

- Cold working is when deformation ✓ of steel takes place below the recrystallisation temperature ✓ of the steel.
- Hot working is when deformation ✓ of steel takes place above the recrystallisation temperature ✓ of the steel.

(4)

9.4 Strongbacks:

It reduces distortion. ✓

(1)

9.5 Soften metal:

Annealing ✓

(1)

9.6 Elastic deformation:

It occurs when the joint recovers to its original position ✓ once the stresses have been relieved. ✓

(2)

9.7 Shrinkage in welding:

- Solidification shrinkage ✓
- Transverse shrinkage ✓
- Longitudinal shrinkage ✓
- Thickness shrinkage ✓
- Thermal contraction ✓
- Transformation shrinkage ✓

(Any 3 x 1) (3)

[18]

QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 Locking out of large machines:

- To ensure that isolation switches are switched off. ✓
- To ensure that switches are locked out and tagged to inform others that maintenance work is being conducted. ✓
- To ensure that nobody can turn on the machine while maintenance is being conducted. ✓
- To prevent injuries. ✓
- To prevent damage to equipment. ✓

(Any 2 x 1) (2)

10.2 Tagging plates:

It has multiple holes so that more than one technician can lock out ✓ the machine simultaneously. ✓

(2)

10.3 Lack of drill press maintenance:

- Premature failure of machine components due to breakage. ✓
- Decreases lifespan of components due to excessive wear and tear. ✓
- Create unsafe conditions. ✓
- Inaccurate finish. ✓
- Loss of production. ✓

(Any 2 x 1) (2)

10.4 Guidelines for a bench grinder:

- Check for cracks on the grinding wheels. ✓
- Dress the grinding wheel. ✓
- Adjust the tool rest to maximum 3 mm. ✓
- Check for loose nuts and bolts. ✓
- Clean the machine. ✓
- Oil up the bearings. ✓
- Check electrical connections. ✓
- Check guards are safely installed and are not damaged. ✓
- Check the tool rest for damage. ✓

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

QUESTION 11: DEVELOPMENT (SPECIFIC)

11.1 Type of hopper:

Rectangle to rectangle ✓ off centre. ✓

(2)

11.2 11.2.1 True length A-4:

$$\begin{aligned} A-4 &= \sqrt{350^2 + 450^2 + 600^2} \\ &= \sqrt{122500 + 202500 + 360000} \\ &= \sqrt{685000} \checkmark \\ &= 827,65 \text{ mm} \checkmark \end{aligned}$$

(5)

11.2.2 True length C-2:

$$\begin{aligned} C-2 &= \sqrt{150^2 + 450^2 + 600^2} \\ &= \sqrt{22500 + 202500 + 360000} \\ &= \sqrt{585000} \checkmark \\ &= 764,85 \text{ mm} \checkmark \end{aligned}$$

(5)

11.2.3 True length D-3:

$$\begin{aligned} D-3 &= \sqrt{750^2 + 150^2 + 600^2} \\ &= \sqrt{562500 + 22500 + 360000} \\ &= \sqrt{945000} \checkmark \\ &= 972,11 \text{ mm} \checkmark \end{aligned}$$

(5)

11.2.4 True length X-Y:

$$\begin{aligned} X-Y &= \sqrt{350^2 + 600^2} \checkmark \\ &= \sqrt{122500 + 360000} \\ &= \sqrt{482500} \\ &= 694,62 \text{ mm} \checkmark \end{aligned}$$

(2)

11.2.5 X-Z on base:

$$\begin{aligned} X-Z &= 350 + 200 \checkmark \\ &= 550 \text{ mm} \checkmark \end{aligned}$$

(2)
[21]

TOTAL: 200