



Province of the
EASTERN CAPE
EDUCATION

**NATIONAL
SENIOR CERTIFICATE**

GRADE 12

SEPTEMBER 2021

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

MARKS: 200

This marking guideline consists of 13 pages.

SECTION A: COMPULSORY**QUESTION 1: MULTIPLE-CHOICE QUESTIONS**

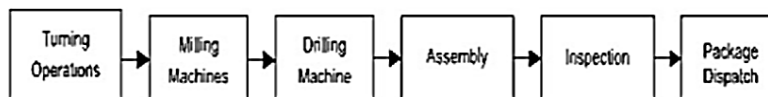
- 1.1 C ✓
 1.2 D ✓
 1.3 D ✓
 1.4 A ✓
 1.5 B ✓
 1.6 B ✓

(6 x 1) [6]

QUESTION 2: SAFETY (GENERIC)**2.1 Safety precautions**

- Pressure gauges must be checked and tested regularly and adjusted or replaced if any malfunctioning occurs. ✓
- Supporting pins that keep the platform at a desired height on the frame must be inspected for damage. ✓
- Check the floor for oil and apparatus for leaks.
- The platform on which the workpiece rests must be rigid and square with the press cylinder.

(Any 2 x 1) (2)

2.2 Product Layout

✓✓ (2)

- 2.3 **Perspex shield** is installed to shield flying objects hurting the operator's eye. ✓

(1)

- 2.4 2.4.1 Identification of machine
 Surface grinder ✓

(1)

2.4.2 Labels for parts of a surface grinder

- A – Workpiece ✓
 B – Machine spindle ✓
 C – Magnetic table ✓
 D – Grinding wheel ✓

(4 x 1) (4)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 Heat treatment refers to heating and cooling of metals under controlled conditions in their solid state so as to change their properties. ✓✓ (2)

3.2 HEAT TREATMENT PROCESS

	PROCESS	PROPERTY
3.2.1	Hardening	Very hard, maximum tensile and brittle ✓
3.2.2	Tempering	Ductile ✓
3.2.3	Annealing	Soft and ductile. ✓
3.2.4	Normalising	Tough and machinable. ✓

(4 x 1) (4)

3.3 Purpose for case hardening:

- It hardens the surface. ✓
- It provides a wear resistant surface. ✓
- Strengthens core to withstand applied loads. ✓ (Any 2 x 1) (2)

3.4 Carbon effect:

Steel with low carbon content ✓ will not respond very much to the hardening process. ✓ (2)

3.5

- Sound test workshop test on materials ✓
- Bend test ✓
- Filling test
- Machining test (Any 2 x 1) (2)

3.6 Reasons for annealing:

- To relieve internal stresses that may have been set up during other processes. ✓
- To soften them to facilitate the machining processes. ✓
- To make material ductile.
- Refine their grain structures.
- Reduce brittleness. (Any 2 x 1) (2)

[14]**QUESTION 4 MULTIPLE-CHOICE QUESTIONS (SPECIFIC)**

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

(14 x 1) **[14]**

QUESTION 5: MATERIALS TEMPLATES – ROLLING AND BENDING**5.1 Purpose of purlins in roof trusses:**

- Purlins are fastened to the roof trusses ✓ to attach the roof covering. ✓ (2)

5.2 Reason why stiffeners are used in beams.

- To strengthen the web of the beam. ✓ (1)

5.3 The use of strip templates:

- They are used for longer sections of angle iron to mark off holes to be drilled. ✓ (1)

5.4 What does templates indicate?

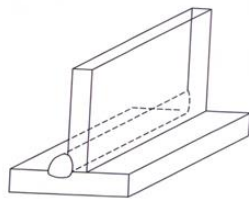
- The correct form and measurements of the project ✓
- The type of material to be used. (thickness and size) ✓
- Job number
- Drawing number
- The number of components required
- This side up or other side up markings
- Coloured or shaped markings to denote hole diameters (Any 2 x 1) (2)

5.5 Labels of roof truss:

- A – Purlin ✓
- B – Rafter ✓
- C – Tie beam ✓
- D – Shoe plate ✓
- E – Inclined toe ✓ (5 x 1) (5)

5.6 Sketches:

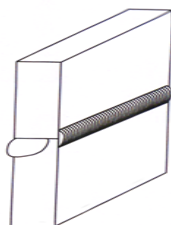
5.6.1



✓✓✓

(3)

5.6.2



✓✓✓

(3)

5.7 Calculations:

$$\text{Mean diameter} = 220 + 220 + 12 \div 2 \quad \checkmark$$

$$= 452 \div 2$$

$$= 226 \text{ mm} \quad \checkmark$$

(2)

$$\text{Circumference} = 3,142 \times 226 \text{ mm}$$

$$= 710,09 \text{ mm} \quad \checkmark$$

(1)

$$\text{Length required for 2 straight pieces} = 66 \text{ mm} + 66 \text{ mm}$$

$$= 132 \text{ mm} \quad \checkmark$$

$$\text{Length of material for 1 clamp} = 710,09 \text{ mm} + 132 \text{ mm}$$

$$= 842,309 \text{ mm} \quad \checkmark$$

$$\text{Length of material for 20 clamps} = 842,309 \text{ mm} \times 20$$

$$= 16\,841 \text{ mm} \quad \checkmark$$

(3)

[23]

QUESTION 6: TOOLS**6.1 TWO different types of tap wrenches:**

- T-handle or double handle OR ✓
- Adjustable wrenches ✓

(2)

6.2 Uses of bench grinders:

- Grinding off excess material ✓
- Cleaning surfaces with a wire wheel ✓
- Polishing or buffing

(Any 2 x 1) (2)

6.3 Purpose of a powersaw:

- It is used to rough cut large sections of metal. ✓

(1)

6.4 Determine the drilling speed of a pedestal drilling machine:

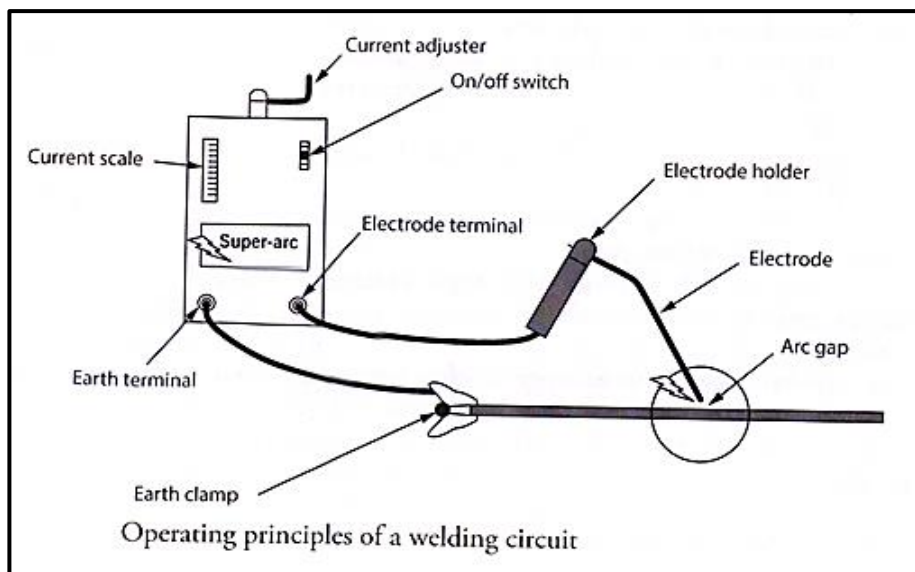
- Slower speed – for large diameters ✓
- Faster speed – for small diameter holes. ✓

(2)

6.5 Reasons why guillotines have material thickness cutting limits:

- To preserve the shearing blades. ✓
- Thicker or harder material will chip the brittle blade and result in poor future cuts or jamming of the guillotine. ✓

(2)

6.6 Sketch of basic AC arc welding machine:

(Any 7 labels x 1)

(7)

6.7 The use of shielding gas in MIG welding:

- MIG welding machines use a shielding gas to protect the weld pool ✓ from atmospheric gases. ✓

(2)

[18]

QUESTION 7: FORCES7.1 7.1.1 **Stress**

- This is an internal force in material resisting a load. ✓✓ (2)

7.1.2 **Strain**

- This is the measurement of the deformation produced by the external forces and is determined by the ratio between deformation and original length. ✓✓ (2)

7.1.3 **Safety factor**

- This is the maximum number of times with which the maximum stress is decreased to obtain a safe stress. ✓✓ (2)

7.2 7.2.1 **The stress in the material:**

$$\text{Stress} = \frac{\text{Load}}{\text{Area}}$$

$$\text{but Area} = \frac{\pi d^2}{4}$$

$$= \frac{\pi \times (0,05)^2}{4} \quad \checkmark$$

$$1,964 \times 10^{-3} \text{ m}^2 \quad \checkmark$$

$$\text{Stress} = \frac{50 \times 10^3}{1,964 \times 10^{-3}} \quad \checkmark$$

$$= 25,46 \times 10^6 \text{ Pa}$$

$$= 25,46 \text{ MPa} \quad \checkmark \quad (4)$$

7.2.2 **The strain if the final length of the bar is 3,00 m.**

$$\text{Strain} = \frac{\Delta L}{OL}$$

but

$$\text{Final length} = OL + \Delta L$$

$$\Delta L = \text{final length} - OL \quad \checkmark$$

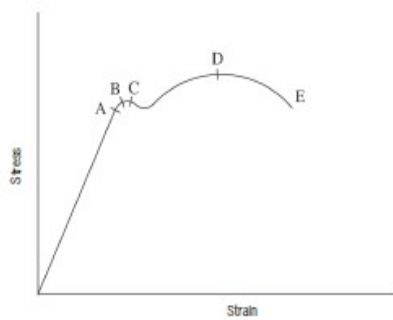
$$= 3,005 - 3$$

$$= 0,005 \text{ m} \quad \checkmark$$

$$\text{Strain} = \frac{0,005}{3}$$

$$= 1,67 \times 10^{-3} \quad \checkmark \quad (3)$$

7.3 Labelled sketch of the stress strain graph.



KEY

A limit of proportionality

B Elastic limit

C Yield point

D Maximum stress

E Break stress

(Each label x 1)

(7)

7.4 7.4.1 Calculate the reactions at the supports LR and RR

CALCULATING REACTIONS

Take moments about RR

$$\text{LR} \times 13 = (50 \times 5 \times 10,5) + (400 \times 8) + (600 \times 3) \quad \checkmark$$

$$= 2\,625 + 3\,200 + 1\,800 \quad \checkmark$$

$$\text{LR} = 586,5 \text{ N} \quad \checkmark$$

Take moments about LR

$$\text{RR} \times 13 = (600 \times 10) + (400 \times 5) + (50 \times 5 \times 2,5) \quad \checkmark$$

$$= 6000 + 2000 + 625 \quad \checkmark$$

$$\text{RR} = 663,5 \text{ N} \quad \checkmark$$

(6)

7.4.2 Calculate the BM at each point of the beam A, B, C and D.

BENDING MOMENTS

$$\text{BMA} = 586,5 \times 0 = 0 \text{ Nm} \quad \checkmark$$

$$\text{BMB} = (586,5 \times 5) - (250 \times 2,5) = 2307,5 \text{ Nm} \quad \checkmark$$

$$\text{BMC} = (586,5 \times 10) - (250 \times 7,5) - (400 \times 5) = 1\,990 \text{ Nm} \quad \checkmark$$

$$\text{BMD} = (586,5 \times 13) - (250 \times 10,5) - (400 \times 8) - (600 \times 3) = 0 \text{ m} \quad \checkmark \quad (4)$$

7.4.3 Calculate the shear force at A, B, C and D.

SHEAR FORCE

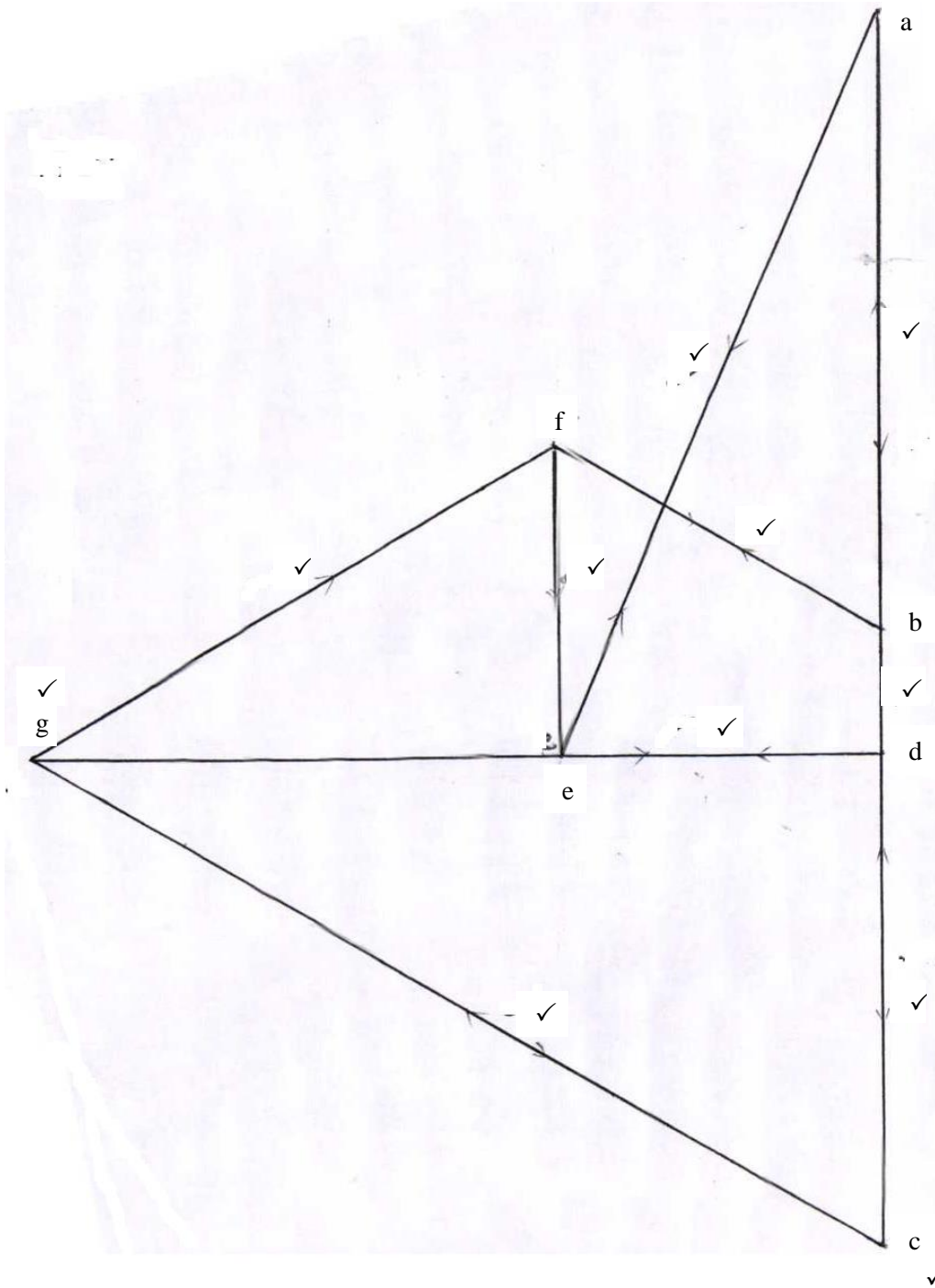
$$\text{SFA} = 586,5 \text{ N} \quad \checkmark$$

$$\text{SFB} = 586,5 - 250 = 336,5 \text{ N} \quad \checkmark$$

$$\text{SFC} = 586,5 - 250 - 400 = -64,5 \text{ N} \quad \checkmark$$

$$\text{SFD} = 586,5 - 250 - 400 - 600 = -663,5 \text{ N} \quad \checkmark \quad (4)$$

7.5 Vector diagram: Scale 10 mm = 1 N



(11)
[45]

QUESTION 8: JOINING METHODS (INSPECTION OF WELDS)**8.1 Internal defects – Nickbreak test:**

- Slag inclusion ✓
- Porosity ✓
- Lack of fusion ✓
- Oxidised metal
- Burned metal

(Any 3 x 1) (3)

8.2 Visual requirements for an acceptable weld:

- Shape of the profile ✓
- Uniformity of the surface ✓
- Overlap ✓
- Free from any external defects
- Penetration bead
- Root groove

(Any 3 x 1) (3)

8.3 Elements during the visual inspection in welding:

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

(Any 3 x 1) (3)

8.4 Performing an X-ray test on a welded joint:

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

(5)

8.5 Factors that determine the current setting in arc welding.

- Base metal type ✓
- Base metal thickness ✓
- Electrode thickness ✓

(3 x 1) (3)

8.6 Factors that should be considered during oxyacetylene welding to ensure quality welding:

- Correct flame for the work at hand ✓
- Correct angle of welding torch and rod ✓
- Depth of fusion ✓
- The welding rate (Any 3 x 1) (3)

8.7 Preventative measures for porosity during MIG welding:

- Cleaning the welding surface. ✓
- Avoid rust in MIG wire electrode. ✓
- Ensure that supply of shielding gas is not interrupted. ✓
- Avoid welding in windy condition. (Any 3 x 1) (3)

[23]

QUESTION 9: JOINING METHODS (STRESSES AND DISTORTION)

9.1 Methods used 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 strongbacks
- Use clamps, jigs and fixtures (Any 5 x 1) (5)

9.2 Distortion on a welded joint:

- Weld distortion is the warping of the base plate ✓ caused by heat from the welding arc/flame. ✓ (2)

9.3 The meaning of shrinkage in a welded joint:

- Shrinkage is a form of plastic deformation ✓ where the metal has deformed because of contraction on cooling. ✓ (2)

9.4 The iron-carbon equilibrium diagram labels:

- A – Ferrite and pearlite ✓
- B – Ferrite and austenite ✓
- C – Austenite ✓
- D – Cementite and austenite ✓
- E – Pearlite and cementite ✓ (5)

9.5 The factors that affect the grain size of steel when it is being cold worked:

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

[18]

QUESTION 10: MAINTENANCE**10.1 Tagging plates have multiple holes:**

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

(2)

10.2 General maintenance guidelines for a pedestal drilling machine:

- Visual checks of electrical wiring, switches, etc. ✓
- Verify that all guards are secure and function correctly ✓
- Ensure workspace is clear and without hindrances.
- Confirm availability and conditions of PPE
- Lubricate moving parts.
- Use moisture-penetrating oil spray to prevent rust.
- Check the availability of specific tools.
- Check the run-out of the spindle.
- Inspect belts for wear and tear.
- Ensure the drive belt is correctly tensioned.
- Check the condition of the rack and pinion mechanisms and lubricate.
- Ensure cuttings are removed.
- Inspect the Morse taper sleeves for burrs/scratches.

(Any 2 x 1)

(2)

10.3 Reasons for the maintenance of machines in the welding workshop:

- Promote cost saving. ✓
- Improves safety. ✓
- Increases equipment efficiency.
- Fewer equipment failure.
- Improves reliability of equipment.

(Any 2 x 1)

(2)

10.4 Methods to reduce friction when drilling holes:

- By reducing both drill speed and feed speed. ✓
- By applying lubrication. (cutting fluid) ✓

(2)

[8]

QUESTION 11: TERMINOLOGY (DEVELOPMENT)

Calculations:

$$11.1 \quad 1 - 2 = \frac{\pi x D}{12} \checkmark$$

$$= \frac{3.142 \times 72}{12} \checkmark$$

$$1 - 2 = 18,849 \checkmark$$

$$1 - 2 = 2 - 3 = 3 - 4 = 18,849 \checkmark \quad (4)$$

$$11.2 \quad 1 - X = \sqrt{(OX - R)^2} \checkmark + \text{Vertical height}^2 \checkmark$$

$$= \sqrt{(45 - 36)^2} + 50^2 \checkmark$$

$$= 50,8 \quad \checkmark \quad (4)$$

$$11.3 \quad 1 - a = \sqrt{(1 - x)^2} \checkmark + (a - x)^2 \checkmark + \text{Vertical height}^2 \checkmark$$

$$= \sqrt{(9)^2} + 45^2 + 50^2 \checkmark$$

$$= 67,868 \quad \checkmark \quad (5)$$

$$11.4 \quad 2 - a = \sqrt{(o - x) - R \cos 30^\circ}^2 \checkmark + [(a - x) - R \sin 30^\circ]^2 \checkmark + \text{height}^2 \checkmark$$

$$= \sqrt{(45 - 36 \cos 30^\circ)^2} + [(a - x) - R \sin 30^\circ]^2 + \text{height}^2$$

$$= \sqrt{(45 - 36 \cos 30^\circ)^2} + (45 - 36 \sin 30^\circ)^2 + 50^2 \checkmark$$

$$= \sqrt{(13,823^2} + 27^2 + 50^2 \checkmark$$

$$= 58,481 \quad \checkmark \quad (6)$$

$$11.5 \quad a - x = 90 \div 2 \quad \checkmark$$

$$= 45 \quad \checkmark \quad (2)$$

[21]**TOTAL: 200**