



Province of the
EASTERN CAPE
EDUCATION

Iphondo leMpuma Kapa: Isebe leMfundo
Provinsie van die Oos Kaap: Department van Onderwys
Porafensie Ya Kapa Botjhabela: Lefapha la Thuto

NATIONAL SENIOR CERTIFICATE

GRADE 12

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MECHANICAL TECHNOLOGY WELDING AND METAL WORK MARKING GUIDELINE

MARKS: 200

This marking guideline consists of 16 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

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

QUESTION 2: SAFETY (GENERIC)**2.1 Recommendations for the application of first aid:**

- It is vital that the person applying first aid remembers his/her limitations and realises that only first aid needs to be applied before the casualty is referred to a medical practitioner. ✓
- If possible, take away the cause of the accident to avoid any further injuries. ✓
- Attention must be given instantly to loss of blood and breathing difficulties. ✓
- The pulse must be checked and the pulse rate counted.
- Determine the state of shock and treat the patient if necessary.
- Investigate for the broken limbs and provide the necessary treatment.
- If clothes must be removed, make sure to respect the injured person's privacy at all times.
- Ensure that the injured person is as comfortable as possible.
- If the injured person is unconscious, ascertain the degree of consciousness and possible cause and treat accordingly.
- Call an ambulance or injured person's doctor and relatives as soon as possible.
- Do not remove anything that is stuck to the wound.
- Never use sticky plaster on the wound.
- Cover the wound with a clean, lint-free cloth.
- Avoid using any oily substances or lotions on wound.
- If necessary, cool wounds with cold water.
- With burns, do not under any circumstances puncture the blister. (3 x 1) (3)

2.2 Reason to avoid standing in wet surroundings or having wet clothes and hands:

To avoid getting shocked by the arc welding high voltage. ✓ (1)

2.3 The importance of ventilation during arc welding:

To ensure the free flow of air to channel out the bad fumes ✓ caused by the burning flux which are harmful to human lungs. ✓ (2 x 1) (2)

- 2.4 The maximum gap is 3 mm. ✓ (1)
- 2.5 **Advantages of product layout of machines:**
- 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. (3 x 1) (3)
- [10]**

QUESTION 3: MATERIALS (GENERIC)

3.1 Machining test:

- 3.1.1 Easy to cut ✓ (1)
- 3.1.2 Difficult to cut ✓ (1)
- 3.1.3 Easy to cut ✓ (1)
- 3.1.4 Difficult to cut ✓ (1)

3.2 Tests to identify various metals:

3.2.1 Sound test:

- Tapping the metal with a hammer (any metal object) ✓ and identify the sound. ✓

OR

- Dropping the metal on the floor ✓ and identify the sound. ✓ (Any 1 x 2) (2)

3.2.2 Spark test:

- Holding the metal against the grinding wheel in a dimly lit area ✓ and observe the colour, length and shape of the sparks. ✓ (2)

3.3 Purpose of heat treatment of steel

- To change ✓ the properties of steel. ✓
- To change ✓ the grain structure of steel. ✓ (Any 1 x 2) (2)

3.4 THREE factors for heat treatment of steel

- Heating temperature / Carbon content ✓
- Soaking (Time period at temperature) / Work piece size ✓
- Cooling rate / Quenching rate (Quenching medium) ✓ (3)

3.5 Quenching medium

- Water ✓
 - Oil ✓
 - Brine ✓ (Any 1 x 1) (1)
- [14]**

QUESTION 4: MULTIPLE CHOICE QUESTION (SPECIFIC)

4.1 D ✓

4.2 A ✓

4.3 C ✓

4.4 D ✓

4.5 A ✓

4.6 A ✓

4.7 B ✓

4.8 D ✓

4.9 B ✓

4.10 C ✓

4.11 D ✓

4.12 A ✓

4.13 C ✓

4.14 A ✓

[14]

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

- 5.1 Template loft is the heart of a structural workshop. ✓✓ (2)
- 5.2 Template loft must be separated, because in the template loft must be quiet ✓ and have enough light. ✓ (2)
- 5.3 **The template loft floor must:**
- be a wooden floor ✓
 - be kept clean ✓
 - have a matt black finish ✓
 - have a permanent base ✓
 - have centre lines to save time in marking out ✓
 - be large enough to accommodate the required work. ✓ (Any 2 x 1) (2)
- 5.4 **Weld symbol:**
- A – Tail ✓
- B – Weld symbol ✓
- C – Pitch of weld ✓
- D – Weld all round ✓
- E – Arrow ✓
- F – Site of weld ✓ (6)
- 5.5 **Dimensions of the material:**
- 5.5.1 Mean diameter = Outside diameter - plate thickness ✓
- = 810 – 30 ✓
- = 780 mm ✓ (3)
- 5.5.2 Mean circumference = $\pi \times$ mean diameter
- = $\pi \times 780$ ✓
- = 2450.4 mm ✓
- = 2450 mm ✓ (3)
- 5.6 **Roof truss:**
- A – Rafter ✓
- B – Cleat ✓
- C – Purlin ✓
- D – Gusset plate ✓
- E – Tie beam / Main tie ✓ (5)

[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)**6.1 Identify given machine, give function and label parts:**

6.1.1 Pedestal drill / Drill press ✓ (1)

6.1.2 To cut / drill holes ✓ (1)

6.1.3 A – Table / Machine table / Working table ✓
B – Chuck ✓
C – Motor / Head ✓
D – Column / Pillar ✓ (4)

6.2 Arc welding machine:

6.2.1 A – Arc welding machine / Power source / Inverter ✓
B – Earth clamp /work clamp ✓
C – Electrode / Rod / welding rod ✓
D – Electrode holder ✓ (4)

6.2.2 • Holds the electrode ✓
• Provide current to the electrode ✓
• Used with electrode to weld ✓ (Any 1 x 1) (1)

6.3 Rolling machines:

• Vertical rolls ✓
• Horizontal pyramid rolls ✓
• Offset pinch rolls ✓ (3)

6.4 MIG welding process:

A – Molten metal / Weld pool / Weld bead ✓
B – Electrode wire / Electrode ✓
C – Nozzle / Contact tip / Electrical contact / Gas shroud ✓
D – Shielding gas ✓ (4)
[18]

QUESTION 7: FORCES(SPECIFIC)**7.1 Stress and Strain:**

7.1.1

$$A = \frac{\pi(0,032)^2}{4} \checkmark$$

$$= 8,042477193 \times 10^{-4} \text{ m}^2 \checkmark$$

$$\text{or } 0,0008042477193 \text{ m}^2$$

Stress:

$$\text{stress} = \frac{\text{Force}}{\text{Area}} \checkmark$$

$$\sigma = \frac{100000 \text{ N}}{0,0008042477193 \text{ m}^2} \checkmark$$

$$\sigma = 124339799,3 \text{ Pa} \checkmark$$

$$\text{OR } \sigma = 124339,8 \text{ kPa}$$

$$\text{OR } \sigma = 124,3 \text{ MPa}$$

(5)

7.1.2 **Strain:**

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

$$\therefore \text{Strain} = \frac{0,5}{120} \checkmark$$

$$\varepsilon = 4,1666666666667 \times 10^{-3}$$

$$\text{OR } \varepsilon = 0,00416666666 \checkmark$$

(3)

7.2 Stress – strain diagram:A – Limit of proportional $\checkmark$ B – Elastic limit $\checkmark$ C – Yield point $\checkmark$ D – Maximum stress $\checkmark$ E – Break point $\checkmark$

(5)

7.3 Beams:

7.3.1 Take moments about RR:

$$RL \times 10 = (8 \times 8) + (14 \times 5) + (6 \times 2) \checkmark$$

$$RL \times 10 = 6 + 70 + 12$$

$$RL \times 10 = 146$$

$$RL = \frac{146}{10} \quad \checkmark$$

$$RL = 14,6 \text{ kN} \quad \checkmark$$

Take moments about RL:

$$RR \times 10 = (6 \times 8) + (14 \times 5) + (8 \times 2) \checkmark$$

$$RR \times 10 = 48 + 70 + 16$$

$$RR \times 10 = 134 \quad \checkmark$$

$$RR = \frac{134}{10}$$

$$RR = 13,4 \text{ kN} \quad \checkmark \quad (6)$$

Calculating bending moments at B, C and D:

7.3.2 $Bm \text{ B} = (14,6 \times 2) - (8 \times 0) = 29,2 \text{ kN.m} \quad \checkmark$

$$Bm \text{ C} = (14,6 \times 5) - (8 \times 3) - (14 \times 0) = 49 \text{ kN.m} \quad \checkmark$$

$$Bm \text{ D} = (14,6 \times 8) - (8 \times 6) - (14 \times 3) - (6 \times 0) = 26,8 \text{ kN.m} \quad \checkmark \quad (3)$$

Shear forces at A, B, C, D and E:

$$7.3.3 \quad \mathbf{SF_A} = 14,6 + 0$$

$$= 14,6 \text{ kN } \checkmark$$

$$\mathbf{SF_B} = 14,6 - 8$$

$$= 6,6 \text{ kN } \checkmark$$

$$\mathbf{SF_C} = 6,6 - 14$$

$$= -7,4 \text{ kN } \checkmark$$

$$\mathbf{SF_D} = -7,4 - 6$$

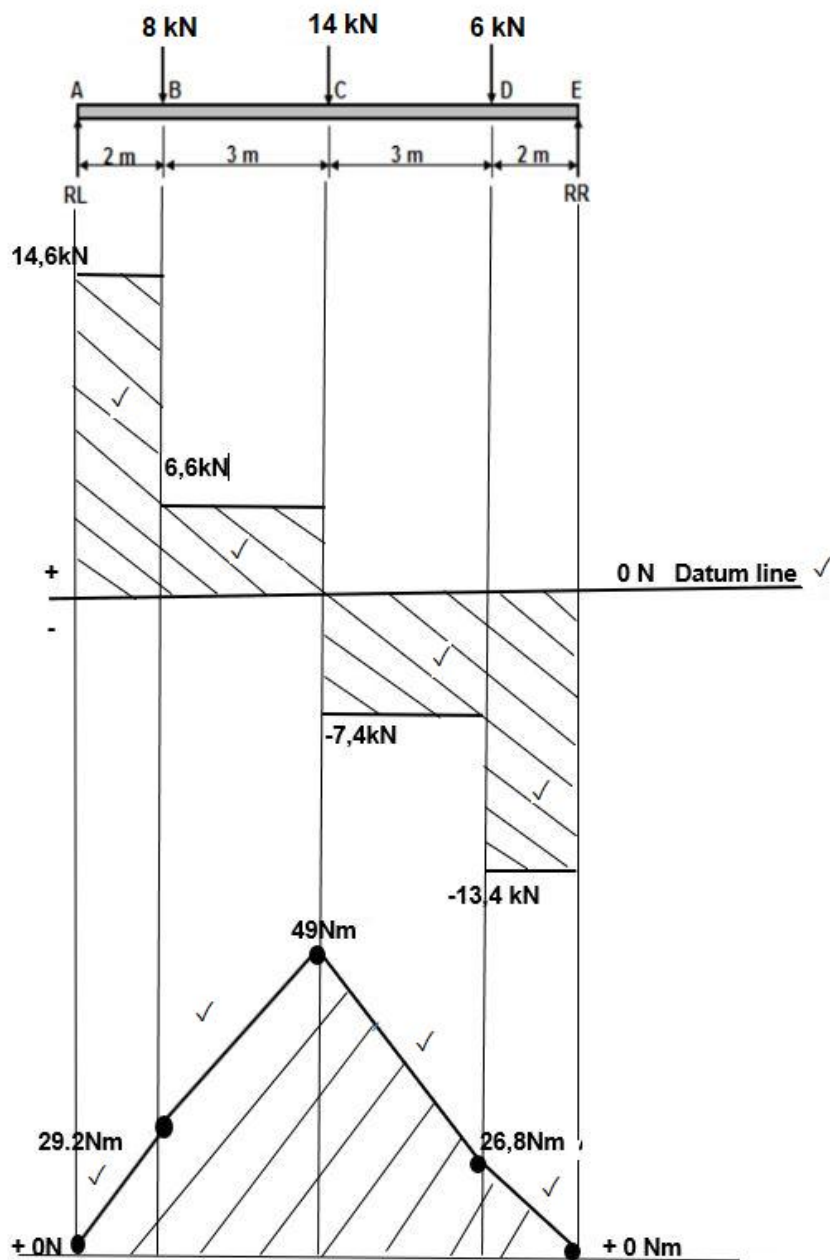
$$= -13,4 \text{ kN } \checkmark$$

$$\mathbf{SF_E} = -13,4 + 13,4$$

$$= 0 \text{ kN } \checkmark$$

(5)

7.3.4 Shear Force and Bending Moment Diagram



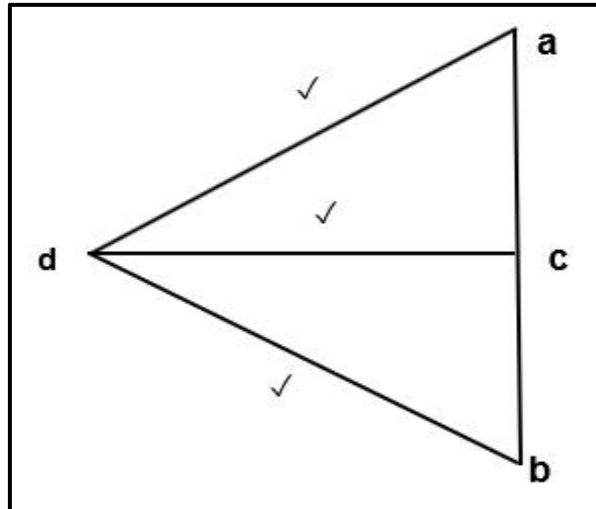
Note to marker:

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

(9)

7.4 Vector diagram:

Scale 1 mm : 5 N



Member	Magnitude	Nature
AD	490 – 510N ✓	STRUT ✓
BD	490 – 510N ✓	STRUT ✓
CD	415 – 435 N ✓	TIE ✓

NB: Marker must redraw the diagrams according to the given scale.

When marking, use a tolerance of ± 2 mm.

(9)
[45]

QUESTION 8: JOINING METHODS (WELD INSPECTION)**8.1 Factors to be observed during oxy-acetylene welding:**

- Correct flame for the work on hand. ✓
 - Correct angle of welding torch and welding rod. ✓
 - Depth penetration and amount of fusion. ✓
 - The rate of progress along the joint. ✓
 - The distance of the nozzle from the parent metal. ✓
- (Any 2 x 1) (2)

8.2 Defects that can be observed during visual inspection:

- Spatter ✓
 - Cracks ✓
 - Undercutting ✓
 - Weld crater ✓
 - Surface pitting of porosity ✓
- (Any 4 x 1) (4)

8.3 Non-destructive tests:

- X – ray testing. ✓
 - Liquid dye penetrant testing. ✓
 - Ultrasonic testing. ✓
- (Any 2 x 1) (2)

8.4 Weld dimensions:

- A – Penetration. ✓
 - B – Width. ✓
 - C – Height. ✓
- (3)

8.5 Causes of the following arc welding defects:**8.5.1 Slag inclusion:**

- Defective consumables. ✓
 - Inadequate shielding gas. ✓
 - Joint contamination. ✓
 - Too low current. ✓
 - Improper slag removal from previous weld. ✓
 - Excessive weaving. ✓
 - Electrode at incorrect angle. ✓
- (Any 2 x 1) (2)

8.5.2 Undercutting:

- Too high welding current ✓
 - Electrode at incorrect angle ✓
 - Excessive weaving ✓
 - Arc length too long ✓
 - Travel speed too high ✓
- (Any 2 x 1) (2)

8.6 Welding defects:

8.6.1 Spatter. ✓ (1)

8.6.2 Porosity. ✓ (1)

8.7 Liquid dye penetrant:

- Clean the surface to be tested. ✓
- Spray the liquid dye penetrant onto the surface. ✓
- Allow liquid dye to penetrate. ✓
- Remove excess dye with a cleaner / water. ✓
- Spray a developer onto the surface to bring out the colour / Using a UV light to show defects. ✓
- Observe surface for defects. ✓

(6)

[23]

QUESTION 9: JOINING METHODS - STRESSES AND DISTORTION (SPECIFIC)**9.1 Definitions of terms:**

9.1.1 Shrinkage: Weld shrinkage is a form of plastic deformation ✓ where the metal has deformed as a result of contraction on cooling. ✓ (2)

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

9.2 Factors that influence the coefficient of friction between two materials:

- Use strong-back ✓
 - Apply intermittent welding ✓
 - Anticipate the shrinkage forces ✓
 - Do not over – weld ✓
 - Plan the welding sequence ✓
 - Place welds near the neutral axis ✓
 - Use clamps, jigs and fixtures ✓
 - Use as few passes as possible ✓
 - Use back – step welding ✓
- (Any 3 x 1) (3)

9.3 Causes of residual stress in welds:

- Heat present in the weld. ✓
 - Qualities of parent metal, filler rod or electrode. ✓
 - Shape and size of weld. ✓
 - Number of successive welds runs. ✓
 - Comparative weight of weld and parent metal. ✓
 - Type of welding joint used. ✓
 - Welding method used to mitigate stress and distortion. ✓
 - Type of structure of neighbouring joints. ✓
 - Freedom of joint to be able to expand and contract. ✓
 - Rate of cooling. ✓
 - Stresses already present in the parent metal. ✓
- (Any 1 x 1) (1)

9.4 Difference between cold working and hot working of steel:

- **Cold working** is when deformation of steel takes place below ✓ the recrystallization temperature of the steel. ✓
 - **Hot working** is when deformation of steel takes place above ✓ the recrystallization temperature of the steel. ✓
- (4)

9.5 Types of carbon steels and their carbon content %:

Low carbon steel ✓	(0,15 – 0,30%) ✓
Medium carbon steel ✓	(0,31 – 0,70%) ✓
High carbon steel ✓	(0,71 – 1,50%) ✓

(6)

[18]

QUESTION 10: MAINTENANCE (SPECIFIC)**10.1 THREE causes of malfunction of guillotines:**

- Friction ✓
- Overloading ✓
- Lack of lubrication / Incorrect lubrication ✓ (2)

10.2 Methods of reducing friction:

- Friction reduced by applying cutting fluid. ✓
- Friction reduced by applying light oil to the drill bit. ✓ (Any 1 x 1) (1)

10.3 Factors to consider when selecting the cutting speed:

- Rate of feed ✓
- Type of material ✓
- Material of which the drill is made ✓
- Use of cutting fluids ✓
- Condition of the machine ✓
- Diameter of drill bit ✓
- Firmness with which the work is clamped ✓ (Any 2 x 1) (2)

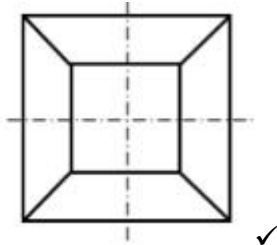
10.4 Factors of overloading a drilling machine:

- When the drill bit is forced into the material at a faster rate. ✓
- By trying to drill a large hole without first drilling a pilot hole. ✓ (2)

[8]

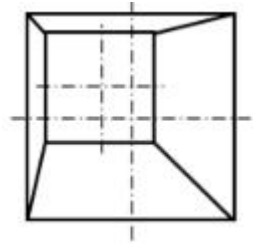
QUESTION 11: TERMINOLOGY - DEVELOPMENT (SPECIFIC)**11.1 Sketches of on-center hopper and off-center hopper:**

On-centre hopper:



✓

Off-centre hopper:



✓

(2)

$$\begin{aligned}
 11.1.1 \quad TL: A - 1 &= \sqrt{X^2 + Y^2 + VH^2} \quad \checkmark \\
 &= \sqrt{200^2 + 200^2 + 600^2} \quad \checkmark \\
 &= \sqrt{440\,000} \quad \checkmark \\
 &= 663,3 \text{ mm} \approx 663 \text{ mm} \quad \checkmark
 \end{aligned}$$

(4)

$$\begin{aligned}
 11.1.2 \quad TL: A - 2 &= \sqrt{X^2 + Y^2 + VH^2} \quad \checkmark \\
 &= \sqrt{(200 + 400)^2 + 200^2 + 600^2} \quad \checkmark \\
 &= \sqrt{600^2 + 200^2 + 600^2} \\
 &= \sqrt{760\,000} \quad \checkmark \\
 &= 871,77 \text{ mm} \approx 872 \text{ mm} \quad \checkmark
 \end{aligned}$$

(4)

$$\begin{aligned}
 11.1.3 \quad TL: A - X2 &= \sqrt{X^2 + Y^2 + VH^2} \quad \checkmark \\
 &= \sqrt{200^2 + (200 + 400)^2 + 600^2} \quad \checkmark \\
 &= \sqrt{200^2 + 600^2 + 600^2} \\
 &= \sqrt{760\,000} \\
 &= 871,77 \text{ mm} \approx 872 \text{ mm} \quad \checkmark
 \end{aligned}$$

(3)

$$\begin{aligned}
 11.1.4 \quad TL: X1 - X2 &= \sqrt{X^2 + VH^2} \quad \checkmark \\
 &= \sqrt{200^2 + 600^2} \quad \checkmark \\
 &= \sqrt{400\,000} \\
 &= 632,5 \text{ mm} \approx 633 \text{ mm} \quad \checkmark
 \end{aligned}$$

(3)

11.2 Transformers are used to connect ✓ ducting sections of dissimilar ✓ shapes to each other. ✓

(3)

11.3 Square ✓ to round transformer. ✓

(2)

[21]**TOTAL: 200**