Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2023

MECHANICAL TECHNOLOGY: WELDING AND METALWORK MARKING GUIDELINE

MARKS: 200

This marking guideline consists of 12 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 C ✓ (1)

1.2 D ✓ (1)

1.3 C ✓ (1)

1.4 C ✓ (1)

1.5 A ✓ (1)

1.6 B ✓ (1)

[6]

QUESTION 2: SAFETY (GENERIC)

2.1 **Arc welding safety precautions:**

- Wear the correct PPE. ✓
- Ensure the electrode holder is well insulated. ✓
- The environment must be free of water and combustible materials. ✓
- Ensure the environment is well ventilated. ✓ (Any 3 x 1) (3)

2.2 **Pedestal drilling machine safety precautions:**

- Wear correct PPE. ✓
- Make sure all guards are in place. ✓
- Clamp the workpiece securely. ✓
- Use the correct drill bit. ✓
- Do not make any adjustment while the machine is in motion. ✓
- Use the correct speed. ✓
- Do not remove chips by hand. ✓ (Any 2 x 1) (2)

2.3 Manual guillotine maximum cutting thickness is 1,20 mm ✓ (1)

2.4 2.4.1 **Advantages of product layout:**

- Handling of material is limited to a minimum. ✓
- Time period of manufacturing cycle is less. ✓
- Production control is almost automatic. ✓
- 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)

2.4.2 **Advantages of the process layout:**

- High machine utilisation because more than one product is manufactured. ✓
- Better supervision as a result of subdivision of processes. ✓
- Less interruption in flow of work when machines become defective. ✓
- Lower equipment cost, since one machine can produce more than one product. ✓
- Better control of total manufacturing cost. ✓
- Greater flexibility in the production process. ✓ (Any 2 x 1) (2)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 **Purpose of case hardening:**
- To produce a hard case over ✓ and tough core. ✓ (2)

3.2 **Using high carbon steel for case hardening**
- The hardness will penetrate the core. ✓ (1)

3.3 **Factors of hardness:**
- Work piece size ✓
- Quenching rate ✓
- Carbon content ✓ (3)

3.4 **Types of quenching mediums:**
- Water and salt (brine) ✓
- Tap water ✓
- Liquid salts ✓
- Molten lead ✓
- Soluble oil and water ✓
- Oil ✓ (Any 3 x 1) (3)

3.5 **Colour coding of engineering materials:**
- To identify the type of materials as well as the carbon content of steel ✓ (1)

3.6 **Types of tests:**

3.6.1
- Filing test ✓
- Machining test ✓ (Any 1 x 1) (1)

3.6.2
- Sound test ✓
- Spark test ✓ (Any 1 x 1) (1)

3.6.3
- Bending test ✓ (1)

3.7 **Machine for spark test:**
- Pedestal grinding machine ✓ (1)

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VRAAG 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

4.1 D ✓

4.2 D ✓

4.3 C ✓

4.4 A ✓

4.5 A ✓

4.6 D ✓

4.7 A ✓

4.8 B ✓

4.9 A ✓

4.10 A ✓

4.11 D ✓

4.12 B ✓

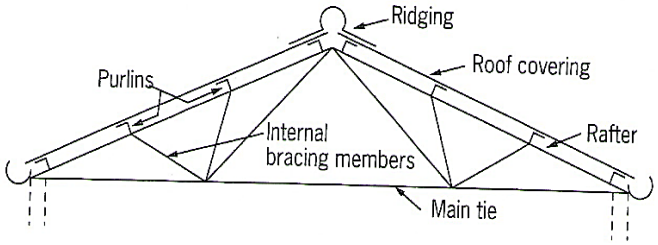
4.13 A ✓

4.14 D ✓ (14 x 1) **[14]**

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 Other side up ✓ (1)

5.2 Sketch of roof truss:



✓✓✓✓✓✓✓ (6)

5.3. Calculations of steel ring:

5.3.1 Mean Ø = Outside Ø – plate thickness

OR

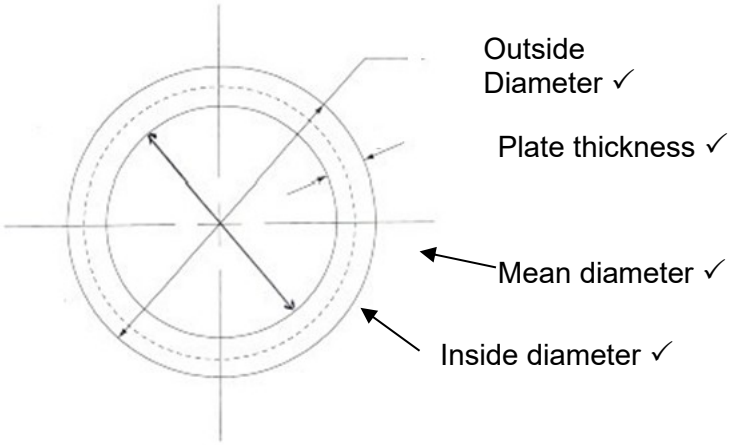
Inside Ø + plate thickness

Mean Ø = 520 – 42 ✓
= 478 mm ✓

Mean Circumference = π x mean Ø
= π x 478
= 1501,87 mm ✓

Rounded of to 1 502 mm for one ring. ✓ (4)

5.3.2



(4)

5.4 A – Contour symbol ✓
B – Finish symbol grinding ✓
C – Length of weld ✓
D – Pitch of weld ✓
E – Weld all round ✓
F – Arrow ✓
G – Finish symbol machining ✓
H – Tail ✓ (8)

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QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 A – Current adjuster ✓
B – Electrode terminal ✓
C – Electrode holder ✓
D – Electrode ✓
E – Arc gap ✓
F – Earth terminal ✓
G – Earth clamp ✓
H – Current scale ✓ (8)

6.2 Metal inert gas ✓ (1)

6.3 CO_2 and Terrell ✓✓ (2)

6.4 The *power saw* is used to rough-cut large sections of metal ✓ before they are further machined or used in manufacturing. It uses a reciprocating movement. ✓
The *band saw* cut in a horizontal position continuously in a forward direction ✓ due to the fact that the band is continuously moving in a circular path. ✓ (4)

6.5 Stock ✓
Mixer ✓
Nozzle ✓ (3)
[18]

QUESTION 7: FORCES (SPECIFIC)

7.1 7.1.1 **Stress**

Stress = $\frac{LOAD}{AREA}$

$= \frac{80 \text{ x } 10^3}{\frac{\pi D^2}{4}}$ ✓

$\pi D^2 = \frac{4 \text{ x } 80 \text{ x } 10^3}{30 \text{ x } 10^6}$ ✓

$D^2 = \frac{4 \text{ x } 80 \text{ x } 10^3}{\pi \text{ x } 30 \text{ x } 10^6}$ ✓✓

D = 58,2 mm ✓ (5)

7.1.2 **Strain**

Young's Modulus = $\frac{STRESS}{STRAIN}$

Strain = $\frac{Stress}{Young's\ modulus}$ ✓

$= \frac{30 \text{ x } 10^6}{90 \text{ x } 10^9}$ ✓

Strain = 0,00033 ✓ (3)

7.1.3 **Change in length**

$$\text{Strain} = \frac{\textit{Change in length}}{\textit{Original length}}$$

Change = Strain x Original length ✓

= 0,00033 x 4 ✓

= 0,00133 mm ✓ (3)

7.2 7.2.1 **Reactions**

Take reactions RL and RR

RR x 10 = (3 x 3) + (10 x 4) + (6 x 7) ✓

= 9 + 40 + 42

= 91 ✓

RR = 9,1 N ✓

RL x 10 = (6 x 3) + (10 x 6) + (3 x 7) ✓

= 18 + 60 + 21

= 99 ✓

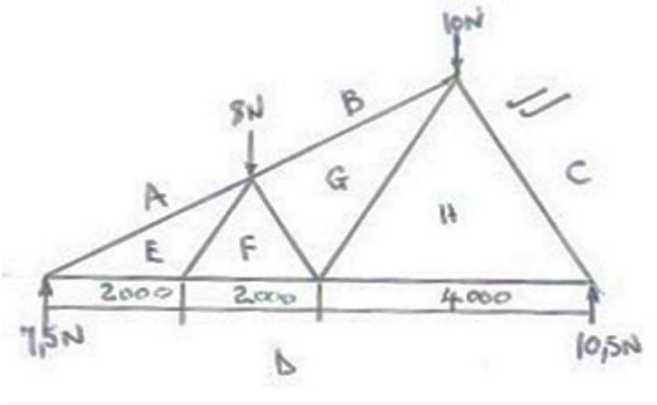
RL = 9,9 N ✓ (6)

7.2.2 BM_A: (9,9 x 3) = 29,7 N/m ✓

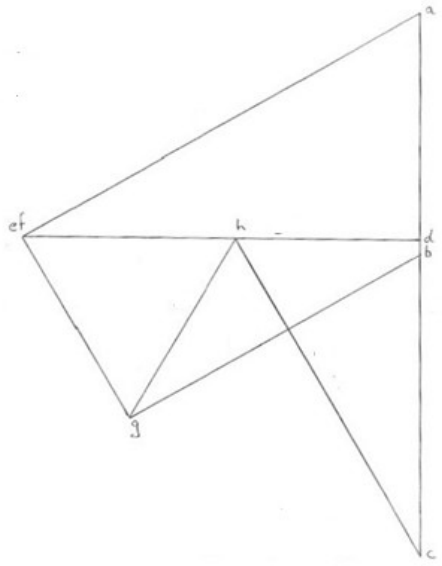
BM_B: (9,9 x 5) – (3 x 2) = 43,5 N/m ✓✓

BM_C: (9,9 x 7) – (3 x 4) – (10 x 3) = 27,3 N/m ✓✓ (5)

7.3 **Framework:**



Member	Strut	Tie	Force
AE	✓✓		15,3 N ✓
BG	✓✓		11,3 N ✓
CH	✓✓		12,2 N ✓
FG	✓✓		6,9 N ✓
EF			
DE		✓✓	13,25 N ✓
DF		✓✓	13,25 N ✓
DH		✓✓	6,2 N ✓
GH		✓✓	7 N ✓



Guide (23)

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QUESTION 8: JOINING METHODS (INSPECTION OF WELDS)

8.1
- The liquid dye penetrant is sprayed onto the clean surface being inspected. ✓
- Allow a short time for the liquid to penetrate. ✓
- Remove the excess dye with a cleaner (solvent). ✓
- Wash the surface and allow to dry. ✓
- When the surface is dry, spray it with a developer to bring out the colour, which was sprayed on and penetrated any cracks or pin holes. ✓
- Fluorescent liquids are also used for the surface being inspected. ✓✓
- After a short while, remove the liquid with a cleaner and wait for it to dry. ✓
- A black-light source (ultraviolet light) is then brought up to the surface. ✓
- Areas where the fluorescent liquid has penetrated will show up under the light. ✓ (Any 8 x 1) (8)

8.2 It refers to a cavity-type formed by gas ✓ during the solidification ✓ of molten weld metal. ✓ (3)

8.3
- Shape of profile ✓
- Uniformity of surface ✓
- Overlap ✓
- Undercutting
- Penetration bead
- Root groove (Any 3 x 1) (3)

8.4
- Slag inclusion ✓
- Porosity ✓
- Lack of fusion ✓
- Oxidised or burnt metal ✓ (4 x 1) (4)

8.5
- Correct flame for the work at hand ✓
- Correct angle of welding torch and welding rod ✓
- Depth penetration and amount of fusion
- The rate of progress along the joint (Any 2 x 1) (2)

8.6
- Good for ferrous and non-ferrous metals ✓
- Low cost ✓
- Easy to apply ✓
- Minimal training required (Any 3 x 1) (3)

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

9.1
- Do not over weld. ✓
- Control the fill up. ✓
- Use intermittent welds. ✓
- Use the smallest leg size for fillet welds. ✓
- Use minimum root opening.
- Use minimum included angle.
- Select joints that use minimum weld metal. (Any 4 x 1) (4)

9.2
- Do not over weld. ✓
- Proper preparation is needed. ✓
- Use intermittent welding. ✓
- Use as few passes as possible. ✓
- Place welds near the neutral axis. ✓
- Use back step welding.
- Anticipate shrinkage forces.
- Plan the welding sequence.
- Minimise welding time. (Any 5 x 1) (5)

9.3 Low carbon steel (0,15–0,30%) ✓ known as mild steel. ✓
Medium carbon steel (0,31–0,70%) ✓ known as spring steel. ✓
High carbon steel (0,71–1,5%) ✓ known as tool steel. ✓ (6)

9.4 It is common in gas metal arc welding ✓ and comprises of droplets of molten material ✓ that are generated at or near the welding arc. ✓ (3)
[18]

QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 To accommodate multiple technicians to do maintenance, ✓ using their own locks. ✓ (2)

10.2 If excessive loads are applied onto the spindle bearings, ✓ the grinding wheel and the grinding machine motor. ✓ (2)

10.3
- The journals and bearings/bushes must be well lubricated. ✓
- Failure to lubricate the components will result in friction and wear of the components. ✓ (2)

10.4
- To monitor the machine's condition. ✓
- To assist in upholding warrantees and guarantees that forms part of the service agreements. ✓ (2)
[8]

QUESTION 11: TERMINOLOGY (SPECIFIC)

11.1 11.1.1 Length CG = $\sqrt{60^2 + 130^2 + 260^2}$ ✓

= $\sqrt{88\ 100}$

= 296,82 mm ✓ (2)

11.1.2 Length BG = $\sqrt{60^2 + 175^2 + 260^2}$ ✓

= $\sqrt{101\ 825}$

= 319,10 mm ✓ (2)

11.1.3 Length AE = $\sqrt{60^2 + 160^2 + 260^2}$ ✓

= $\sqrt{96\ 800}$

= 311,13 mm ✓ (2)

11.1.4 Length GD = $\sqrt{130^2 + 140^2 + 260^2}$ ✓

= $\sqrt{104\ 100}$

= 322,43 mm ✓ (2)

11.1.5 Length HC = $\sqrt{40^2 + 130^2 + 260^2}$ ✓

= $\sqrt{86\ 100}$

= 293,43 mm ✓ (2)

11.1.6 Length HK = $\sqrt{130^2 + 260^2}$ ✓

= $\sqrt{84\ 500}$

= 293,43 mm ✓ (2)

11.2 11.2.1 Length AB = π x D ÷ 2 ✓

= π x 800 ÷ 2 ✓

=1 256,8 mm ✓ (3)

11.2.2 Circumference of small circle:

Circumference = $\pi \times D$ ✓

= π x 350 ✓

= 1 099,7 mm ✓ (3)

11.2.3 Length 0 – 2:
0 – 2 = D ÷ 2 ✓

= 350 ÷ 2 ✓

= 175 mm ✓ (3)
[21]

TOTAL: 200