basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

MAY/JUNE 2024

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 17 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 A ✓ (1)

1.2 B ✓ (1)

1.3 A ✓ (1)

1.4 D ✓ (1)

1.5 C ✓ (1)

1.6 C ✓ (1)
[6]

QUESTION 2: SAFETY (GENERIC)

2.1 **First aid:**

- When illness occurs. ✓
- When an injury is sustained. ✓
- When an accident occurs. ✓

(Any 2 x 1) (2)

2.2 **Bench grinder:**

A. A fire extinguisher should be available. ✓
B. Safety glasses must be worn. ✓
C. Maximum grinding wheel speed. ✓
D. Maximum distance between tool rest and grinding wheel. ✓ (4)

2.3 **Drill press:**

- Never try to stop/hold the work piece by hands when the drill bit get stuck during drilling. ✓
- Don't force a drill bit into the work piece. ✓
- Keep loose clothing and hair away from revolving parts. ✓
- Never leave the machine running if it is unattended. ✓
- Use a brush or wooden rod to remove chips from the drill. ✓
- Do not put hands near moving parts. ✓
- Never clean or adjust the machine while it is in motion. ✓
- Never try to stop the drill/chuck by hands. ✓

(Any 2 x 1) (2)

2.4 **Surface grinder:**

- Never clean or adjust the machine while it is in motion. ✓
- Know how to stop the machine in an emergency. ✓
- Do not use excessive force when grinding the work piece. ✓
- Immediately report any dangerous defects of the machine. ✓
- Stop using defective machinery until it has been repaired by a qualified person. ✓
- Ensure that the grinding wheel is not submerged in coolant. ✓
- Never leave the machine running if it is unattended. ✓
- Do not put hands near moving parts. ✓

(Any 2 x 1) (2)
[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 **Critical temperature:**

3.1.1 **Hardening:**
Above ✓ (1)

3.1.2 **Tempering:**
Below ✓ (1)

3.1.3 **Normalising:**
Above ✓ (1)

3.2 **Machining test:**
- The chips heating colour ✓
- The chips curl ✓ (2)

3.3 **Material tests:**
- Sound test ✓
- Bending test ✓
- Filing test ✓
- Hardness test ✓
- Density test ✓
- Weight measurement ✓
- Magnetic test ✓
- Visual inspection/observation ✓
- Scratch test ✓

(Any 3 x 1) (3)

3.4 **Quenching methods:**
- Carburising ✓
- Nitriding ✓
- Cyaniding ✓

(Any 2 x 1) (2)

3.5 **Heat treatment temperature:**
- Pyrometer ✓
- Crayons ✓
- Visually ✓
- Magnet ✓

(Any 1 x 1) (1)

3.6 **Heat-treatment steps:**
- Heat the metal. ✓
- Soak the metal. ✓
- Cool the metal. ✓ (3)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

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

[14]

QUESTION 5: TERMINOLOGY(TEMPLATES) (SPECIFIC)

5.1 **Labeling of roof truss:**

A - Roof sheeting ✓
B - Ridging ✓
C - King post ✓
D - Tie beam/main tie ✓
E - Internal bracing ✓
F - Rafter ✓
G - Gusset plate ✓ (7)

5.2 **Brass ring calculations:**

5.2.1 $\text{Mean Ø} = \text{Outside Ø} - \text{plate thickness}$

$= 380 - 15$ ✓

$= 365 \text{ mm}$ ✓ (2)

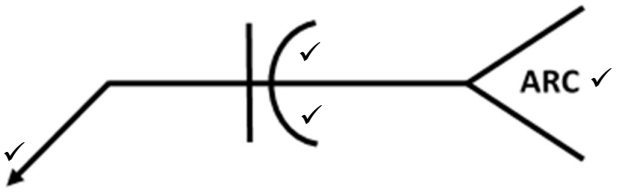
5.2.2 $\text{Mean circumference} = \pi \times \text{Mean Ø}$

$= \pi \times 365$ ✓

$= 1146{,}68$ ✓

$= 1147 \text{ mm}$ ✓ (3)

5. 3 **Weld symbol:**



(4)

5.4 **Supplementary weld symbols:**

- Indicate additional ✓ information about a weld. ✓
- Supplementary ✓ information about a weld. ✓

(Any 1 x 2) (2)

5.5 **Advantages of using templates:**

- Quicker to use to improve mass production. ✓
- Accurate production. ✓
- Cheap to manufacture. ✓
- Unskilled labour will be able to use it. ✓
- Avoid unnecessary wastages / cost effective. ✓
- It gives uniformity in production. ✓
- Can be reused. ✓

(Any 2 x 1) (2)

5.6 **Template machine tools:**

- Planer ✓
- Circular saw ✓
- Drilling machine ✓
- Jig saw ✓
- Sanding machine ✓
- Shears ✓
- Cut off saw ✓
- Bench grinder ✓
- Hydraulic press ✓

(Any 3 x 1) (3)
[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 **Working principles:**

6.1.1 **Power driven guillotine:**
- Activated by foot pedal. ✓
- Driven by an electric motor, flywheel, gearbox and axle. ✓
- Top cutting blade moves downwards. ✓
- Uses eccentric motion for the cutting stroke. ✓ (4)

6.1.2 **Pyramid bending rolls**:
- A bending roll has three rollers mounted in a horizontal position. ✓
- At the bottom there are two fixed rollers next to each other, rotating in unison. ✓
- The top roller is adjustable (up and down) applying downward pressure on the metal. ✓
- That causes the metal to deflect and ultimately form the round shape desired. ✓ (4)

6.2 **Uses of the hydraulic press:**
- Installing components. ✓
- Removing components. ✓
- To press profiles. ✓
- Bending. ✓

(Any 2 x 1) (2)

6.3. **Types of hardness testers:**
- Rockwell Hardness tester ✓
- Brinell Hardness tester ✓
- Vickers Hardness tester ✓

(Any 2 x 1) (2)

6.4 **Labels for gas welding:**
A – Filler rod/Welding rod/Brazing rod ✓
B – Welding tip/Welding nozzle ✓
C – Flame ✓
D – Parent metal/Work piece ✓ (4)

6.5 **Function of the plasma cutter:**
Cuts ✓ through electrically conductive materials. ✓ (2)

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QUESTION 7: FORCES (SPECIFIC)

7.1 **Beams:**

7.1.1 **Distributed load:**
10 x 3= 30 N ✓ (1)

7.1.2 **Reaction (RL):**
Take moments about RR:

RL x 10 = (25 ✓x 2) + (30 ✓x 6,5) + (15 ✓x 8)

= 50 + 195 + 120

$\therefore \frac{10\ RL}{10} = \frac{365}{10}$

RL = 36,5 N ✓

Reaction (RR):
Take moments about RL:

RR x 10 = (15 ✓x 2) + (30 ✓x 3,5) + (25 ✓x 8)

= 30 + 105 + 200

$\therefore \frac{10\ RR}{10} = \frac{335}{10}$

RR= 33,5 N ✓ (8)

7.1.3 **Shear force:**

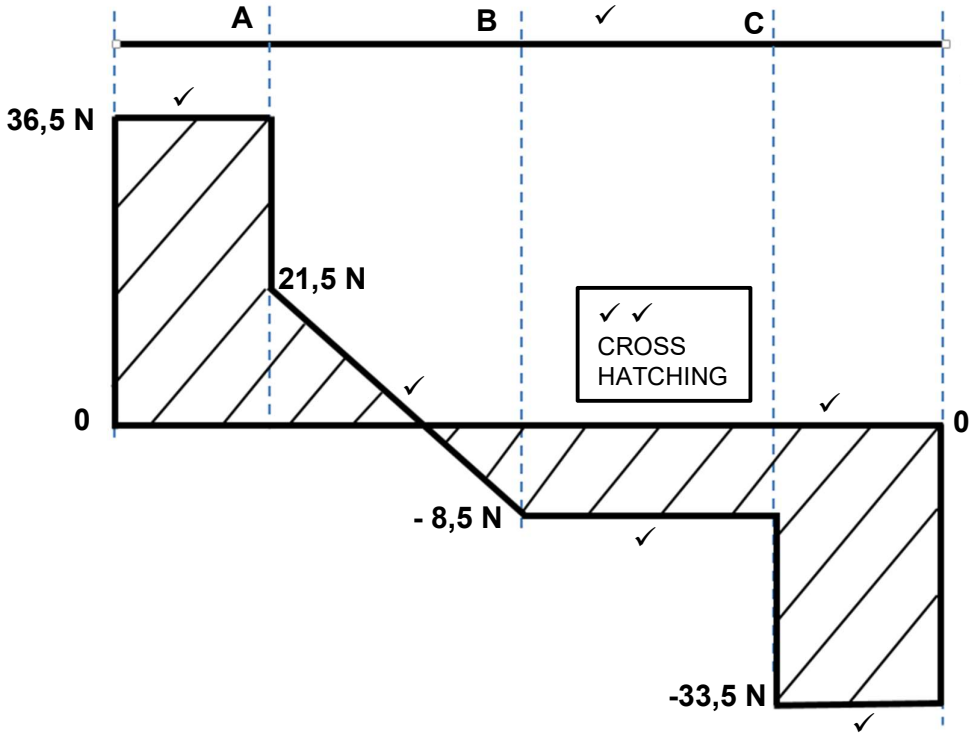
SF_A = 36,5 – 15 ✓
= 21,5 N ✓

SF_B = 36,5 – 15 – 30 ✓
= –8,5 N ✓

SF_C = 36,5 – 15 – 30 – 25 ✓
= –33,5 N ✓ (6)

7.1.4 **Scale:**

Space diagram 1 m = 10 mm
Shear force 1N = 1 mm



Note to marker:
Marker must redraw the shear force diagram according to given scales for marking purposes.

(8)

7.2 Stress and Strain:

7.2.1 Stress:

$$A = \frac{\pi D^2}{4}$$
$$= \frac{\pi \times 0{,}036^2}{4} \checkmark$$
$$= 1{,}01787602 \times 10^{-3} m^2 \checkmark$$

$$\text{Stress} = \frac{F}{A}$$
$$= \frac{110 \times 10^3 \checkmark}{1{,}01787602 \text{ x} 10^{-3}} \checkmark$$
$$= 108068171{,}2 \text{ Pa}$$
$$= 108{,}07 \text{ MPa} \checkmark$$

(5)

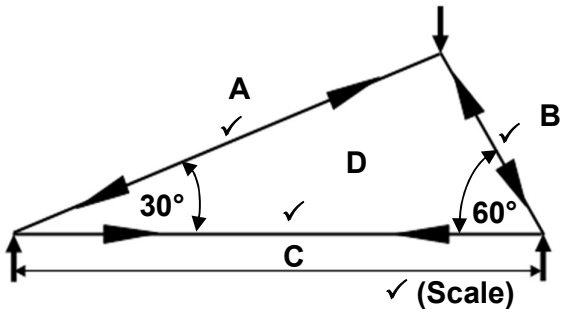
7.2.2 Strain:

$$\varepsilon = \frac{\Delta L}{OL}$$
$$\varepsilon = \frac{0{,}6 \checkmark}{125} \checkmark$$
$$= 0{,}0048 \checkmark$$

(3)

7.3 **Simple frame:**

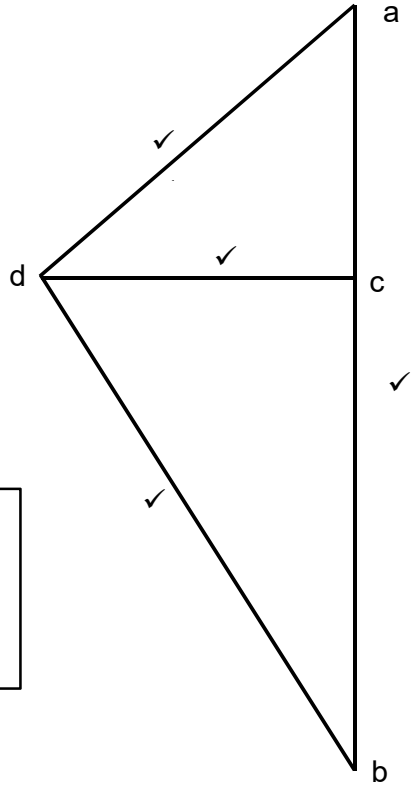
7.3.1 **Space diagram:**



NOTE: Draw to scale on transparency for marking purpose. Mark allocation for scale and each member with arrows showing strut or tie.

(4)

7.3.2 **Force diagram:**



Note to marker:
Marker must redraw the space and force diagrams according to given scales for marking purposes.

(4)

7.3.3 **Magnitude and nature of force:**

Member	**Force**	**Nature**
AD	100 N ✓	Strut ✓
BD	174 N ✓	Strut ✓
CD	86 N ✓	Tie ✓

NOTE: Allow ± 2 mm tolerance.

(6)

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

8.1 **Prevent incomplete penetration:**

- Use correct travel speed. ✓
- Use narrow/correct joint. ✓
- Use correct welding current. ✓
- Use correct electrode angle. ✓
- Use correct weaving technique. ✓
- Clean the base/parent metal. ✓

(Any 3 x 1) (3)

8.2 **Visual inspection of welds:**

- Cracks ✓
- Lack of fusion ✓
- Excessive spatter ✓
- Undercutting. ✓
- Craters ✓

(Any 2 x 1) (2)

8.3 **Fusion:**

The proper bonding of the weld metal ✓ with the base metal. ✓ (2)

8.4 **Undercutting:**

- Adjust the welding parameters. ✓
- Control heat input. ✓
- Ensure proper electrode angle. ✓ (3)

8.5 **Purpose of the nick break test:**

- To assess the ductility. ✓
- To check penetration. ✓
- To check for fusion. ✓
- To check porosity. ✓
- To check for undercutting. ✓

(Any 2 x 1) (2)

8.6 **Width and height of a weld bead:**

To provide structural integrity ✓ and proper strength ✓ distribution along the joint. ✓ (3)

8.7 **Inspection of welds:**

- Clean bead. ✓
- Constant width and height. ✓
- Fusion and penetration. ✓
- Absence of cracks. ✓
- Undercutting. ✓
- Craters ✓

(Any 3 x 1) (3)

8.8 **Liquid dye test on a welded joint:**

- Clean the surface to be tested. ✓
- Spray the liquid dye penetrant onto the surface and allow liquid dye to penetrate. ✓
- Remove excess dye with a cleaner. ✓
- Spray a developer onto the surface to bring out the colour. ✓
- Observe surface for defects. ✓ (5)

[23]

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

9.1 **Stress relieving:**

- To reduce/eliminate residual stresses in welded structures. ✓
- To improve their dimensional stability. ✓
- To improve resistance to distortion. ✓ (3)

9.2 **Factors contributing to distortion and residual stress:**

- Material properties. ✓
- Joint design. ✓
- Welding process. ✓
- Parameters. ✓
- Rate of cooling. ✓

(Any 3 x 1) (3)

9.3 **Mechanical properties:**

- Hardness ✓
- Strength ✓
- Ductility ✓
- Malleability ✓
- Elasticity ✓

(Any 4 x 1) (4)

9.4 **Factors influencing the grain size:**

- The amount of temperature and duration of the annealing process. ✓
- The composition of the steel. ✓
- Its melting point. ✓ (3)

9.5 **Cause of shrinkage:**

The cooling of the weld metal, which leads to contraction. ✓ (1)

9.6 **Welding methods:**

- Tack welding. ✓
- Intermittent welding. ✓
- Back-step welding. ✓
- Do not over weld. ✓
- Place welds near neutral axis. ✓
- Use as few passes as possible. ✓
- Anticipate shrinkage forces. ✓
- Use strongbacks. ✓
- Use clamps, jigs and fixtures. ✓

(Any 4 x 1) (4)
[18]

QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 **Failure in machines:**

- Lack of lubrication or incorrect lubrication. ✓
- Overloading. ✓
- Friction. ✓

(Any 2 x 1) (2)

10.2 **Power driven guillotine:**

- Test for correct operation. ✓
- Check that all guards are in place and operational. ✓
- Check if operating instructions are displayed. ✓
- Ensure that ancillary equipment is closely located. ✓
- Check if appropriate PPE is kept close by. ✓
- Check if housekeeping equipment is readily available. ✓
- Ensure that the guillotine is properly secured to the floor. ✓
- Tighten loose nuts and bolts. ✓
- Lubricate the machine adequately. ✓
- Clean the machine. ✓

(Any 4 x 1) (4)

10.3 **Failure of rollers:**

- Worn or damaged bearings. ✓
- Misalignment. ✓
- Contamination. ✓
- Excessive load. ✓
- Inadequate lubrication. ✓

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

QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

11.1 Square ✓ to round. ✓ (2)

11.2 **Cone:**

11.2.1 **Type of cone:**
- Conical frustrum ✓
- Truncated cone ✓

(Any 1 x 1) (1)

11.2.2 **Conical frustrum:**
A – Vertical height ✓
B – Top radius/Small radius ✓
C – Slant height ✓
D – Base radius/Large radius ✓ (4)

11.3 **Hopper:**

11.3.1 **A-1**

$$A-1 = \sqrt{480^2 + 700^2 + 700^2} \quad (\checkmark\ \checkmark\ \checkmark)$$
$$= \sqrt{230400 + 490000 + 490000}$$
$$= \sqrt{1210400} \ \checkmark$$
$$= 1100{,}18 \text{ mm} \ \checkmark$$

(5)

11.3.2 **C-3**

$$C-3 = \sqrt{250^2 + 120^2 + 700^2} \quad (\checkmark\ \checkmark\ \checkmark)$$
$$= \sqrt{62500 + 14400 + 490000}$$
$$= \sqrt{566900} \ \checkmark$$
$$= 752{,}93 \text{ mm} \ \checkmark$$

(5)

11.3.3 **X_1-X_2**

$$X_1 - X_2 = \sqrt{480^2 + 700^2} \quad (\checkmark\ \checkmark)$$
$$= \sqrt{230400 + 490000}$$
$$= \sqrt{720400} \ \checkmark$$
$$= 848{,}76 \text{ mm} \ \checkmark$$

(4)
[21]

TOTAL: [200]