



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:

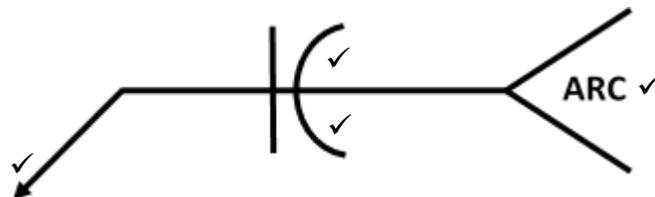
5.2.1 $\text{Mean}\varnothing = \text{Outside}\varnothing - \text{plate thickness}$
 $= 380 - 15$ ✓
 $= 365 \text{ mm}$ ✓

(2)

5.2.2 $\text{Mean circumference} = \pi \times \text{Mean}\varnothing$
 $= \pi \times 365$ ✓
 $= 1146,68$ ✓
 $= 1147 \text{ mm}$ ✓

(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)

[18]

QUESTION 7: FORCES (SPECIFIC)

7.1 Beams:

7.1.1 Distributed load:

$$10 \times 3 = 30 \text{ N } \checkmark$$

(1)

7.1.2 Reaction (RL):

Take moments about RR:

$$RL \times 10 = (25 \times 2) + (30 \times 6,5) + (15 \times 8)$$

$$= 50 + 195 + 120$$

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

$$RL = 36,5 \text{ N } \checkmark$$

Reaction (RR):

Take moments about RL:

$$RR \times 10 = (15 \times 2) + (30 \times 3,5) + (25 \times 8)$$

$$= 30 + 105 + 200$$

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

$$RR = 33,5 \text{ N } \checkmark$$

(8)

7.1.3 Shear force:

$$SF_A = 36,5 - 15 \checkmark \\ = 21,5 \text{ N } \checkmark$$

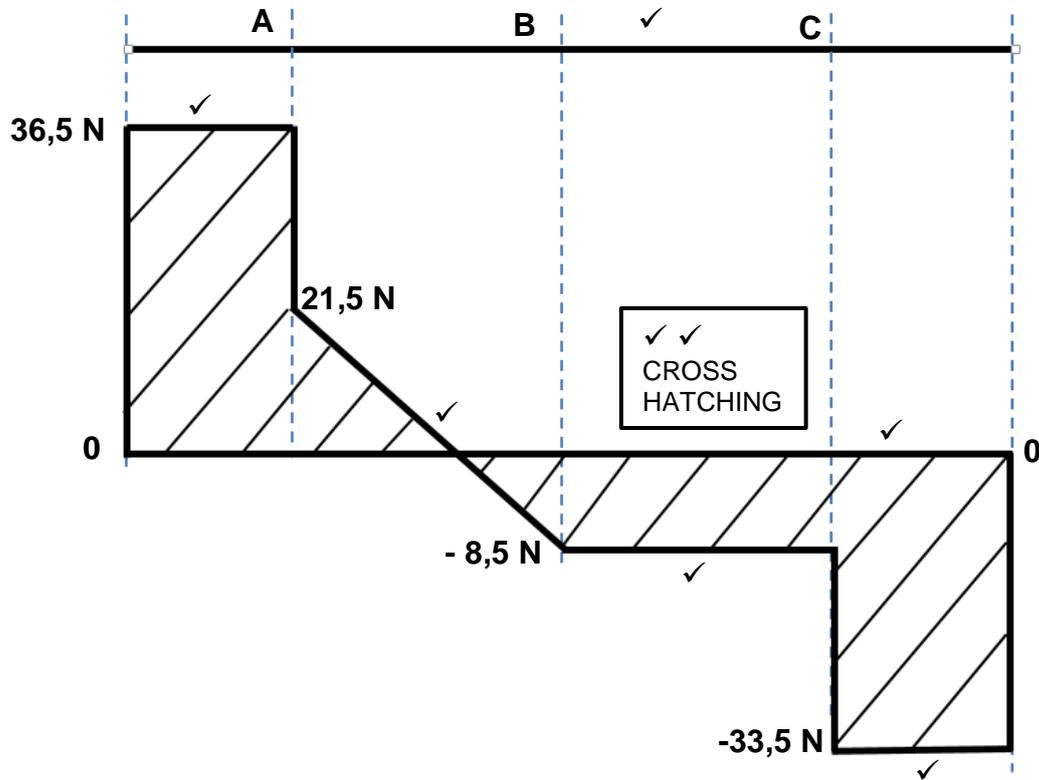
$$SF_B = 36,5 - 15 - 30 \checkmark \\ = -8,5 \text{ N } \checkmark$$

$$SF_C = 36,5 - 15 - 30 - 25 \checkmark \\ = -33,5 \text{ N } \checkmark$$

(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:

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

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

(5)

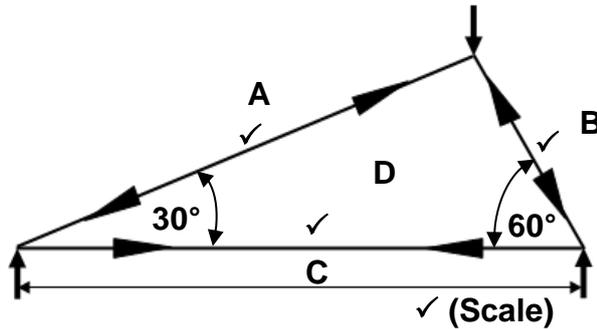
7.2.2 Strain:

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

(3)

7.3 Simple frame:

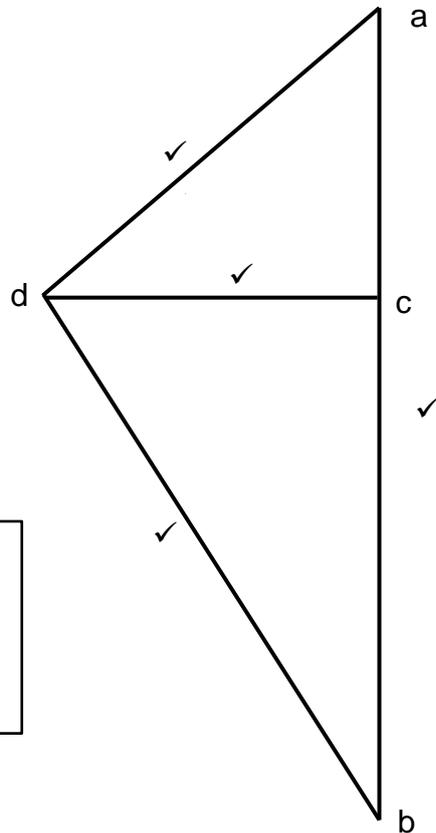
7.3.1 Space diagram:



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)

[45]

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**

$$\begin{aligned} A-1 &= \sqrt{480^2 + 700^2 + 700^2} \\ &= \sqrt{230400 + 490000 + 490000} \\ &= \sqrt{1210400} \checkmark \\ &= 1100,18 \text{ mm } \checkmark \end{aligned}$$

(5)

11.3.2 **C-3**

$$\begin{aligned} C-3 &= \sqrt{250^2 + 120^2 + 700^2} \\ &= \sqrt{62500 + 14400 + 490000} \\ &= \sqrt{566900} \checkmark \\ &= 752,93 \text{ mm } \checkmark \end{aligned}$$

(5)

11.3.3 **X₁-X₂**

$$\begin{aligned} X_1 - X_2 &= \sqrt{480^2 + 700^2} \\ &= \sqrt{230400 + 490000} \\ &= \sqrt{720400} \checkmark \\ &= 848,76 \text{ mm } \checkmark \end{aligned}$$

(4)

[21]

TOTAL: 200