



basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 12

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

NOVEMBER 2024

MARKING GUIDELINES

MARKS: 200

These marking guidelines consists of 19 pages.

QUESTION 1: MULTIPLE-CHOICE (GENERIC)

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

QUESTION 2: SAFETY (GENERIC)

2.1 Horizontal band saw (Already been switched on):

- Never leave the band saw unattended while in motion. ✓
- Switch off the band saw when leaving. ✓
- Use a brush or wooden rod to remove chips/swarf/filings. ✓
- When reaching around a revolving band saw, be careful that your clothes do not get caught in the blade. ✓
- Don't stop a revolving bandsaw blade with your hand. ✓
- Don't adjust the band saw while working. ✓
- Don't open any guard while in motion. ✓
- Keep hands away from action points. ✓
- Do not force the band saw blade into the material. ✓
- Apply cutting fluid if required. ✓
- Avoid overcrowding of persons around the machine. ✓
- Do not lean on the machine. ✓
- Check if the machine is running smoothly. ✓

(Any 2 x 1) (2)

2.2 First aid basic treatment:

- Examination ✓
- Diagnosis ✓
- Treatment ✓

(3)

2.3 Oxygen fittings with oil and grease:

It forms a flammable mixture. ✓

(1)

2.4 Disadvantages of the process layout:

- Production is not always continuous. ✓
- Transportation costs between process departments may be high. ✓
- Additional time is spent in testing and sorting as the product moves to the different departments. ✓
- Damage to fragile goods may result from extra handling. ✓

(Any 2 x 1) (2)

2.5 Advantages of the product layout:

- 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. ✓

(Any 2 x 1) (2)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 Filing test:

- 3.1.1 Files easily ✓ (1)
- 3.1.2 Hard to file ✓ (1)
- 3.1.3 Files easily ✓ (1)

3.2 Heat treatment:

It is the heating ✓ and cooling ✓ of metals under controlled conditions / as to change their properties. ✓ (3)

3.3 Heating of metal:

If metal is heated too fast, the outside of the metal becomes hotter ✓ than the inside, ✓ then it is very difficult ✓ to achieve a uniform structure. ✓ (4)

3.4 Case hardening:

- Low-carbon steel / Mild steel ✓
- Low-alloy steel ✓ (2)

3.5 Tempering:

- It is to relieve the strains ✓ induced during the hardening process. ✓
- Increase toughness. ✓✓
- Decrease brittleness. ✓✓
- Achieve a finer grain structure. ✓✓

(Any 1 x 2) (2)
[14]

QUESTION 4: MULTIPLE-CHOICE (SPECIFIC)

4.1	D ✓	(1)
4.2	B ✓	(1)
4.3	D ✓	(1)
4.4	B ✓	(1)
4.5	C ✓	(1)
4.6	B ✓	(1)
4.7	C ✓	(1)
4.8	D ✓	(1)
4.9	B ✓	(1)
4.10	A ✓	(1)
4.11	C ✓	(1)
4.12	A ✓	(1)
4.13	B/C ✓	(1)
4.14	D ✓	(1)
		[14]

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 Template loft separation:

- It is quieter. ✓✓
- The lighting is better. ✓✓
- All equipment is readily available. ✓✓
- It is a permanent base. ✓✓
- Marking on the floor enhances accuracy. ✓✓
- Specialists work in the template loft. / More specialised work is done in the template loft. ✓✓

(Any 1 x 2) (2)

5.2 Template loft tools: (*Due to the large number of alternatives, marker discretion must be used - discuss with IM*).

- Hand saws ✓
- Chisels ✓
- Plane ✓
- Drill and drill bits ✓
- Steel tape ✓
- Straight edge ✓
- Compass ✓
- Trammel pins ✓
- Carpenter's square ✓
- Protractor ✓
- Chalk line ✓
- Clamps. ✓

(Any 3 x 1) (3)

5.3 Steel ring calculations:

5.3.1 Mean \varnothing = Outside \varnothing – Plate thickness

$$= 980 - 25 \checkmark$$

$$= 955 \text{ mm} \checkmark$$

(2)

5.3.2 Mean circumference = $\pi \times \text{Mean } \varnothing$

$$= \pi \times 955 \checkmark$$

$$= 3000,22 \checkmark$$

$$= 3000 \text{ mm} \checkmark$$

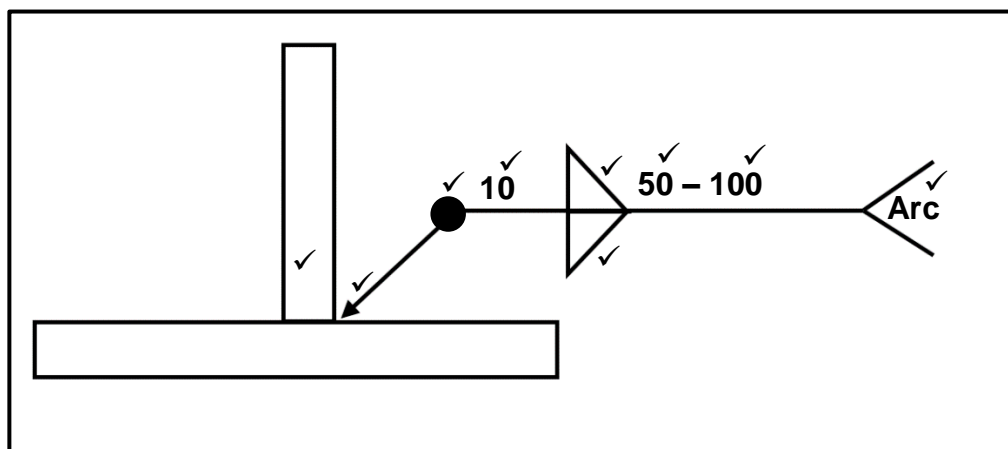
(3)

5.4 **Factors for selecting materials for templates:**

- Durability ✓
- Cost effective ✓
- Light weight ✓
- Moisture resistant ✓
- Flexible ✓
- Size ✓
- Accuracy required ✓

(Any 2 x 1) (2)

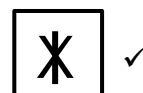
5.5 **Fillet weld on T-joint:**



(9)

5.6 **Welding symbols:**

5.6.1 Spot weld:



(1)

5.6.2 Seam weld:



(1)
[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 Working principles of:

6.1.1 Punch and cropping machine:

- Cropping machines are electrically driven. ✓
- Uses a heavy fly wheel/hydraulics and clutch system. ✓
- It engages various blades/punches. ✓
- Uses shearing/punching motion to cut the various profiles. ✓ (4)

6.1.2 Resistance welding machine:

- Current flows through a resistance to fuse plates together. ✓
- Two copper electrodes are pressed against the plates. ✓
- Heavy current is passed between the electrodes. ✓
- The two plates melt and fuse together, forming a weld nugget or spot weld. ✓ (4)

6.2 Uses of the drill press:

- Drilling ✓
- Ream work ✓
- Countersinking ✓
- Sawing – hole saw ✓
- Sanding ✓
- Wire brushing ✓
- Buffing/Polishing ✓
- Boring ✓
- Tapping ✓
- Spot facing ✓
- Honing ✓

(Any 3 x 1) (3)

6.3 Types of taps:

- Taper tap/starting tap/first tap ✓
- Intermediate/second tap ✓
- Plug or bottoming tap ✓ (3)

6.4 Brinell hardness test procedure:

- Makes use of a steel ball as indenter. ✓
- A load is applied to the test piece. ✓
- The diameter of the indentation is measured with a microscope. ✓
- The diameter is used to determine the Brinell reading. ✓ (4)

[18]

QUESTION 7: FORCES (SPECIFIC)

7.1 Beams:

7.1.1 Calculate the reaction left (RL):

Take moments about RR:

$$\begin{aligned} RL \times 10 &= (50 \times 2) + (75 \times 5) + (60 \times 8) \\ &= 100 + 375 + 480 \\ RL &= \frac{955}{10} \\ &= 95,5 \text{ N} \end{aligned}$$

Calculate the reaction right (RR):

Take moments about RL:

$$\begin{aligned} RR \times 10 &= (60 \times 2) + (75 \times 5) + (50 \times 8) \\ &= 120 + 375 + 400 \\ RR &= \frac{895}{10} \\ &= 89,5 \text{ N} \end{aligned} \quad (8)$$

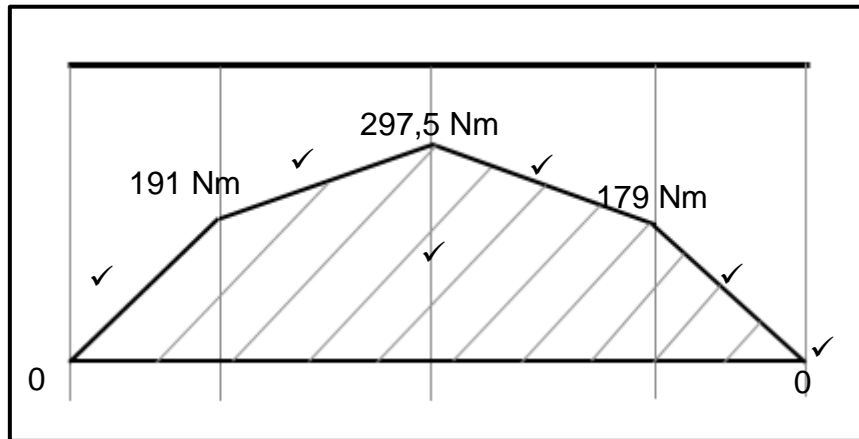
7.1.2 Bending moments:

$$\begin{aligned} BM_B &= (95,5 \times 2) - (60 \times 0) \\ &= 191 \text{ Nm} \end{aligned}$$

$$\begin{aligned} BM_C &= (95,5 \times 5) - (60 \times 3) - (75 \times 0) \\ &= 297,5 \text{ Nm} \end{aligned}$$

$$\begin{aligned} BM_D &= (95,5 \times 8) - (60 \times 6) - (75 \times 3) - (50 \times 0) \\ &= 179 \text{ Nm} \end{aligned} \quad (5)$$

7.1.3 **Bending moment diagram:**



Note to marker:

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

(6)

7.2 **Stress and Strain:**

7.2.1 **Area:**

$$\begin{aligned} A &= \frac{\pi D^2}{4} \\ &= \frac{\pi (0,038)^2}{4} \checkmark \\ &= 1,13 \times 10^{-3} \text{ m}^2 \checkmark \end{aligned}$$

(2)

7.2.2 **Stress:**

$$\begin{aligned} \text{Stress} &= \frac{F}{A} \\ &= \frac{120 \times 10^3}{1,13 \times 10^{-3} \text{ m}^2} \checkmark \\ &= 106,19 \text{ MPa} \checkmark \end{aligned}$$

(3)

7.2.3 Strain:

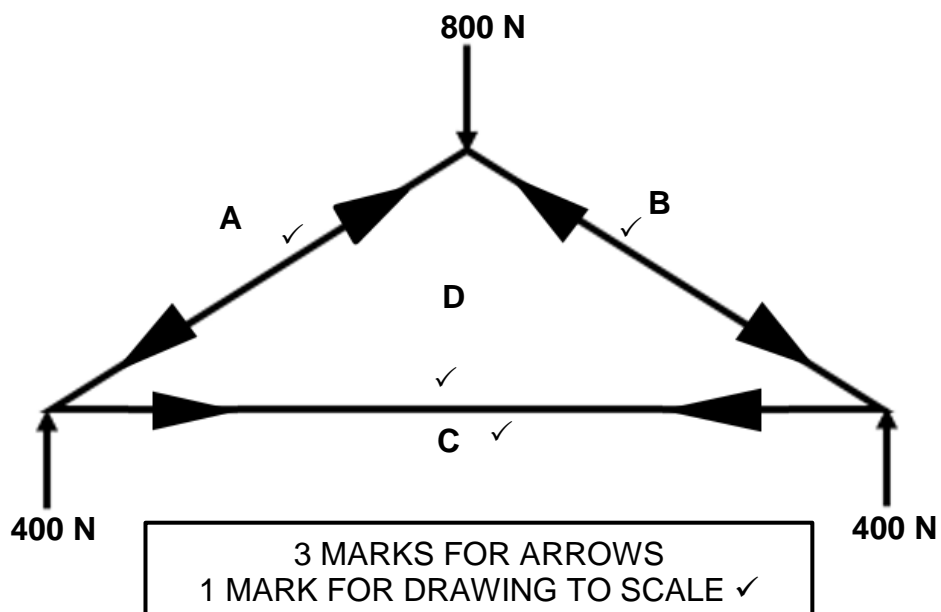
$$\begin{aligned}\varepsilon &= \frac{\Delta l}{ol} \\ \varepsilon &= \frac{0,55}{125} \\ &= 0,0044 \quad \text{or} \quad 4,4 \times 10^{-3}\end{aligned}\quad (3)$$

7.2.4 Calculation of Young's Modulus:

$$\begin{aligned}E &= \frac{\text{stress}}{\text{strain}} \\ &= \frac{106,19}{4,4 \times 10^{-3}} \\ &= 24,13 \text{ GPa}\end{aligned}\quad (3)$$

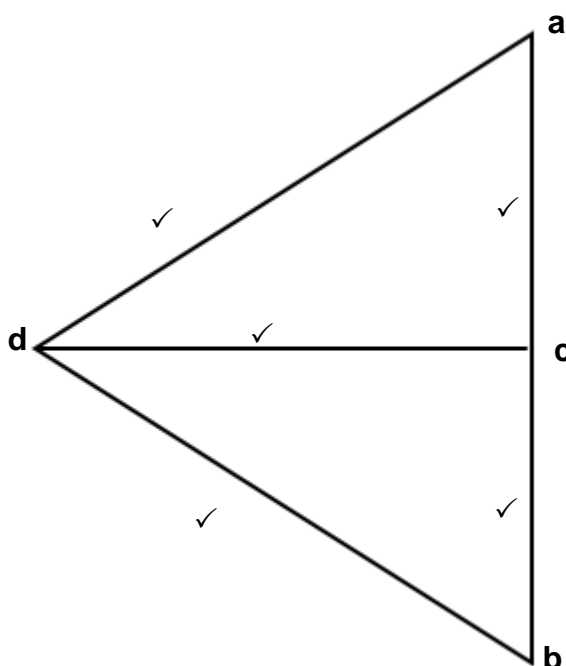
7.3 Simple frame:

7.3.1 Space diagram:



(4)

7.3.2 Vector diagram:



NOTE: Draw to scale on transparency for marking purpose
Tolerance of 2 mm.

(5)

7.3.3 Magnitude and nature of force:

Member	Force	Nature
AD	810 N(790-830) ✓	Strut ✓
BD	810 N(790-830) ✓	Strut ✓
CD	700 N(680-720) ✓	Tie ✓

(6)
[45]

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

8.1 Factors to consider during the inspection of welds:

- Bead ✓
- Width
- Height ✓
- Fusion
- Penetration ✓
- Pits ✓
- Undercutting ✓
- Distortion ✓
- Cracks ✓
- Spatter ✓
- No Slag inclusion ✓
- Proper start of weld ✓
- Termination of weld ✓

(Any 2 x 1) (2)

8.2 Welding defects:

8.2.1 Weld spatter:

- Too low welding voltages. ✓
- Too high welding current. ✓
- Arc length too long. ✓
- Not applying anti-spatter spray. ✓
- Electrode angle too small. ✓
- Welding speed incorrect. ✓
- Wrong polarity (DC). ✓
- Contaminated surface. ✓
- Wet electrodes. ✓
- Inadequate consumables. (e.g wrong electrodes, not enough shielding gas, etc.) ✓

(Any 2 x 1) (2)

8.2.2 Cracks:

- Wrong selection of electrode. ✓
- A restrained welded joint. ✓
- Fast cooling. ✓
- Improper welding technique. ✓
- Absence of preheating and post-heating of the joint. ✓
- Parent metal of poor weldability/High carbon content. ✓
- High residual stress on the base metal. ✓

(Any 2 x 1) (2)

8.3 Preventions for welding defects:

8.3.1 Incomplete penetration:

- Use correct arc length. ✓
- Use correct electrode angle. ✓
- Use correct current setting. ✓
- Use correct travel speed. ✓
- Use correct joint preparation/Remove mould scale/Clean joint. ✓

(Any 2 x 1) (2)

8.3.2 Undercutting:

- Decrease arc travel speed. ✓
- By raising arc voltage. ✓
- By lowering arc voltage. ✓
- By lowering the current. ✓
- Ensure proper joint preparation/Remove mould scale/Clean joint. ✓
- Use correct electrode angle. ✓

(Any 2 x 1) (2)

8.4 Label weld dimension:

- A. Penetration ✓
- B. Width ✓
- C. Height/Reinforcement/Cap height/Overfill ✓
- D. Weld bead/Deposited metal ✓
- E. Base metal/Work-piece/Test piece/Parent metal ✓

(5)

8.5 Machinability test for welded joints:

- To evaluate the surface finish. ✓
- To evaluate the integrity of the weld. ✓
- To evaluate defects such as porosity, inclusions or excessive hardness. ✓
- To determine the ease of machining. ✓

(Any 2 x 1) (2)

8.6 Free-bend test on a welded joint:

- To determine the percentage elongation of a welded metal. ✓
- It measures the ductility of the weld deposit. ✓
- It measures the heat affected area adjacent to the weld. ✓

(Any 2 x 1) (2)

8.7 Label X-ray test:

- A. Gamma ray/X-rays ✓
- B. Radioactive source/X-ray machine ✓
- C. Test piece/Work piece ✓
- D. Photographic film/Film ✓

(4)

(23)

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

9.1 Factors affecting grain size of steel:

- The prior amount of cold work. ✓
- The temperature and time of the annealing process. ✓
- The composition/Type of steel. ✓
- The melting point. ✓

(4)

9.2 Factors that affect distortion and residual stress:

- Welding current ✓
- Type/Size of electrode ✓
- Cooling rate ✓
- Size/Thickness of the material ✓

(Any 3 x 1) (3)

9.3 Label iron-carbon equilibrium diagram:

- A. Carbon percentage ✓
- B. Temperature in degrees Celsius ✓
- C. AC₃ / Higher critical temperature ✓
- D. AC₁ / Lower critical temperature ✓

(4)

9.4 Quenching media:

- Oil ✓
- Water ✓
- Brine ✓
- Air ✓
- Liquid salts ✓
- Sand ✓
- Ash ✓
- Lime ✓
- Molten lead ✓
- Nitrogen air-infused air ✓

(Any 2 x 1) (2)

9.5 Stress relieving:

- Annealing ✓
- Tempering ✓
- Normalising ✓

(Any 1 x 1) (1)

9.6 Definition of terms:

9.6.1 Distortion:

Distortion is the warping ✓ of the base plate caused by heat. ✓

(2)

9.6.2 **Elastic deformation:**

Is the ability of a material to regain its shape ✓ after the stresses have been relieved. ✓

(2)
[18]

QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 Maintenance in operating systems:

- It helps prolong the lifespan of hardware. ✓
- Minimizes downtime. ✓
- Improves system security. ✓
- Ensures efficient operation. ✓
- Improves safety. ✓

(Any 2 x 1) (2)

10.2 Lack of lubrication:

- It causes increased friction between moving parts. ✓
- It causes excessive heat. ✓
- It causes wear. ✓
- Potential damage to components. ✓

(Any 2 x 1) (2)

10.3 Overloading machine:

- Premature failure of machine components. ✓
- Decreased lifespan. ✓
- It can create a safety hazard. ✓

(Any 2 x 1) (2)

10.4 Maintenance guidelines for a power saw:

- Visual checks of electrical wiring. ✓
- Clearing the workspace. ✓
- Lubricating moving parts. ✓
- Monitor wheel bearings. ✓
- Checking hydraulic oil. ✓
- Repairing any existing leaks. ✓
- Check blade tension. ✓
- Check for proper alignment. ✓
- Inspect belts for wear. ✓
- Daily inspect the chip removal system/band guides. ✓
- Align vice to blade. ✓
- Check that guards are in place. ✓
- Blade condition. ✓

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

QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

11.1 Gravity flow:

To discharge ✓ its content at the bottom. ✓

(2)

11.2 Value of X:

$$\begin{aligned} X &= \sqrt{40^2 + 30^2} \checkmark \\ &= \sqrt{1600 + 900} \\ &= \sqrt{2500} \checkmark \\ &= 50 \text{ mm } \checkmark \end{aligned}$$

(3)

11.3 Square to square off centre hopper:

11.3.1 B-3:

$$\begin{aligned} B-3 &= \sqrt{\overset{\checkmark}{300}^2 + \overset{\checkmark}{600}^2 + \overset{\checkmark}{850}^2} \\ &= \sqrt{90000 + 360000 + 722500} \\ &= \sqrt{1172500} \checkmark \\ &= 1082,82 \text{ mm } \checkmark \end{aligned}$$

(5)

11.3.2 X-Y:

$$\begin{aligned} X-Y &= \sqrt{\overset{\checkmark}{250}^2 + \overset{\checkmark}{850}^2} \\ &= \sqrt{62500 + 722500} \\ &= \sqrt{785000} \checkmark \\ &= 886 \text{ mm } \checkmark \end{aligned}$$

(4)

11.3.3 C-4:

$$\begin{aligned} C-4 &= \sqrt{\overset{\checkmark}{700}^2 + \overset{\checkmark}{350}^2 + \overset{\checkmark}{850}^2} \\ &= \sqrt{490000 + 122500 + 722500} \\ &= \sqrt{1335000} \checkmark \\ &= 1155,42 \text{ mm } \checkmark \end{aligned}$$

(5)

11.4 Square to square ✓ hopper on centre. ✓

(2)

[21]

TOTAL: 200