

**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 12**

**SEPTEMBER 2018**

**MECHANICAL TECHNOLOGY: WELDING AND  
METAL WORK  
MARKING GUIDELINE**

**MARKS: 200**

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This marking guideline consists of 16 pages.

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**QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)**

- |     |     |            |
|-----|-----|------------|
| 1.1 | D ✓ | (1)        |
| 1.2 | C ✓ | (1)        |
| 1.3 | D ✓ | (1)        |
| 1.4 | D ✓ | (1)        |
| 1.5 | D ✓ | (1)        |
| 1.6 | B ✓ | (1)        |
|     |     | <b>[6]</b> |

**QUESTION 2: SAFETY (GENERIC)****2.1 Unsafe conditions:**

- Working at unsafe speeds. ✓
  - Grinding without goggles. ✓
  - Fooling and playing around workshop. ✓
  - Spilling liquids on floor. ✓
  - Lubricating/cleaning moving parts. ✓
  - Wearing loose clothing near moving parts. ✓
  - Grinding on the side of the grinding wheel. ✓
- (Any 4 x 1) (4)

**2.2 Assessing a first aid situation:**

- Environmental observation. ✓
  - Visible signs and symptoms. ✓
  - Indicators to diagnosis. ✓
  - Vital functions. ✓
  - Stopping any serious bleeding. ✓
  - Immediate treatment of cardiac arrest. ✓
- (Any 2 x 1) (2)

**2.3 2.3.1 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)

**2.3.2 Advantages of the process layout of machines**

- 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.**

The objective is to produce a hard case over a tough core. ✓✓

(2)

**3.2 Factors of hardness.**

- Work piece size ✓
- Quenching rate ✓
- Carbon content ✓

(3)

**3.3 Four kinds of quenching mediums.**

- Water and salt (brine) ✓
- Tap water ✓
- Liquid salts ✓
- Molten lead ✓
- Soluble oil and water ✓
- Oil ✓

(Any 4 x 1)

(4)

**3.4 Reason for hardened steel to be tempered:**

To reduce brittleness ✓ and to give the workpiece a more fine-grained structure ✓

(2)

**3.5 Test on materials:**

Type of Test	Mild Steel	High Speed Steel	Cast Iron
Sound Test	Medium metallic sound ✓	Low ring sound ✓	Dull sound ✓

(3)  
[14]**QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)**

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

4.13 B ✓ (1)

4.14 D ✓ (1)

**[14]**

### QUESTION 5: TERMINOLOGY (TEMPLATES, ROLLING AND BENDING) (SPECIFIC)

#### 5.1 Advantages of lattice girders:

Lattice girders tend to be very rigid ✓ and give good strength to weight ratios over long spans. ✓

(2)

#### 5.2 Calculation on basketball hoop:

Mean  $\varnothing$  = Outside  $\varnothing$  – Bar thickness

Mean  $\varnothing$  = Inside  $\varnothing$  + Plate thickness

Mean  $\varnothing$  = 380 + 16 mm

= 396 mm

Mean circumference =  $\pi \times \text{mean } \varnothing$  ✓

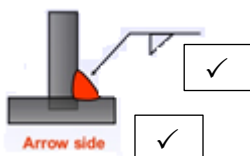
=  $\pi \times 396$  ✓

= 1 244,23 ✓

= 1 244 mm ✓

(4)

#### 5.3 Weld symbol:



(2)

#### 5.4 Template loft:

It is a very important section of a structural workshop, ✓ usually away from the main workshop where quietness and better light facilities are available. ✓

(2)

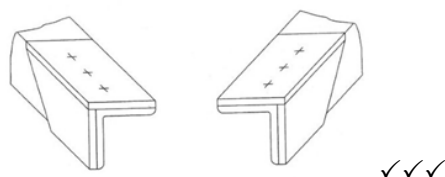
#### 5.5 Purpose of purlins:

To support the roof coverings ✓✓

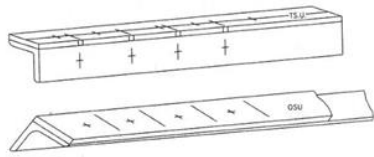
(2)

#### 5.6 Sketches of different templates:

##### 5.6.1 Flange template

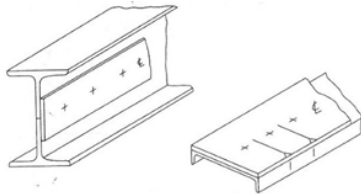


(3)

**5.6.2 Strip template**

✓✓✓

(3)

**5.6.3 Web template**

✓✓✓

(3)

**5.7 Basic principles of marking-off:**

- Measure accurately ✓
- Show all detail ✓
- Scribe lines must be clearly visible
- Use a prick punch to make lines clearer and permanent

(Any 2 x 1)

(2)

**[23]**

**QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)****6.1 6.1.1 Bench grinder ✓****Function:**

It is used to drive abrasive wheels, which hand grind cutting tools and perform other rough grinding. ✓

(2)

**6.1.2 Power-driven guillotine ✓****Function:**

To cut plates. ✓

(2)

**6.1.3 Power saw ✓****Function:**

It is used to roughly cut large sections of metal before they are further machined or used in manufacturing. ✓

(2)

**6.1.4 Pedestal drill press ✓****Function:**

Used to drill a wide variety of materials including ferrous and non-ferrous metals and composite plastics. ✓

(2)

**6.1.5 Hydraulic press ✓****Function:**

To install or remove components, such as bearings or bushes, in mechanical devices ✓

(2)

**6.1.6 Oxy- acetylene equipment: ✓****Function:**

To enable gas welding or cutting, by means of the oxy-acetylene flame ✓

(2)

**6.2 Drill bit sizes**

6.2.1 8 mm → 6, 8 mm to be drilled ✓

(1)

6.2.2 10 mm → 8, 5 mm to be drilled ✓

(1)

**6.3 Power saw**

The blade is tensioned in the frame and cuts in a forward and backwards (reciprocating) motion similar to that of a hacksaw. ✓

(1)

**6.4 Type of roller**

Pyramid bending rolls ✓

(1)

**6.5 Cutting limitations of plasma cutters:**

Hand held torches can cut up to 38 mm thick ✓

Computer controlled torches can cut up to 150 mm thick plates ✓

(2)

**[18]**

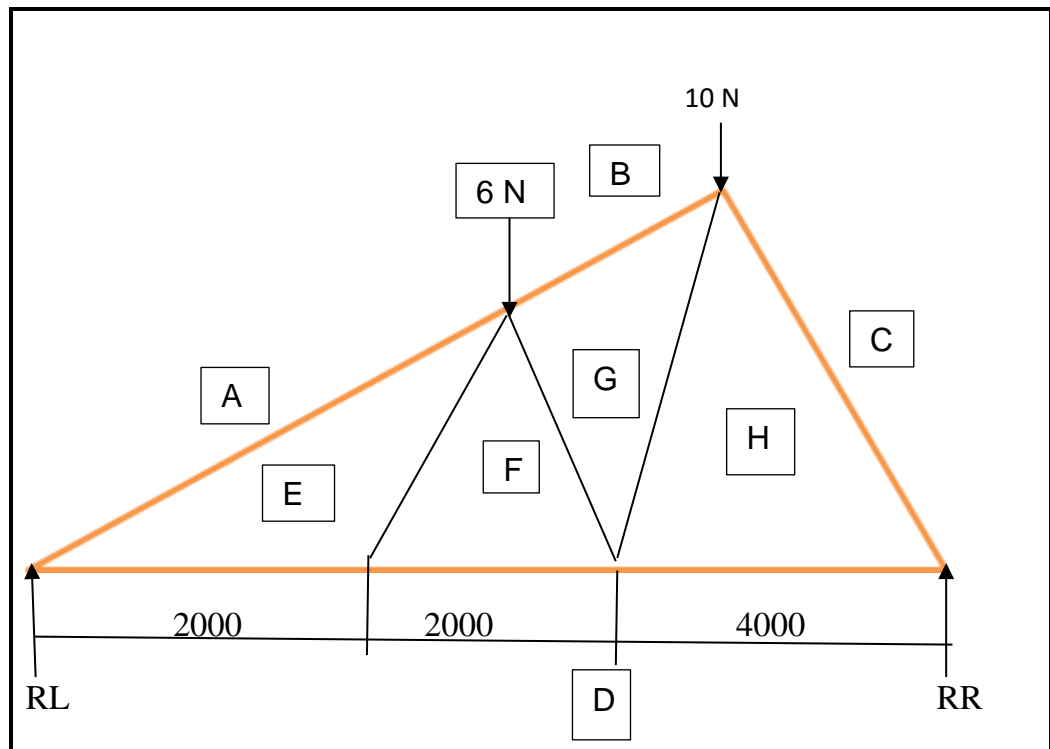


**QUESTION 7: FORCES (SPECIFIC)**

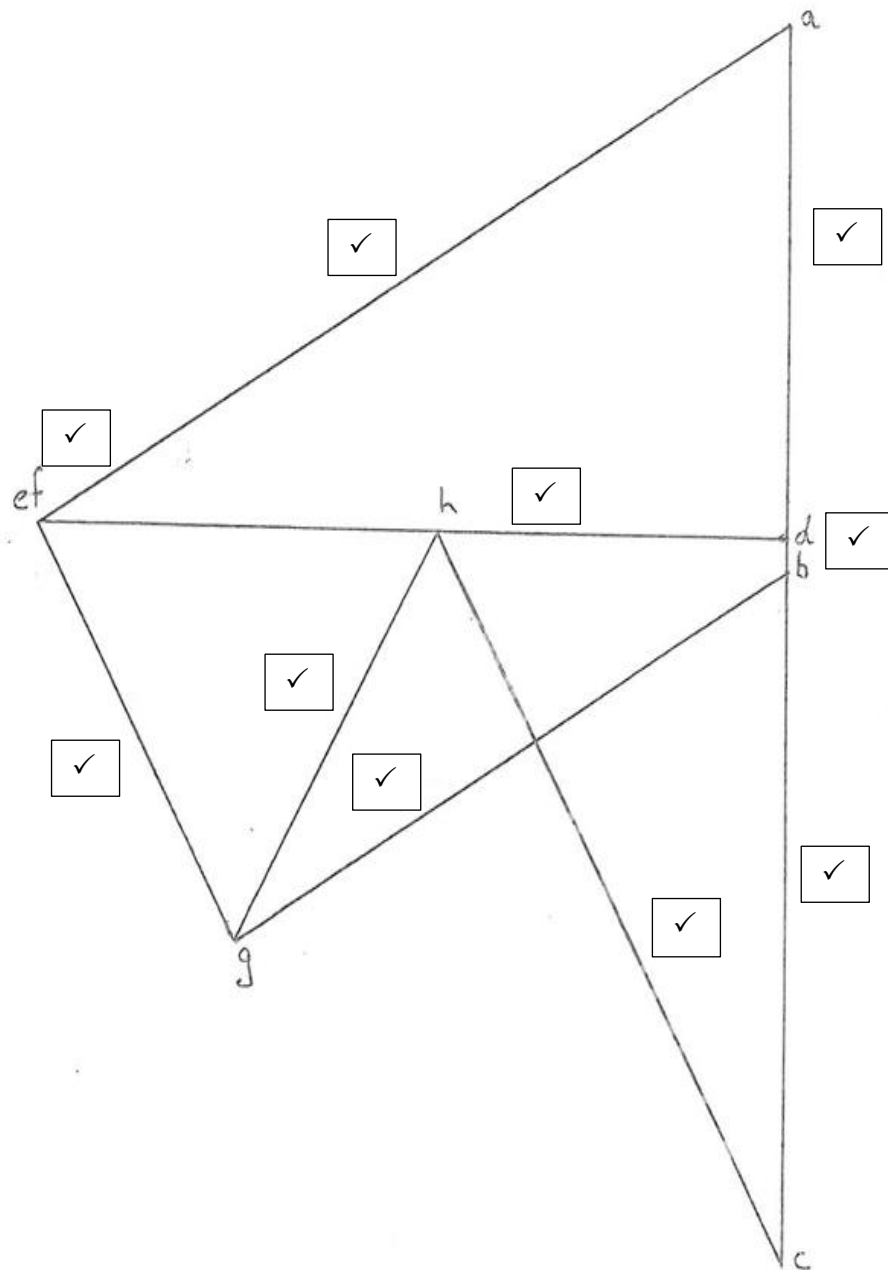
7.1    7.1.1    RR:  $RL \times 8 = (10 \times 2) + (6 \times 5) \checkmark$   
 $= 20 + 30$   
 $= 50 \checkmark$   
 $RL = 6,25 \text{ N} \checkmark$

$RL: RR \times 8 = (6 \times 3) + (10 \times 6) \checkmark$   
 $= 18 + 60$   
 $= 78 \checkmark$   
 $RR = 9,75 \text{ N} \checkmark$

(6)

**DIAGRAM 7.1**

## 7.1.2



(10)

## 7.2 Definitions:

**Strain:** Is the ratio between the change in length and the original length and is expressed as a constant. ✓✓

(2)

**Stress:** It is an external force applied to an object. Force per unit area. ✓✓

(2)

$$\begin{aligned}
 7.3 \quad \text{Stress} &= \frac{\text{Load}}{\text{Area}} \checkmark \\
 &= \frac{60 \times 10^3}{\frac{45 \times 45}{10^6}} \checkmark \checkmark \\
 &= \frac{60 \times 10^3 \times 10^6}{45 \times 45} \checkmark \\
 &= \frac{60 \times 10^9}{2025} \checkmark \\
 &= 29\,629\,629,63 \text{ Pa} \checkmark
 \end{aligned}$$

OR

$$= 29,63 \text{ MPa}$$

$$\begin{aligned}
 E &= \frac{\text{STRESS}}{\text{STRAIN}} \checkmark \\
 &= \frac{29\,629\,629,63}{150 \times 10^9} \checkmark
 \end{aligned}$$

$$\text{Strain} = 1,975308 \times 10^{-3} \checkmark$$

$$\begin{aligned}
 \text{STRAIN} &= \frac{\text{CHANGE IN LENGTH}}{\text{ORIGINAL LENGTH}} \checkmark \\
 &= 1,975308 \times 10^{-4} \times 2 \text{ m} \checkmark
 \end{aligned}$$

$$\begin{aligned}
 \text{Change in Length} &= 3,95 \times 10^{-4} \checkmark \\
 &= 0,395 \text{ mm} \checkmark
 \end{aligned}$$

(13)  
[33]

**QUESTION 8: JOINING METHODS (SPECIFIC)****8.1 Non-destructive tests:**

- Liquid dye penetrant test ✓
- X-Ray test ✓
- Ultrasonic test ✓

(3)

**8.2 Nick-break test:**

- Make a hacksaw cut through the centre of the weld. ✓
- Cut should be about 6,5 mm deep. ✓
- Place the saw-nicked specimen on two steel supports. ✓
- Use a sledgehammer to break the specimen by striking it in the zone where you made the saw cuts. ✓
- The weld metal exposed in the break should be completely fused and should be free from slag inclusions and contain no gas pockets greater than 1,6 mm. ✓
- There should be not more than one pore or gas pocket per square centimetre.

(5)

**8.3 Factors of a good arc:**

- The surface condition ✓
- The travel speed ✓
- The welding current ✓
- The arc voltage ✓
- The angle of the torch/electrode/shroud

(Any 4 x 1) (4)

**8.4 Welding defects:**

- Incomplete penetration ✓
- Lack of fusion ✓
- Porosity ✓
- Undercutting ✓
- Distortion
- Cracks
- Spatter
- Slag inclusion

(Any 4 x 1) (4)

**8.5 Methods to reduce stress:**

- Peening ✓
- Controlled heating, followed by controlled cooling ✓

(2)

**8.6 Welding spatter:**

It is the little droplets of molten material that are generated at or near the welding arc. ✓✓

It is generally regarded as a nuisance and is a critical factor to consider when developing an application.

(2)

**8.7 Cause of spatter:**

A disturbance in the molten weld pool during the transfer of wire into the weld, ✓ caused by voltage being too low or amperage being too high. ✓

(2)

**8.8 Oxy-acetylene mild steel flame:**

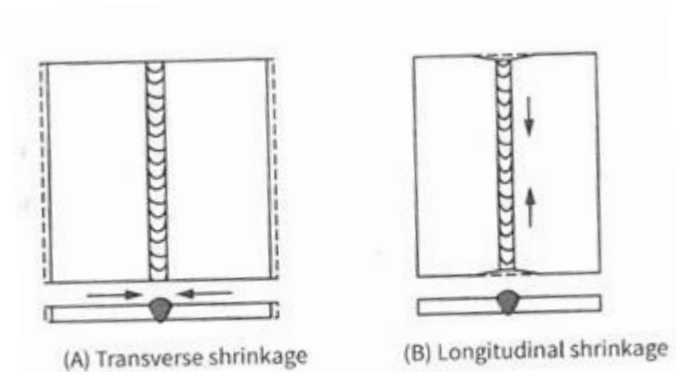
Neutral flame ✓

(1)

**[23]**

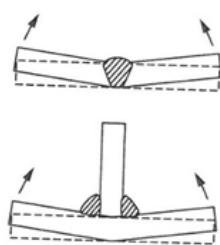
**QUESTION 9: JOINING METHODS (STRESSES AND DISTORTION) (SPECIFIC)**

9.1



✓✓✓

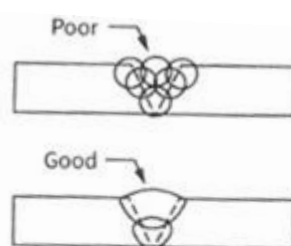
(9)



Angular distortion

✓✓✓

✓✓✓



Minimum number of passes

Use as few passes as possible

**9.2 Types of cracks:**

HAZ(Heat affected zone)cracks ✓

Centre line cracks ✓

Crater cracks ✓

Transverse cracks ✓

(4)

**9.3 Criteria for free bend test:**

It measures the ductility of the weld deposit and the heat affected area adjacent to the weld. ✓

It is used to determine the percentage of elongation of the weld metal. ✓

(2)

**9.4 Advantages of liquid dye over X-ray or ultra-sonic test:**

• Good for ferrous and non-ferrous metals ✓

• Low cost ✓

• Easy to apply and interpret ✓

• Minimal training required

(Any 3 x 1) (3)

**QUESTION 10: MAINTENANCE (SPECIFIC)****10.1 Results of a lack of lubrication:**

Overloading ✓

Friction ✓

(2)

**10.2 Definition of friction:**

Rubbing of one part ✓ against another ✓

(2)

**10.3 Overloading:**

Excessive loads on machine parts ✓

Running a machine or device at a rate higher than at which it was designed to operate ✓

(2)

**10.4 Consequences of overloading –guillotine:**

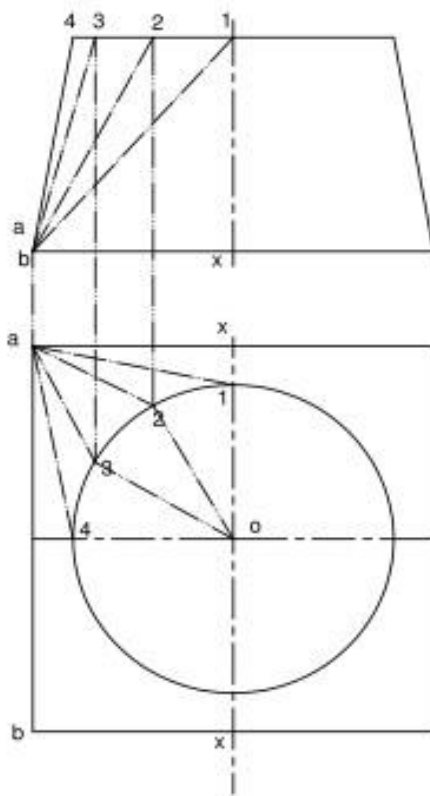
Cutting plate of excessive thickness or hardness will damage both the blade ✓ and hydraulic system, resulting in costly damage ✓

(2)

**[8]**

**QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)**

11.1



$$\begin{aligned}
 11.1.1 \quad A - B : (1 - 2) &= \frac{n \times 30}{12} \checkmark \\
 &= \frac{94,26}{12} \checkmark \\
 &= 7,85 \checkmark \quad (3)
 \end{aligned}$$

$$\begin{aligned}
 11.1.2 \quad (A - 1) : X - 1 &= \sqrt{(ox - R)^2 + h^2} \checkmark \\
 &= \sqrt{(45 - 15)^2 + 50^2} \checkmark \\
 &= 73,65 \checkmark \quad (3)
 \end{aligned}$$

$$\begin{aligned}
 11.1.3 \quad (1 - a) &= \sqrt{(37,5^2 + 32^2 + 50^2)} \checkmark \checkmark \\
 &= 70,2 \checkmark \checkmark \quad (4)
 \end{aligned}$$

$$\begin{aligned}
 11.1.4 \quad 2 - a &= \sqrt{(45 - 15 \cos 30^\circ)^2 + (45 - 15 \sin 30^\circ + 50^2)} \checkmark \\
 &= \sqrt{(32^2 + 37,5^2 + 50^2)} \checkmark \\
 &= \sqrt{4930,25} \checkmark \\
 &= 70,2 \checkmark \quad (4)
 \end{aligned}$$

$$\begin{aligned}
 11.1.5 \quad a - 3 &= \sqrt{(45 - 15 \cos 30^\circ)^2 + (45 - 15 \sin 30^\circ + 50^2)} \checkmark \\
 &= \sqrt{(32^2 + 37,5^2 + 50^2)} \checkmark \\
 &= \sqrt{4930,25} \checkmark \\
 &= 70,2 \checkmark \quad (4)
 \end{aligned}$$

