NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2019

# MECHANICAL TECHNOLOGY: WELDING AND METALWORK

## MARKING GUIDELINES

Time: 3 hours 200 marks

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**These marking guidelines are prepared for use by examiners and sub-examiners, all of whom are required to attend a standardisation meeting to ensure that the guidelines are consistently interpreted and applied in the marking of candidates' scripts.**

**The IEB will not enter into any discussions or correspondence about any marking guidelines. It is acknowledged that there may be different views about some matters of emphasis or detail in the guidelines. It is also recognised that, without the benefit of attendance at a standardisation meeting, there may be different interpretations of the application of the marking guidelines.**

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## QUESTION 1 MULTIPLE-CHOICE QUESTIONS (Generic)

1.1 A

1.2 C

1.3 D

1.4 A

1.5 B

1.6 D

## QUESTION 2 SAFETY (Generic)

2.1 **Name THREE safety rules to be remembered when using a manual guillotine**

- Keep hands clear of blade.
- Don't cut material that is thicker than machine can handle.
- Do not adjust or service during operation.
- Blade guard or back of machine to catch material.

2.2 **Explain the difference between an *act* and a *condition***

- An act is something that workers do that could cause unsafe conditions in a workshop leading to injury.
- A condition is something created by the act or the unsafe conditions of the building or equipment where workers are working.

2.3 **Name TWO advantages of a process layout**

- High machine utilisation.
- Better supervision.
- Less interruption.
- Lower equipment cost.
- Better control of total manufacturing cost.
- Greater flexibility in the production process.

2.4 **What is the maximum distance that the tool rest should be set from the grinding wheel of a bench grinder?**

- 3 mm

## QUESTION 3 MATERIALS (Generic)

3.1 **List THREE factors that must be considered when hardening steel through heat treatment.**

- Workpiece size
- Quenching rate
- Carbon content

3.2 **Name TWO testing machines used to check the resistance to bending, scratching and abrasion.**

- Vickers
- Rockwell
- Brinell

3.3 **What is the reason for doing the following heat-treatment processes?**

3.3.1 **Tempering**

Tempering is a process used to relieve strains induced during the hardening process.

3.3.2 **Annealing**

Metal is annealed to relieve internal stresses that may have been set up during previous workings and to soften the material.

3.3.3 **Normalising**

Normalising is done to relieve internal stress produced by machining, welding or forging.

3.4 **What sound do the following materials make when tapped with a hammer?**

3.4.1 **Cast iron** Very dull sound

3.4.2 **Cast steel** High ringing sound

3.4.3 **Mild steel** Medium metallic sound

## QUESTION 4 MULTIPLE-CHOICE QUESTIONS (Specific)

4.1 B

4.2 D

4.3 D

4.4 D

4.5 C

4.6 B

4.7 C

4.8 C

4.9 B

4.10 C

4.11 A

4.12 B

4.13 B

4.14 C

## QUESTION 5 TERMINOLOGY (Templates) (Specific)

5.1 **What is a *flange template* used for?**

A flange template is used to mark angle cleats and is fitted over the edge of the angle iron.

5.2 **What is a *lattice girder* and what is it used for?**

A lattice girder is called a truss and is used over long spans of a structure.

5.3 **Calculate the dimensions of an 10 mm × 10 mm steel square bar that is to be rolled into a cylindrical form with an external diameter of 700 mm.**

Mean dia = ED – Plate thickness
Mean dia = 700 – 10
Mean dia = 690 mm

Circumference = $\pi \times$ *Mean dia*
Circumference = $\pi \times$ *690*
Circumference = 2167,70 mm

5.4 **Resistance welding refers to a group of processes and uses symbols to indicate the type of weld to be used on the joint. Name FIVE resistance symbols used.**

- Spot
- Seam
- Projection
- Foil seam
- Flash or resistance butt

5.5 **What is the purpose of supplementary symbols? Give THREE examples.**

The purpose of supplementary symbols is to provide extra (supplementary) information regarding a welded joint
Contour Finish
Site weld
Weld all round

## QUESTION 6 TOOLS AND EQUIPMENT (Specific)

6.1 **Explain the principle of operation of the following equipment utilised in a welding workshop:**

6.1.1 **Spot Welder**

Spot welders do not use a consumable electrode like conventional welders. It utilises a heating effect when the current occurs and flows through the plates fusing them together.

6.1.2 **Plasma cutter**

Plasma cutting is done by an electrically charged accelerated jet of hot plasma. It creates an electrical channel of ionised gas that is plasma through the workpiece that is clamped via a grounding clamp. The plasma provides sufficient heat to melt the workpiece.

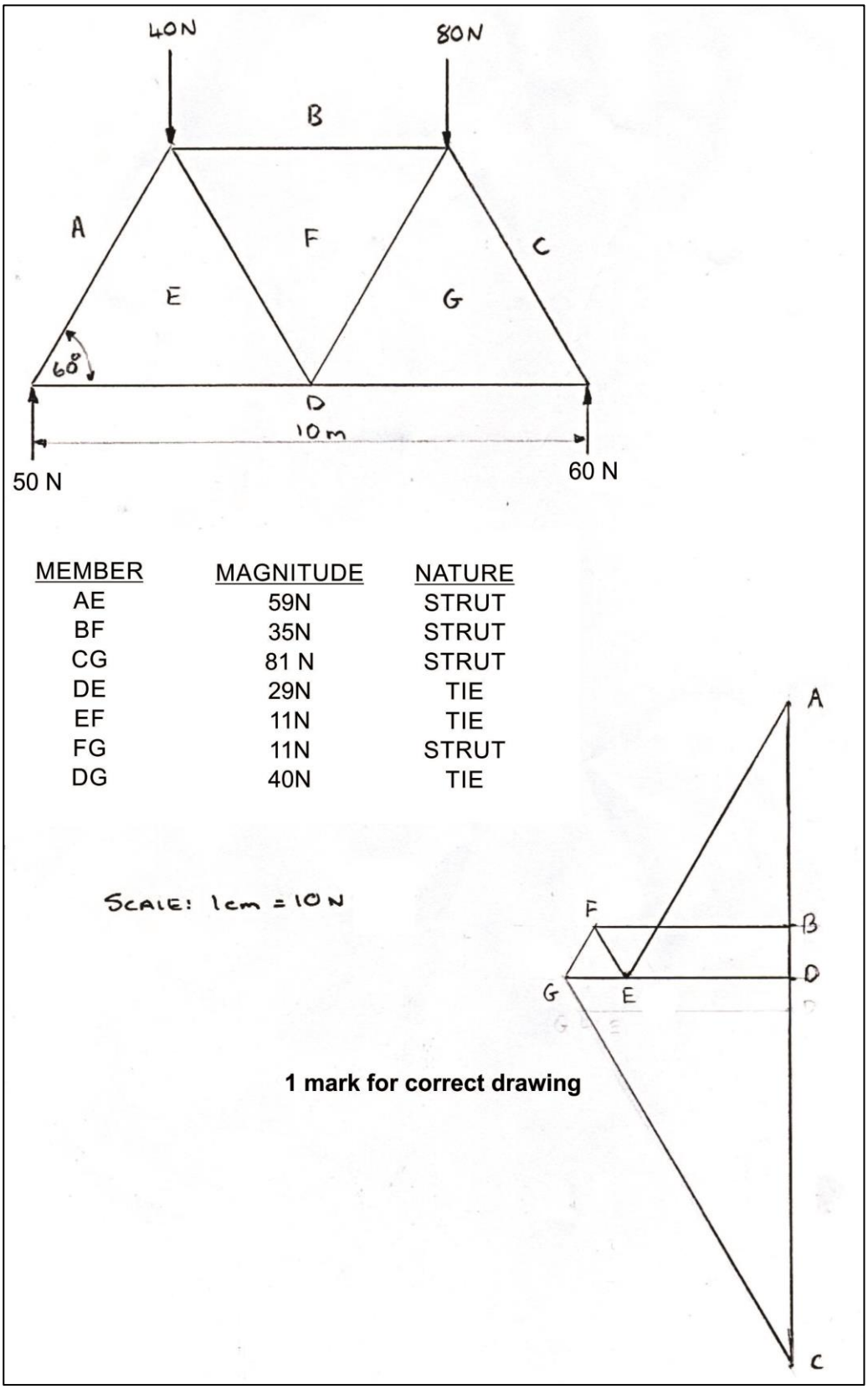
6.2 **What is the primary task of the regulators?**

They are primarily used to change cylinder pressure to operating pressure.

6.3
A Major diameter/ Outside diameter/ Nominal diameter
B Effective diameter
C Minor diameter/ Core diameter
D Crest
E Helix angle
F Pitch
G Thread width (thickness)
H Thread angle

## QUESTION 7 FORCES (Specific)

7.1




| MEMBER | MAGNITUDE | NATURE |
|---|---|---|
| AE | 59N | STRUT |
| BF | 35N | STRUT |
| CG | 81 N | STRUT |
| DE | 29N | TIE |
| EF | 11N | TIE |
| FG | 11N | STRUT |
| DG | 40N | TIE |

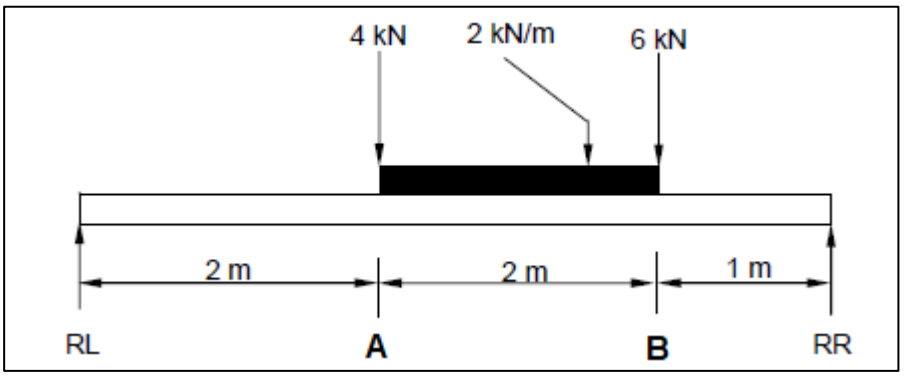
SCALE: 1cm = 10 N




**1 mark for correct drawing**

NOTE: Use a tolerance of 2 mm "+" and "–" on the vector diagram.
= a tolerance of 10 N "+" and "–" on the answer.

7.2

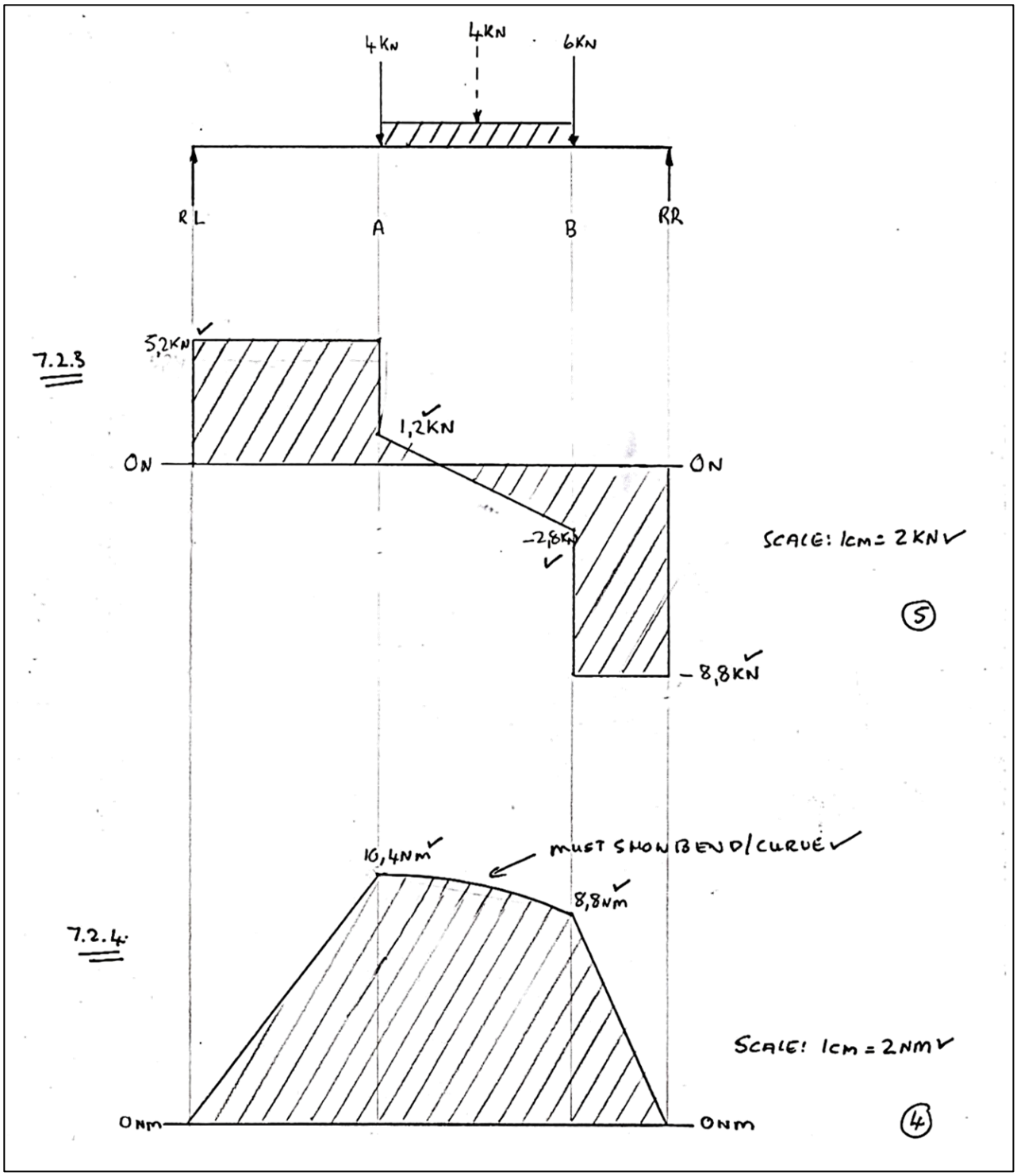



7.2.1 RL × 5 m = (4 kN × 3 m) + (4 kN × 2 m) + (6 kN × 1 m)
RL × 5 m = 26 kN.m
$RL = \frac{26}{5}$
RL = 5,2 kN

RR × 5 m = (6 kN × 4 m) + (4 kN × 3 m) + (4 kN × 2 m)
RR × 5 m = 44 kN.m
$RR = \frac{44}{5}$
RR = 8,8 kN

7.2.2 **Bending moments:**
**BMA:**
(5,2 kN × 2 m) – (4 kN × 0 m) = 10,4 Nm
**BMB:**
(5,2 kN × 4 m) – (4 kN × 2 m) – (4 kN × 1 m) – (6 kN × 0 m) = 8,8 Nm

7.2.3 + 7.2.4




## 7.3 Calculations

### 7.3.1 **The strain in the metal**

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

$$\text{Strain} = \frac{0{,}005}{400}$$

$$\text{Strain} = 0{,}0000125$$

7.3.2 **Young's modulus of elasticity for the metal**

$$YM = \frac{Stress}{Strain}$$

$$YM = \frac{20000000}{0{,}0000125}$$

YM = 1600Mpa OR $1{,}6 \times 10^{12} = 1{,}6$ Tpa

7.3.3 **The diameter of the round bar in mm**

$$D = \sqrt{\frac{4\ x\ A}{\pi}}$$

$$D = \sqrt{\frac{4\ x}{\pi}}0.0009621127$$

D = 0,034999 m
D = 35 mm

**QUESTION 8 JOINING METHODS (Inspection of Weld) (Specific)**

8.1 **It is important to observe the weld whilst welding; observation can improve the standard and ensure that the settings and material are correct. Name TWO inspections for each of the following:**

8.1.1 **Inspection during arc welding.**
Rate of rod-burning
Amount of penetration
Flow of weld metal
Sound of the arc

8.1.2 **Inspection during oxy-acetylene welding.**
Correct flame
Correct angle of blowpipe
Depth of fusion and penetration
Rate of progress along the joint

8.2 **Weld gauges can be used to rapidly check a welded joint for quality. Figure 5 shows a sketch of a welded joint. Name labels A–E.**
A Penetration
B Width
C Height
D Weld bead
E Base metal

8.3 **List the steps to be taken to do a liquid-dye penetrant test**
Clean weld to be inspected
Spray dye on the clean surface
Allow dye to penetrate the weld surface
Clean excess dye away with a cleaning agent
Allow surface to dry thoroughly
Spray developer on surface to bring out faults in weld cracks
Dye shows on surface defects

8.4 **The diagrams 8.4.1 and 8.4.2 shows TWO defects in welded joints. Name the defect, the cause of the defect and the remedy. (Tabulate your answers.)**

| Defect | Cause | Remedy |
|---|---|---|
| 8.4.1 incomplete penetration | • Opposing beads do not penetrate<br>• Weld bead not penetrating full depth<br>• Welding current too low (Any 1) | Increase welding current |
| 8.4.2 Undercutting | • Improper welding parameters<br>• Travel speed too fast<br>• Arc voltage too high (Any 1) | Decrease travel arc speed<br>Reduce voltage |

8.5 **What test is done with high-frequency sound waves?**
Ultrasonic

## QUESTION 9 JOINING METHODS (Stresses and Distortion) (Specific)

9.1 **Which FOUR factors affect shrinkage whilst welding?**
Electrode type
Electrode size
Welding current and flame size
Welding speed
The rate of cooling while and after welding

9.2 **Name FOUR methods that can be applied to reduce distortion.**
Do not over-weld
Intermittent welding
Placing welds close to neutral axis
Use as few passes as possible
Use backstep welding

9.3 **Name the THREE classes of carbon steel and each class's percentage carbon**
Low-carbon steel 0,15% – 0,3%
Medium-carbon steel 0,31% – 0,7%
High-carbon steel 0,71% – 1,5%

9.4 **Name FOUR factors that affect the grain size of steel when it is cold worked.**
Prior amount of cold work
Composition of alloying elements
The annealing time and temperature
The melting point

## QUESTION 10 MAINTENANCE (Specific)

10.1 **After routine service maintenance of machinery is complete, a final inspection of the machinery must be done. Name FOUR conditions that should be observed before starting up machines.**
Technicians confirm the machine is safe
Check all safety guards are fitted and secure
Area around machine is clear
Inform workers machine is going to be powered on

10.2 **What will overloading of the hydraulic guillotine do to the machine?**
Overloading of the machine will cause damage to the blade and possible failure of the hydraulic system.

10.3 **List TWO factors to be considered when choosing the cutting speed of a drilling machine.**
Type of material
Diameter of drill bit
Material
Condition of machine
Rate of feed
Use of cutting fluid
Firmness with which the work is clamped

## QUESTION 11 TERMINOLOGY (Development) (Specific)

11.1 **Conical hopper:**

11.1.1 **Angle E**

70 – 40
30 mm
Tan $\theta = \frac{60}{30}$
Tan $\theta = 2$
E = 63,43°

11.1.2 **Length AC:**

$$AC = \frac{30}{Cos\ 63{,}43°} \text{ OR } AC = \frac{60}{\text{Sin } 63{,}43°}$$

AC = 67,08 mm

11.1.3 **Circumference AB:**

Circ = π x 40
Circ = 125,66 mm

11.1.4 **Circumference CD:**

Circ = π × 70
Circ = 219,91 mm

11.2 **Square-to-square transition:**

11.2.1 **The true length A1**

$A1 = \sqrt{150^2 + 150^2 + 550^2}$

$= \sqrt{22\,500 + 22\,500 + 302\,500}$

= 589,49 mm

11.2.2 **True length X1–X2**

$X1–X2 = \sqrt{150^2 + 550^2}$

$= \sqrt{22\,500 + 302\,500}$

= 570,09 mm

11.2.3 **True length A2**

$A2 = \sqrt{150^2 + 450^2 + 550^2}$

$= \sqrt{22\,500 + 202\,500 + 302\,500}$

= 726,29 mm

11.2.4 **True length of A–X2**

$A–X2 = \sqrt{150^2 + 300^2 + 550^2}$

$= \sqrt{22\,500 + 90\,000 + 302\,500}$

= 644,21 mm

**Total: 200 marks**