NATIONAL SENIOR CERTIFICATE EXAMINATION
NOVEMBER 2020

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

MARKING GUIDELINES

Time: 3 hours 200 marks

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QUESTION 1 MULTIPLE-CHOICE (Generic)

1.1 B ✓ (1)

1.2 D ✓ (1)

1.3 C ✓ (1)

1.4 A ✓ (1)

1.5 B ✓ (1)

1.6 B ✓ (1)
[6]

QUESTION 2 SAFETY (Generic)

2.1 **State TWO responsibilities of an employer regarding the safety in the workplace.**
- The workplace provided must be safe and free of risk. ✓
- Must provide training and instructions. ✓
- Inform employees of the scope of their authority. ✓ (Any 2 × 1) (2)

2.2 **Why is it so important to determine an injured person's vital signs after an injury?**
To determine the injured person's condition, so that brain damage, pain or other injuries can be determined. ✓✓ (2)

2.3 **Name TWO safety rules to be applied when using an angle grinder.**
- Safety guard must be fitted. ✓
- Use the correct disk for the job. ✓
- Do not use excessive force when grinding. ✓
- Make sure disc has no cracks. ✓
- PPE must be worn. ✓
- Beware of lockable switches in the on position when the machine is plugged in and switched on. ✓
- Secure workpiece properly. ✓ (Any 2 × 1) (2)

2.4 **Why should a workpiece be clamped securely when using a drill press?**
- To ensure that it does not come loose/rotate. ✓✓
- Prevent injury to the operator. ✓✓
- To improve accuracy. ✓✓
- To prevent the drill bit from breaking. ✓✓ (Any 1 x 2) (2)

2.5 **Why should the distance between the grinding wheel and tool rest not be more than 3 mm?**
When the gap is more than 3 mm the danger is that the tool or the workpiece being ground can get stuck/lodged in-between the wheel and the rest – causing the wheel to shatter. ✓✓ (2)
[10]

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QUESTION 3 MATERIALS (Generic)

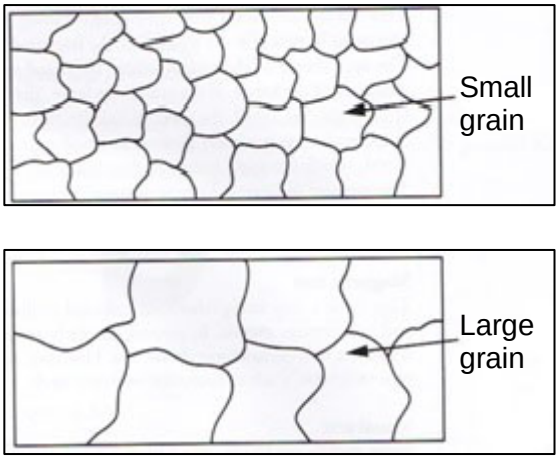
3.1 3.1.1 **A loud and clear sound.**
High-carbon steel ✓ (1)

3.1.2 **A dull sound.**
Low-carbon steel ✓ (1)

3.2 **Describe what *soaking* of a metal involves.**
It involves holding the metal at a predetermined elevated temperature ✓ for a certain period of time ✓ to ensure even penetration of heat. ✓ (3)

3.3 **Explain the process of *normalising* of steel during the heat-treatment process**
Normalising is a process whereby:
- iron-base alloys are heated above ✓ the upper critical temperature ✓
- then soaking the metal until it is uniformly heated ✓
- and cooled to room temperature ✓ (4)

3.4 **Use two neat sketches to explain the differences in grain structure before and after heat treatment.**



(1 mark for each drawing and 1 mark for each label) (4)

3.5 **What is a pyrometer?**
A pyrometer is an instrument that is used to check temperature in a kiln. ✓ (1)

[14]

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QUESTION 4 MULTIPLE-CHOICE QUESTIONS (Specific)

4.1 C ✓ (1)

4.2 A ✓ (1)

4.3 C ✓ (1)

4.4 A ✓ (1)

4.5 A ✓ (1)

4.6 A ✓ (1)

4.7 C ✓ (1)

4.8 B ✓ (1)

4.9 B ✓ (1)

4.10 D ✓ (1)

4.11 C ✓ (1)

4.12 B ✓ (1)

4.13 C ✓ (1)

4.14 A ✓ (1)

[14]

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QUESTION 5 TERMINOLOGY (Templates) (Specific)

5.1 **Regarding templates, what do the following two abbreviations stand for?**

5.1.1 **T.S.U.**
Top side up ✓

5.1.2 **O.S.U.**
Other side up ✓ (2)

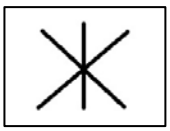
5.2 **What is the purpose of a web stiffener?**
A web stiffener is used to strengthen the web of an I-beam ✓✓ (2)

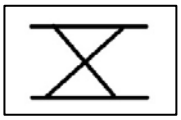
5.3 **What is the primary purpose of the purlins and why are they referred to as secondary members?**
Purlins are used to attach roof material to the truss ✓ and they are laid longitudinally ✓ across the roof trusses and help with bracing the trusses. ✓ (3)

5.4 Mean dia = ID + Plate thickness ✓
Mean dia = 400 + 16 ✓
Mean dia = 416 mm ✓

Circumference = $\pi \times$ *Mean dia* ✓
Circumference = $\pi \times 416$ ✓
Circumference = 1306,9 mm ✓ (6)

5.5

5.5.1  ✓

5.5.2  ✓

5.5.3  ✓

5.5.4 

✓ (4 × 1)

5.6 **Define *resistance welding*.**
Resistance welding is a group of welding processes ✓ where heat to form the weld is generated by the electrical resistance ✓ of material combined with time and force. ✓✓ (4)

5.7 **When using welding symbols, what is the tail of the symbol used for?**
The tail is used to specify additional information ✓ not specified by the symbols. ✓ (2)

[23]

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QUESTION 6 TOOLS AND EQUIPMENT (Specific)

6.1 **Name TWO different types of tap wrenches**

- T-handle tap wrench ✓
- Single-handle tap wrench ✓ (2)

6.2
A Current scale ✓
B Current adjuster ✓
C On/Off switch ✓
D Electrode terminal ✓
E Electrode holder ✓
F Electrode ✓
G Arc gap ✓
H Earth clamp ✓
I Earth terminal ✓ (9)

6.3 **Briefly describe a punch and cropper machine and state what it is used for.**

It is a heavy-duty machine ✓ used for cutting steel profiles ✓ and punching holes in steel. ✓ (3)

6.4 **What is a flashback arrestor and where is it fitted?**

They are used to stop sparks or flame from moving through the pipes ✓ to the gas bottles ✓ and are fitted to the regulators ✓ and at the torch end. ✓ (4)

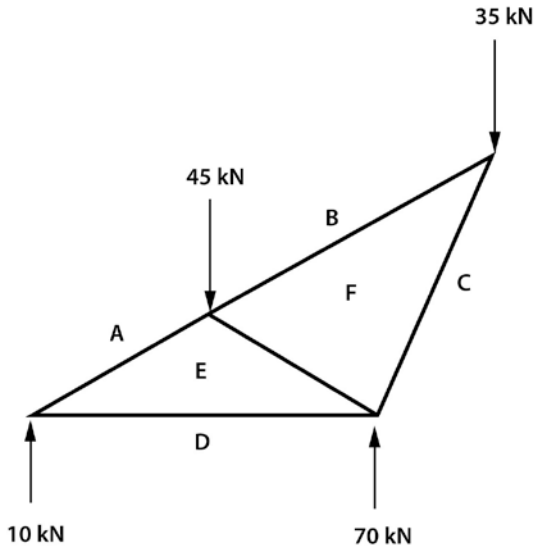
[18]

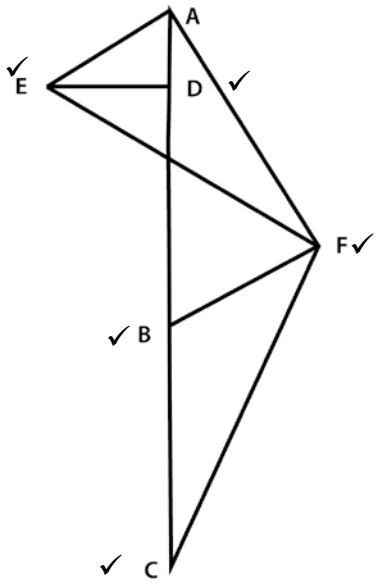
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QUESTION 7 FORCES (Specific)

7.1 **Determine graphically the magnitude and nature of the forces in all the members in Figure 7.1.**

SCALE: 1 cm = 10 kN (Show mark allocation)

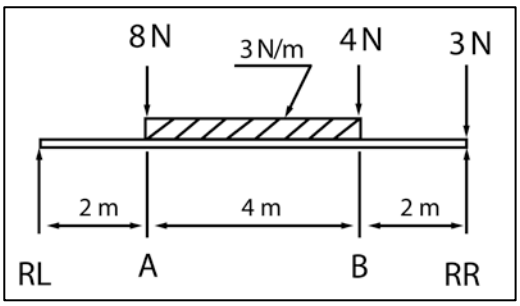




MEMBER	FORCE	NATURE
AE	20 kN ✓	STRUT ✓
BF	25 kN ✓	TIE ✓
CF	51 kN ✓	STRUT ✓
DE	18 kN ✓	TIE ✓
EF	45 kN ✓	STRUT ✓

(15)

7.2



7.2.1 RL × 8 m = (8 N × 6 m) + (12 N × 4 m) + (4 N × 2 m) + (3 N × 0) ✓
RL × 8 m = 104 N
RL = $\frac{104}{8}$ ✓
RL = 13 N ✓

RR × 8 m = (3 N × 8 m) + (4 N × 6 m) + (12 N × 4 m) + (8 N × 2 m) ✓
RR = $\frac{112}{8}$ ✓
RR = 14 N ✓ (6)

7.2.2 **Bending moments:**

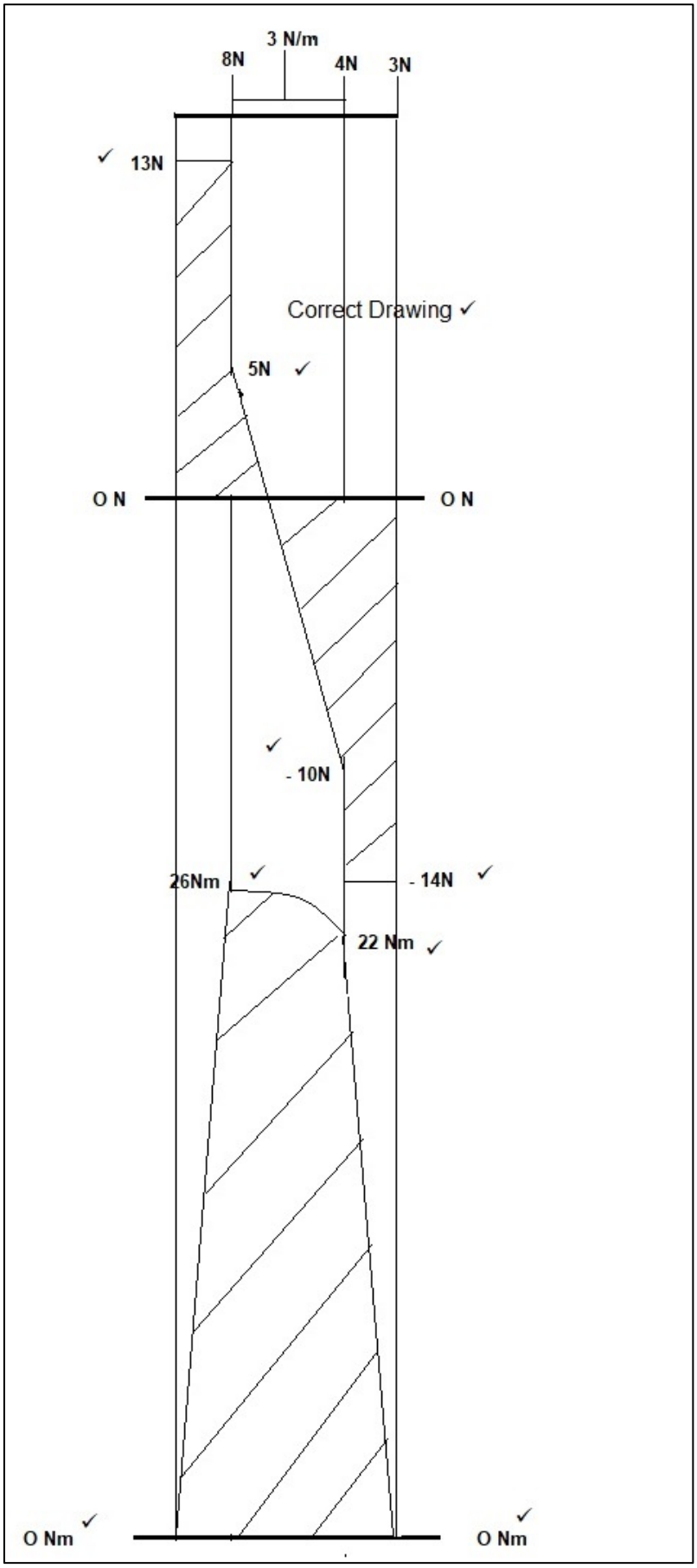
BMA:

(13 N × 2 m) – (8 N × 0 m) = 26 Nm ✓✓✓

BMB:

(13 N × 6 m) – (8 N × 4 m) – (12 N × 2 m) – (4N × 0 m) = 22 Nm ✓✓✓ (6)

7.2.3 + 7.2.4 Scale:1 cm = 2 N for shear force and 1 cm = 2 Nm for bending moment.



(5 + 4)

7.3 **Calculate the compressive stress in a 20 mm round bar if it is subjected to a compressive load of 60 Kn.**

$A = \frac{\pi}{4} \times d^2$
$A = 0{,}7853981 \times (0{,}02^2)$✓
$A = 0{,}0003141\ m^2$ ✓

$Stress = \frac{Load}{Area}$
$Stress = \frac{60\ 000}{0{,}000314}$ ✓
Stress = 190985931,7 Pa
Stress = 190,985 Mpa ✓✓ (5)

7.4 7.4.1 **Load –** An external force acting upon matter. ✓✓ (2)

7.4.2 **Strain –** The ratio between change in length and original length. ✓✓ (2)
[45]

QUESTION 8 JOINING METHODS (Inspection of weld) (Specific)

8.1 **Name three destructive tests exerted onto metals.**
- Nick-break test ✓
- Guided-bend test ✓
- Free-bend testing ✓
- Machinability test ✓ (Any 3 × 1) (3)

8.2 **Mention the FOUR different types of cracks found in welded joints and elaborate on what causes them.**
- Heat-affected cracks ✓ caused by excess hydrogen ✓
- Centreline cracks ✓ caused by improper width to depth ratio ✓
- Crater cracks ✓ caused by lack of filler at the end of the weld ✓
- Transverse cracks ✓ caused by high residual stress ✓ (8)

8.3 **Demonstrate your understanding of the visual inspection process in welding by pointing out any THREE elements that should be inspected during the visual inspection process.**
- Shape of profile ✓
- Uniformity of the surface ✓
- Overlap ✓
- Undercutting ✓
- Penetration bead ✓
- Root groove ✓ (Any 3 × 1) (3)

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8.4 **Name THREE factors that should be observed during the arc-welding process to ensure a good welded joint.**

- Amount of penetration and fusion. ✓
- Rate of electrode burning and progress of the weld. ✓
- The way the weld metal is flowing. (No slag inclusion) ✓
- The sound of the arc, indicating correct current and voltage for the particular weld. ✓ (Any 3 × 1) (3)

8.5 **State TWO causes for each of the following during arc-welding:**

8.5.1 **Welding spatter**

- Too high current ✓
- Too long arc ✓
- Not applying anti-spatter spray ✓
- Electrode angle too small ✓
- Welding speed too fast ✓ (Any 2 × 1) (2)

8.5.2 **Incomplete penetration**

- Too low current ✓
- Too slow welding speed ✓
- Electrode angle too small ✓
- Poor joint preparation ✓ (Any 2 × 1) (2)

8.6 **Why would we do a free-bend test on a piece of metal?**

To measure the ductility of the weld deposit ✓ and to determine the percentage of elongation in the weld metal. ✓ (2)

[23]

QUESTION 9 JOINING METHODS (Stresses and distortion) (Specific)

9.1 **What factors control the rate at which metal cools down?**

Size ✓
Thickness ✓
Thermal conductivity ✓ (3)

9.2 **One of the methods to reduce distortion is *intermittent welding*. Explain how this is done.**

Short welds with gaps in-between ✓ to stop the metal from warping. ✓ Attach stiffeners ✓ to the plate to reduce 75% of distortion and provide strength needed. ✓ (4)

9.3 **What happens when austenite is allowed to cool slowly?**

When austenite is allowed to cool slowly the grain formation will be uniform ✓ and the austenite will decompose into cementite ✓ and ferrite ✓ layers forming pearlite. ✓ (4)

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9.4 **Name THREE quenching media used to cool down steel.**

- Water ✓
- Brine ✓
- Oil ✓
- Air ✓ (Any 3 × 1) (3)

9.5 **Describe the difference between cold working and hot working of steel.**

Cold working is when deformation of steel takes place below ✓ the recrystallisation temperature ✓ of the steel.
Hot working is when deformation of steel takes place above ✓ the recrystallisation temperature ✓ of the steel. (4)

[18]

QUESTION 10 MAINTENANCE (Specific)

10.1 **What is the safest and most efficient way to lubricate guillotine parts?**

Centralised lubrication and piping ✓ mounted on the front of the machine ✓ will be effective and also reduce the risk of hazard and injury. (2)

10.2 **With regard to plant and equipment maintenance, name TWO things that should never be ignored.**

- Maintenance ✓
- Reports of damaged equipment ✓
- Use faulty or damaged equipment ✓ (Any 2 × 1) (2)

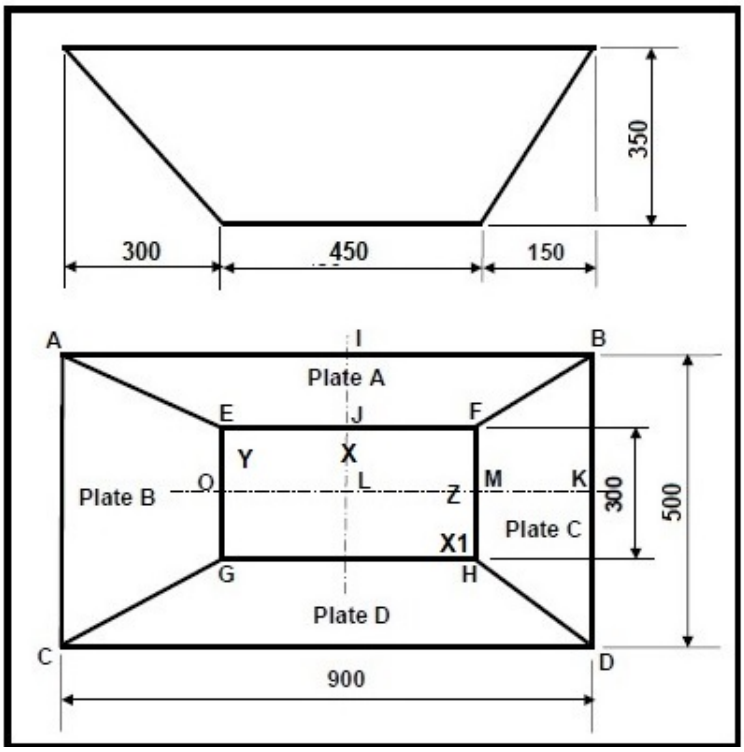
10.3 **Name the four general guidelines to be observed when maintaining a rolling machine.**

- Check switches and condition of wiring ✓
- Lock machine out and tag machine and check the guarding ✓
- Remove lockout and check machine's operation ✓
- Record results in service sheets and log book ✓ (4)

[8]

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QUESTION 11 TERMINOLOGY (Development) (Specific)



11.1 **Calculate the length of IJ on plate A.**

$X = \frac{500 - 300}{2}$

X = 100 mm ✓

$IJ^2 = 350^2 + 100^2$ ✓

$IJ = \sqrt{132\ 500}$

IJ = 364,00 mm ✓ (3)

11.2 **Calculate the length of line AE on plate A.**

$AY^2 = 300^2 + 100^2$ ✓

$AY = \sqrt{100\ 000}$ ✓

AY = 316,2277 mm✓

$AE^2 = AY^2 + EY^2$

$AE^2 = 316{,}22^2 + 350^2$ ✓

$AE = \sqrt{222\ 500}$ ✓

AE = 471,70 mm ✓ (6)

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11.3 **Calculate the length of MK on plate C.**

$MK^2 = MZ^2 + KZ^2$

$MK^2 = 350^2 + 150^2$ ✓

$MK = \sqrt{145\ 000}$ ✓

MK = 380,79 mm ✓ (3)

11.4 **Calculate the length of DH on plate C.**

$DX1^2 = 100^2 + 150^2$ ✓

$DX1 = \sqrt{32\ 500}$ ✓

DX1 = 180,277 mm ✓

$DH^2 = DX1^2 + HX1^2$

$DH^2 = 180{,}277^2 + 350^2$ ✓

$DH = \sqrt{155\ 000}$ ✓

DH = 393,70 mm ✓ (6)

11.5 **Calculate the length AF on plate A**

$AF = \sqrt{AI^2 + IJ^2}$

$AF = 750^2 + 364^2$ ✓

AF = 694 999,64 ✓

AF = 833,67 mm ✓ (3)

[21]

Total: 200 marks

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