MECHANICAL TECHNOLOGY: WELDING AND METALWORK

MARKING GUIDELINES

Time: 3 hours   200 marks

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.

QUESTION 1   MULTIPLE-CHOICE (Generic)

1.1   B

1.2   D

1.3   C

1.4   A

1.5   B

1.6   B

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   **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.

2.3   **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)

2.4   **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 × 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.

QUESTION 3   MATERIALS (Generic)

3.1   3.1.1 **A loud and clear sound.**
          High-carbon steel

       3.1.2 **A dull sound.**
          Low-carbon steel

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

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

3.4   **Use two neat sketches to explain the differences in grain structure before and after heat treatment.**
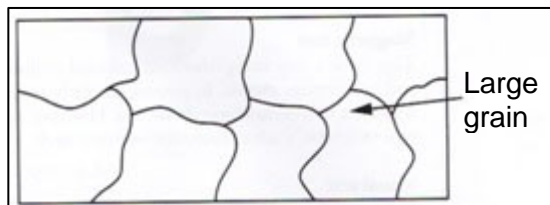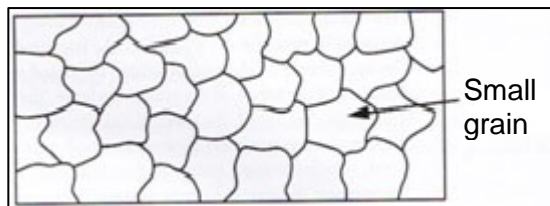
       (1 mark for each drawing and 1 mark for each label)

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

QUESTION 4   MULTIPLE-CHOICE QUESTIONS (Specific)

4.1   C

4.2   A

4.3   C

4.4   A

4.5   A

4.6   A

4.7   C

4.8   B

4.9   B

4.10   D

4.11   C

4.12   B

4.13   C

4.14   A

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

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

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.

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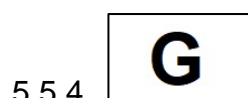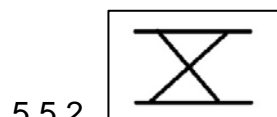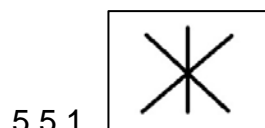   Mean dia = 400 + 16
     Mean dia = 416 mm

     Circumference = $\pi \times Mean\,dia$
     Circumference = $\pi \times 416$
     Circumference = 1306,9 mm

5.5

   5.5.1

   5.5.2

   5.5.3

   5.5.4

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.

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.

QUESTION 6 TOOLS AND EQUIPMENT (Specific)

6.1 **Name TWO different types of tap wrenches**
- T-handle tap wrench
- Single-handle tap wrench

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

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.

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.
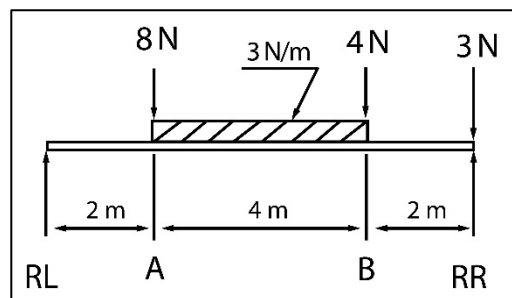
QUESTION 7   FORCES (Specific)

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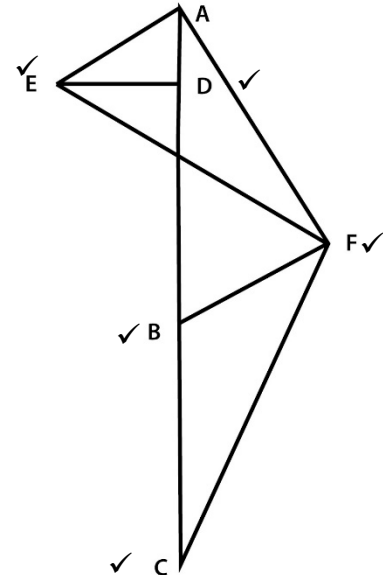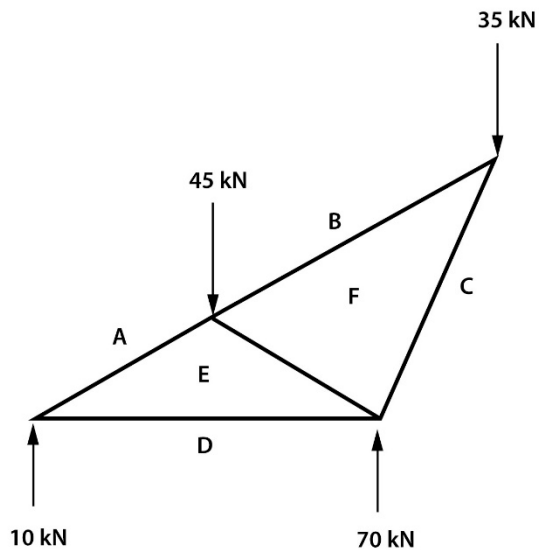
MEMBER	FORCE	NATURE
AE	20 kN	STRUT
BF	25 kN	TIE
CF	51 kN	STRUT
DE	18 kN	TIE
EF	45 kN	STRUT

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)
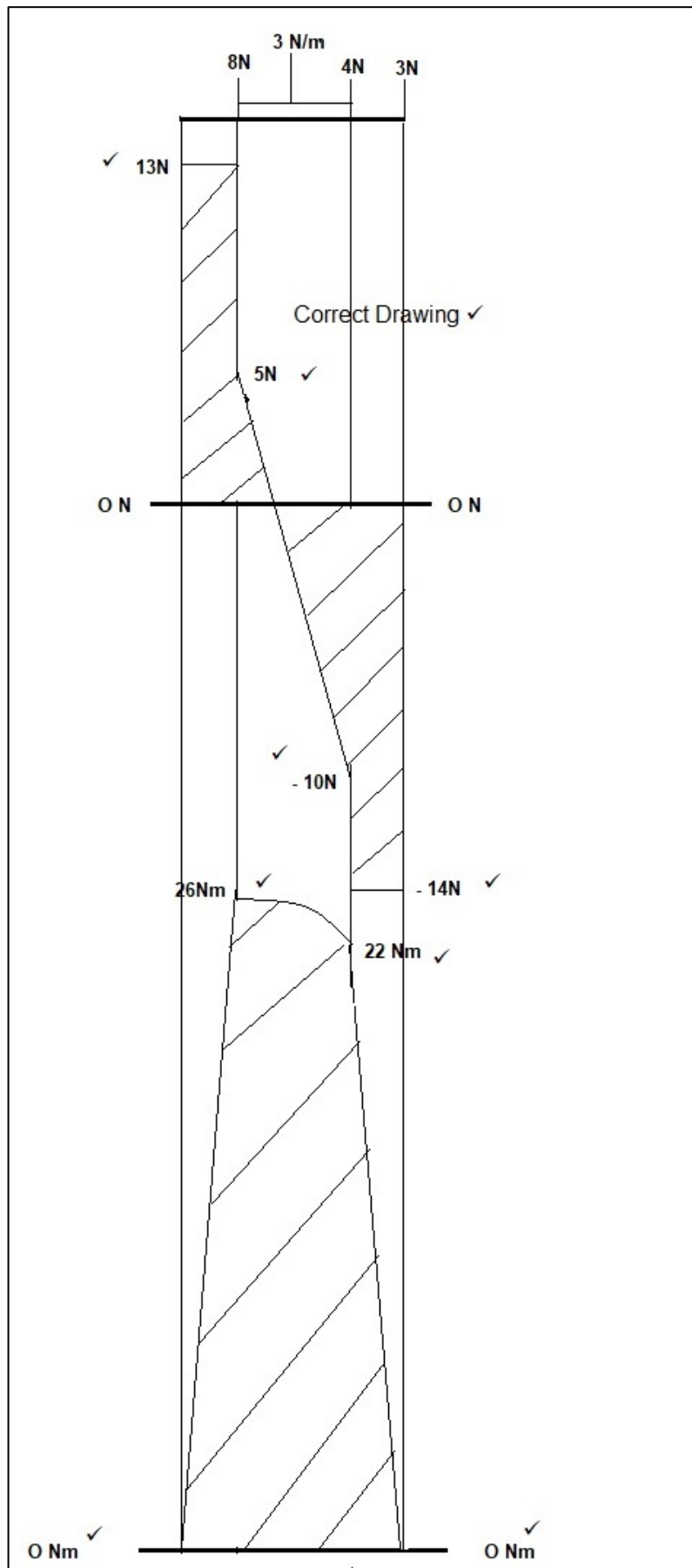$RR = \frac{112}{8}$
RR = 14 N

7.2.2 **Bending moments:**
BMA:
$(13 \text{ N} \times 2 \text{ m}) - (8 \text{ N} \times 0 \text{ m}) = 26 \text{ Nm}$
BMB:
$(13 \text{ N} \times 6 \text{ m}) - (8 \text{ N} \times 4 \text{ m}) - (12 \text{ N} \times 2 \text{ m}) - (4 \text{N} \times 0 \text{ m}) = 22 \text{ Nm}$

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

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

$A = \dfrac{\pi}{4} \times d^2$

$A = 0,7853981 \times (0,02^2)$

$A = 0,0003141 \text{ m}^2$

$\text{Stress} = \dfrac{Load}{Area}$

$\text{Stress} = \dfrac{60\ 000}{0,000314}$

Stress = 190985931,7 Pa

Stress = 190,985 Mpa

7.4   7.4.1 **Load –** An external force acting upon matter.

      7.4.2 **Strain –** The ratio between change in length and original length.

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)

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

8.3 **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)

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)

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)

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

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.

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

9.1 **What factors control the rate at which metal cools down?**
Size
Thickness
Thermal conductivity

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.

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.

9.4 **Name THREE quenching media used to cool down steel.**
- Water
- Brine
- Oil
- Air   (Any 3 × 1)

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.

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.

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)

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

QUESTION 11   TERMINOLOGY (Development) (Specific)
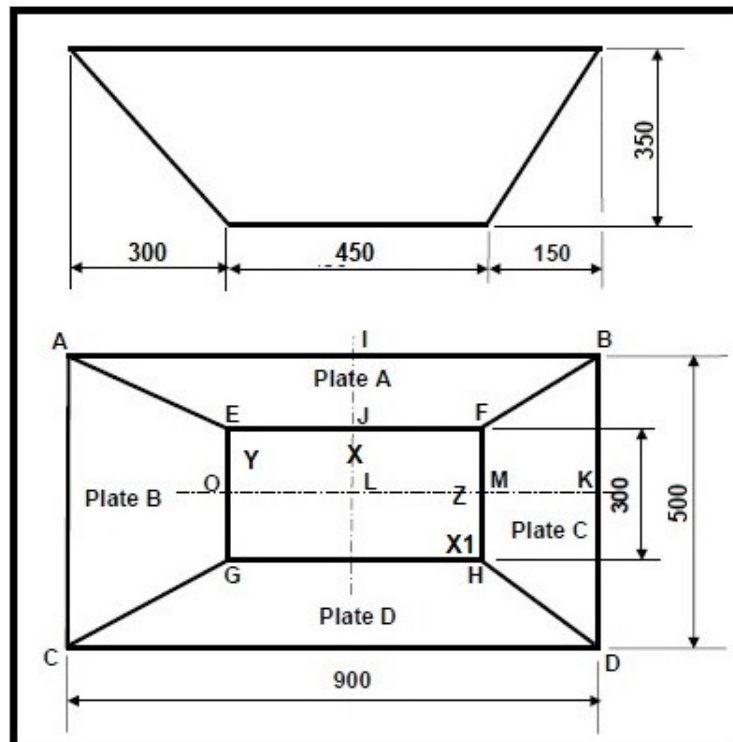
11.1   **Calculate the length of IJ on plate A.**

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

X = 100 mm

IJ^2 = 350^2 + 100^2

IJ = $\sqrt{132\ 500}$

IJ = 364,00 mm

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

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

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

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

Total: 200 marks