These marking guidelines consist of 16 pages.
**QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>1.1</td>
<td>B ✓</td>
<td>(1)</td>
</tr>
<tr>
<td>1.2</td>
<td>B ✓</td>
<td>(1)</td>
</tr>
<tr>
<td>1.3</td>
<td>A ✓</td>
<td>(1)</td>
</tr>
<tr>
<td>1.4</td>
<td>A ✓</td>
<td>(1)</td>
</tr>
<tr>
<td>1.5</td>
<td>D ✓</td>
<td>(1)</td>
</tr>
<tr>
<td>1.6</td>
<td>B ✓</td>
<td>(1)</td>
</tr>
</tbody>
</table>

[6]
QUESTION 2: SAFETY ( GENERIC )

2.1 Angle grinder:
- Do not use excessive force while grinding. ✓
- Ensure that the sparks do not endanger co-workers. ✓
- Keep hands clear from grinding disc. ✓
- Maintain a firm grip on the angle grinder. ✓
- Grinding disc fitted will not turn faster than the manufactures recommendation. ✓
- Make sure that there is no cracks or chips on the grinding disc
- Safety guard must be in place. ✓
- PPE must be worn. ✓
- Beware of lockable switches in the on position when the machine is plugged in and switched on. ✓
- Check for defective cables. ✓
- Secure work piece properly. ✓
- Grinding angle to be away from body to prevent sparks directly on clothing. ✓
- Make sure disc does not wobble during cutting. ✓

(Any 2 x 1) (2)

2.2 Welding goggles:
- To protect your eyes from the spatter / sparks. ✓
- To protect your eyes from the harmful rays / UV rays. ✓
- To ensure proper vision of the process. ✓

(Any 2 x 1) (2)

2.3 PPE – Bench grinder:
- Overall ✓
- Safety goggles / face shield ✓
- Safety shoes ✓
- Safety gloves ✓

(Any 2 x 1) (2)

2.4 Process and product workshop layout:
- The product layout ensures that the machines are arranged in the sequence of the manufacturing process of a product. ✓
- The process layout is based on the type of manufacturing process needed in the making of the product. ✓

(2)

2.5 Employer’s responsibility – equipment:
- They must provide and maintain equipment. ✓
- Ensure that the equipment is safe to use by employees. ✓
- Provide safe storage for equipment. ✓
- Provide proper training of employees in the use of the equipment. ✓
- Enforce safety measures/ OHS acts and Regulations. ✓
- Employer must provide proper personal protective equipment (PPE) for the specific machines. ✓

(Any 2 x 1) (2)

[10]
QUESTION 3: MATERIALS (GENERIC)

3.1 Tests to distinguish between metals:
- Bending test: ✓ hit with hammer. ✓
- Filing test ✓ file material. (colour and ease) ✓
- Machining test ✓ machine material. (type of shaving, ease and colour) ✓
- Sound ✓ drop on floor. (high or low frequency) ✓
- Spark test. ✓ Shape and colour of sparks. ✓

(Any 4 x 2) (8)

3.2 Heat-treatment:

3.2.1 Tempering:
After hardening, the steel must be tempered.
- To relieve the strains induced. ✓ ✓
- To reduce brittleness. ✓ ✓

(Any 1 x 2) (2)

3.2.2 Normalising:
- To relieve the internal stresses. ✓ ✓

(2)

3.2.3 Hardening:
- To produce extremely hard steel. ✓ ✓
- To enable it to resist wear and tear. ✓ ✓

(Any 1 x 2) (2)
QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

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

[14]
QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 **Roof truss:**
A – Purlin ✓
B – Rafter ✓
C – Incline tie ✓
D – Tie beam ✓
E – Shoe plate / Gusset plate ✓

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

5.3 **Dimensions of the material:**

5.3.1 Meanφ = Inside φ + Thickness ✓

\[
= 215 + 20
= 235 \text{ mm}
\]

Mean circumference = \( \pi \times \text{Mean } \phi \)

\[
= \pi \times 235
= 738.27 \text{ mm}
\]

Round off to 740 mm ✓

5.3.2

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QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 Punch and shear machine:
- Croppers are activated by hand or by foot. ✓
- A shear and punch machine is a heavy-duty machine for cutting steel profiles and punching holes into steel plates. ✓
- Croppers are electrically / hydraulically driven engaging various shearing blades to shear / punch different profiles. ✓
- Punches and corresponding dies need to be set to the desired size before punching. ✓
- They do not require cooling fluid because the shearing action does not develop a great deal of heat. ✓

6.2 Plasma cutter:
- The basic cutting process involves creating an electrical channel of ionised gas; that is plasma, ✓ from the plasma cutter itself through the work piece that is being cut. Thus forming a completed electric circuit back to the plasma cutter via a grounding clamp. ✓
- This is accomplished by compressed air that is blown toward the work piece through a focused nozzle at high speed. ✓
- A high frequency, electrical arc is then formed within the gas between an electrode near or integrated into the gas nozzle and the work piece itself. ✓

6.3 Internal Thread cutting process:
- Drill the required core / root / inside diameter. ✓
- Use the three taps in order. ✓
- Check thread with gauge / bolt when complete. ✓

6.4 Brinell hardness test:
- The Brinell hardness tester 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. ✓

6.5 Rockwell hardness testing over Brinell hardness testing:
- The advantages of the Rockwell Hardness method include the direct readout of the Rockwell Hardness number. ✓✓
- Rapid testing time. ✓✓

(Any 1 x 2)
QUESTION 7: FORCES (SPECIFIC)

7.1

<table>
<thead>
<tr>
<th>MEMBER</th>
<th>FORCE (N)</th>
<th>NATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td>AE</td>
<td>140 N ✓</td>
<td>STRUT ✓</td>
</tr>
<tr>
<td>EF</td>
<td>285 N ✓</td>
<td>STRUT ✓</td>
</tr>
<tr>
<td>FC</td>
<td>140 N ✓</td>
<td>STRUT ✓</td>
</tr>
<tr>
<td>BF</td>
<td>100 N ✓</td>
<td>TIE ✓</td>
</tr>
<tr>
<td>ED</td>
<td>100 N ✓</td>
<td>TIE ✓</td>
</tr>
</tbody>
</table>

NOTE: (Tolerance: ±2 mm) (2 mm = 10 N)
7.2 **Beams:**

7.2.1 **Reactions at the supports RL and RR:**

\[ R_L \times 12 = (3 \times 3) + (5 \times 6) + (4 \times 9) \checkmark \]

\[ R_L = 6,25N \checkmark \]

\[ R_R \times 12 = (4 \times 3) + (5 \times 6) + (3 \times 9) \checkmark \]

\[ R_R = 5,75 N \checkmark \] \( (4) \)

7.2.2 **Bending moments:**

\[ BM_B = (6,25 \times 3) \checkmark \]

\[ = 18,75 \text{ N.m} \checkmark \]

\[ BM_C = (6,25 \times 6) - (4 \times 3) \checkmark \]

\[ = 25,5 \text{ N.m} \checkmark \]

\[ BM_D = (6,25 \times 9) - (4 \times 6) - (5 \times 3) \checkmark \]

\[ = 17,25 \text{ N.m} \checkmark \] \( (6) \)

7.2.3 **Bending moments diagram:**

**SCALES:**

- Space diagram: 10 mm = 1 m
- Bending moment diagram: 5 mm = 1 N.m
7.3 **Stress and Strain:**

7.3.1 **Stress in the shaft:**

\[
\text{Area} = \frac{\pi D^2}{4} \\
= \frac{\pi \times (32 \times 10^{-3})^2}{4} \checkmark \\
= 0.8 \times 10^{-3} \text{ m}^2 \checkmark
\]

\[
\sigma = \frac{\text{Load}}{\text{Area}}
\]

\[
= \frac{100 \times 10^3}{0.8 \times 10^{-3}} \checkmark \\
= 125 \times 10^6 \text{ Pa} \quad \text{or} \quad 125 \text{ MPa} \quad \checkmark
\]

(5)

7.3.2 **Strain in the steel:**

\[
\varepsilon = \frac{\Delta L}{\sigma L}
\]

\[
= \frac{0.5}{120} \checkmark \\
= 4.17 \times 10^{-3} \checkmark
\]

(3)

7.3.3 **Young's modulus of elasticity:**

\[
E = \frac{\sigma}{\varepsilon}
\]

\[
= \frac{125 \times 10^6}{4.17 \times 10^{-3}} \checkmark \\
= 29.98 \times 10^9 \text{ Pa} \quad \text{or} \quad 29.98 \text{ GPa} \quad \checkmark
\]

(3)
QUESTION 8: JOINING METHODS (WELD INSPECTION) (SPECIFIC)

8.1 Factors to be observed during oxy-acetylene welding:
- Correct flame for the work at hand. ✓
- Correct angle of welding torch and rod. ✓
- Depth of fusion. ✓
- The welding rate. ✓

(Any 2 x 1) (2)

8.2 Welding defects:

Incomplete penetration:
- Welding current too low. ✓
- Welding speed too fast. ✓
- Incorrect welding angle. ✓
- Poor joint preparation. ✓
- Insufficient root gap. ✓
- Wrong polarity. ✓
- Arc length too short. ✓
- Wrong electrode used. ✓

(Any 2 x 1) (2)

8.3 Methods reducing of welding defects:

8.3.1 Slag inclusion:
- Using well-maintained consumables. ✓
- Ensure adequate shielding gas. ✓
- Clean the joint properly. ✓
- Slag must be removed before welding the next bead. ✓
- Too slow welding movements. ✓
- Electrode too big. ✓
- Wrong or too big weaving action. ✓

(Any 2 x 1) (2)

8.3.2 Centreline cracks:
- Aiming for a width-to-depth ratio of 1:1. ✓
- Decreasing the current to reduce excess penetration. ✓
- Decreasing welding voltage / current. ✓
- Slowing travel speed. ✓
- Reduce high carbon content in weld. ✓
- Welding while joint is under stress due to joint design, use clamping devices. ✓

(Any 2 x 1) (2)
8.4 **Porosity:**
Porosity refers to cavity-type pores ✓ (bubbles or gas pockets) formed by gas ✓ during the solidification ✓ of molten weld metal. (3)

8.5 **Non-destructive test:**
The welded joint is not ✓ destroyed ✓ in the process of testing. (2)

8.6 **Ultrasonic test:**
- To detect internal flaws. ✓
- To detect surface flaws. ✓ (2)

8.7 **Visual inspection:**
- Shape of profile. ✓
- Uniformity of surface. ✓
- Overlap. ✓
- Undercutting. ✓
- Penetration bead. ✓
- Root groove. ✓

(Any 3 x 1) (3)

8.8 **Nick break test:**
- Make a hacksaw cut at both edges, through the centre of the weld. ✓
- Place specimen on two steel supports. ✓
- Use a sledge hammer to break the specimen in the area of the cuts. ✓
- Inspect the exposed weld metal in the break ✓ for incomplete fusion, slag inclusion, etc. ✓

(5) [23]
QUESTION 9: JOINING METHODS (STRESSES AND DISTORTION) (SPECIFIC)

9.1 Shrinkage in welding:
Shrinkage is a form of plastic deformation ✓ where the metal has deformed as a result ✓ of contraction ✓ on cooling. ✓ (4)

9.2 Factors affecting distortion and residual stress:
- If the expansion that occurs when metal is heated is resisted, then deformation will occur. ✓
- When contraction that occurs on cooling is resisted, then a stress will be applied. ✓
- If that applied stress causes movement, then distortion occurs. ✓
- If the applied stress does not cause movement, then there will be residual stress in the welded joint. ✓ (4)

9.3 Back-step welding:

9.4 Factors affecting the temperature of cold worked steel for re-crystallisation:
- The prior amount of cold work. ✓
- The temperature and time of annealing process. ✓
- Composition of the metal. ✓
- The melting point. ✓ (4) [18]
QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 Effect of overloading:

10.1.1 Power saw:
- Driving motor will be damaged. ✓
- Excessive strain on the driving system. ✓
- The cutting blade will be damaged. ✓
- The blade may deflect and result in a skew cut. ✓

(Any 1 x 1) (1)

10.1.2 Bench grinder:
- Result in malfunction due to excessive loads on the spindle bearings, grinding wheel and machine motor. ✓
- Overloading will wear the grinding wheel excessively and unevenly. ✓
- It shortens the life span of the spindle bearings and motor. ✓

(Any 1 x 1) (1)

10.2 Effect of friction:

10.2.1 Drill bit of a pedestal drill:
- Due to the heat caused by friction the cutting edge of the drill bit softens / blunt. ✓
- Lifespan of the drill bit will be reduced. ✓

(Any 1 x 1) (1)

10.2.2 Rolling machine’s bearings:
- Journals and bearings will prematurely wear out. ✓

(1)

10.3 A punch and a shearing machine:
- Check the condition of the switch gear, wiring and isolation. ✓
- Ensure that the isolator is lockable. ✓
- Check the condition of the stop / start equipment. ✓
- Check the operation of emergency stop where fitted. ✓
- Check connections of electrical wiring. ✓

(Any 2 x 1) (2)

10.4 Record keeping:
- Monitoring of the machine’s condition. ✓
- Monitoring of the maintenance costs on the machines. ✓
- Upholding the warranties and guarantees. ✓

(Any 2 x 1) (2)
QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

11.1.1 **Length of IJ:**
Plates A and D.

\[ IJ = IL - JL \] ✓

\[ IJ = 300 - 150 \] ✓

\[ IJ = 150 \text{ mm} \] ✓

(3)

11.1.2 **True length of AE:**

True Length \[ AE = \sqrt{IE^2 + AI^2 + VH^2} \] ✓

\[ AE = \sqrt{150^2 + 350^2 + 450^2} \] ✓

\[ AE = 589.49 \text{ mm} \] ✓

\[ AE = 590 \text{ mm} \] ✓

(6)
11.1.3 **Length of MK:**

\[ MK = LK - LM \]

MK = 350 – 200 ✓
MK = 150 mm ✓

(2)

11.1.4 **The True length of DH:**

True length \( DH = \sqrt{HK^2 + KD^2 + VH^2} \) ✓✓

\[ DH = \sqrt{150^2 + 150^2 + 450^2} \] ✓✓

DH = 497.49 mm ✓
SAY 498 mm ✓

(6)

11.1.5 **Pattern for plates A:**

![Diagram of plate A](image)

(2)

11.1.6 **Pattern for Plate C:**

![Diagram of plate C](image)

(2)

[21]

TOTAL: 200