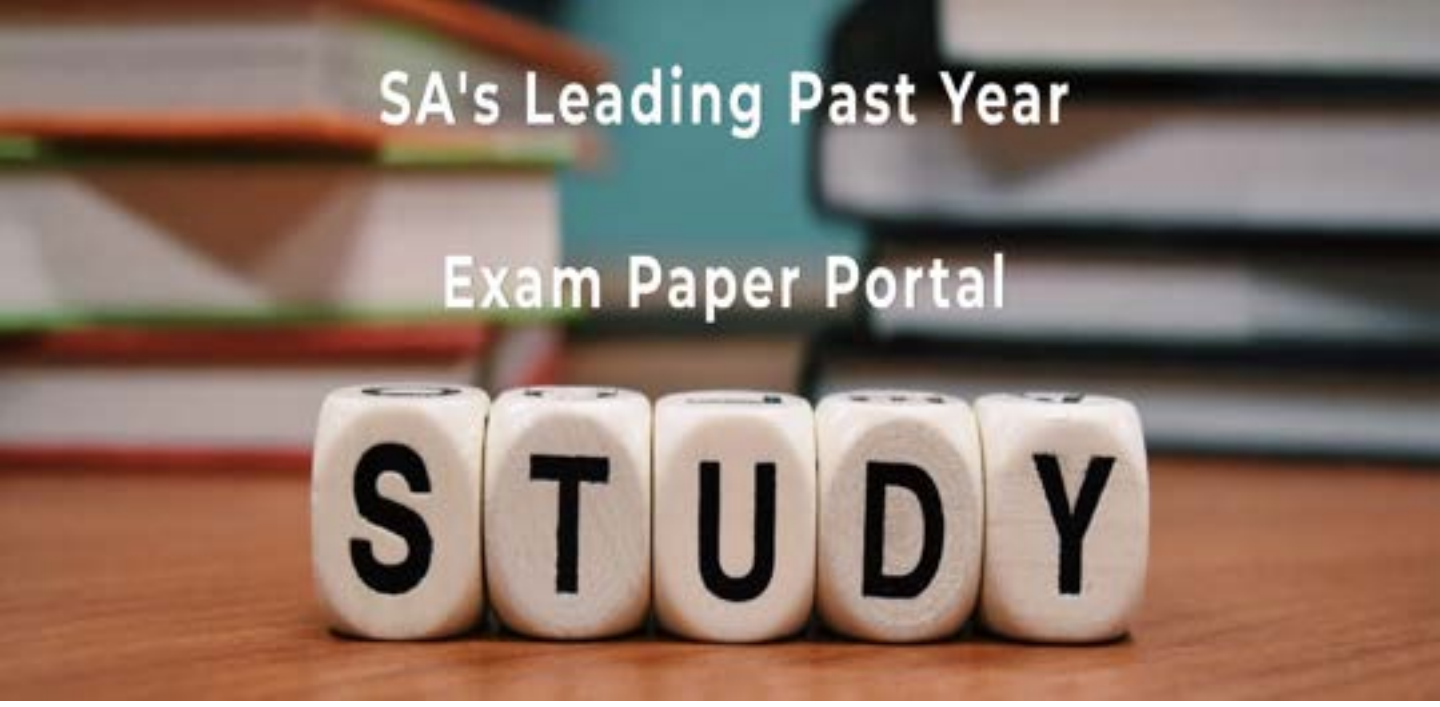

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GRADE 12

MECHANICAL TECHNOLOGY: WELDING AND METALWORK

NOVEMBER 2020

MARKING GUIDELINES

MARKS: 200

These marking guidelines consist of 18 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 A ✓ (1)

1.2 D ✓ (1)

1.3 A ✓ (1)

1.4 C ✓ (1)

1.5 B ✓ (1)

1.6 B ✓ (1)
[6]

QUESTION 2: SAFETY (GENERIC)

2.1 **Work procedures on machine:**
Switch off machine. ✓ (1)

2.2 **The horizontal band saw:**
- No adjustments to machine or work piece. ✓
- Ensure sufficient coolant. ✓
- Do not leave machine unattended while in operation. ✓
- Do not lean on machine. ✓
- Keep hands clear from blade. ✓

(Any 2 x 1) (2)

2.3 **Surgical gloves:**
- Prevent contamination of wound ✓
- To prevent transmission of HIV/AIDS or any blood related diseases to the first aid helper. ✓ (2)

2.4 **Personal protective equipment (PPE) during arc welding:**
- Welding helmet / Helmet ✓
- Safety goggles / Face shield ✓
- Leather apron / Apron ✓
- Leather gloves / Gloves ✓
- Leather spat / Spats ✓
- Safety boots / Safety shoes ✓
- Over-all ✓
- Skull cap ✓
- Neck protection ✓
- Ear plugs / Ear muffs. ✓
- Respirator ✓

(Any 2 x 1) (2)

2.5 **Responsibility of the employer regarding the health and safety:**
- Sufficient lighting ✓✓
- Sufficient ventilation ✓✓
- Provide first-aid equipment ✓✓
- Provide a safe / clean working environment ✓✓
- Provide personal protective equipment (PPE) ✓✓
- Provide safety training to employees ✓✓

(Any 1 x 2) (2)

2.6 **Responsible for administering first aid:**
A qualified / trained first aid person ✓ (1)
[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 **Tests to identify various metals:**

3.1.1 **Sound test:**

- Tapping the metal with a hammer (any metal object) ✓ and identify the sound. ✓
- Dropping the metal on the floor ✓ and identify the sound. ✓

(Any 1 x 2) (2)

3.1.2 **File test:**

File the metal and pay attention to the bite of the file into the metal. ✓ The bigger the bite the softer the metal. **OR** The smaller the bite the harder the metal. ✓ (2)

3.2 **Purpose of heat treatment of steel:**

- To change ✓ the properties ✓ of steel.
- To change ✓ the grain structure ✓ of steel.

(Any 1 x 2) (2)

3.3 **Purpose of case hardening on steel:**

To create a hard / wear resistance surface / case ✓ with a tough core. ✓ (2)

3.4 **The tempering process for steel:**

- Heat the steel to a temperature (temper colour) below the critical temperature. ✓
- Soak it at that temperature for a period. ✓
- Quench / cool in an appropriate quenching agent. ✓ (water, brine, or oil) (3)

3.5 **THREE factors for heat treatment of steel:**

- Heating temperature / Carbon content ✓
- Soaking (Time period at temperature) / Work piece size ✓
- Cooling rate / Quenching rate (Quenching medium) ✓ (3)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

4.1	B / D ✓	(1)
4.2	A ✓	(1)
4.3	C ✓	(1)
4.4	D ✓	(1)
4.5	B ✓	(1)
4.6	D ✓	(1)
4.7	A ✓	(1)
4.8	C ✓	(1)
4.9	D ✓	(1)
4.10	C ✓	(1)
4.11	B ✓	(1)
4.12	C ✓	(1)
4.13	A ✓	(1)
4.14	D ✓	(1)
		[14]

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 **Advantages of templates:**

- Quicker to use to improve mass production ✓
- Accurate production ✓
- Cheap to manufacture ✓
- Unskilled labour will be able to use it ✓
- Avoid unnecessary wastages / cost effective ✓
- Uniformity in production ✓
- Can be reused. ✓

(Any 2 x 1) (2)

5.2 **Use of templates:**

5.2.1 Thin metal is used for profile cutting machines ✓ (1)

5.2.2
- Hardboard templates is used for templates for gussets. ✓
- Hardboard templates are used for checking sizes. ✓
- Hardboard templates is used for marking of holes. ✓

(Any 1 x 1) (1)

5.3 **Components of a roof truss:**

A. Rafter ✓
B. Purlin ✓
C. Internal bracing members / strut ✓
D. Gusset plate ✓
E. Main tie / Tie beam / Beam ✓ (5)

5.4 **A mild steel ring material:**
Calculate the dimensions of the required material:

$$\text{Mean } \theta = \text{Outside } \theta - \text{plate thickness}$$
$$= 280 - 12 \quad \checkmark$$
$$= 268\,\text{mm} \quad \checkmark$$

$$\text{Mean circumference} = \pi \times \text{mean}\theta$$
$$= \pi \times 268 \quad \checkmark$$
$$= 841{,}95\,\text{mm} \quad \checkmark$$
$$\approx 842\ \text{mm} \quad \checkmark$$

(5)

5.5 **Abbreviation 'SANS':**
South African ✓ National Standards ✓ (2)

5.6 **Resistance weld:**

5.6.1 Foil seam ✓ (1)

5.6.2 Flash or resistance butt ✓ (1)

5.7 **Weld dimensions:**

- 5 – size (width) of weld ✓
- 25 – length of weld ✓
- 50 – pitch of welds ✓ (3)

5.8 **Position of the weld:**

5.8.1 Weld on the arrow side ✓ (1)

5.8.2 Weld on both sides ✓ (1)

[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 **Pedestal drill machine:**

A = Table / Machine table / Working table / Platform ✓
B = Chuck / Drill bit holder ✓
C = Motor ✓
D = Pillar / Column ✓ (4)

6.2 **Operating principles:**

6.2.1 **Horizontal band saw:**

- The blade is tensioned around two pulleys. ✓
- The machine is driven by an electric motor. ✓
- The blade is fitted so that it cuts in a continuously forward motion. ✓
- The blade assembly is raised and lowered by hand or by hydraulic controls. ✓
- The metal being cut is held firmly in the stock clamp during the cutting process. ✓

(Any 4 x 1) (4)

6.2.2 **Punch and cropper (shear) machine:**

- It is an electrically driven machine. ✓
- It makes use of a flywheel and clutches ✓ to engage various shearing blades or punches. ✓ (3)

6.3 **Primary function of flashback arrestors:**

It prevents ✓ back-feeding/backfiring. ✓✓ (3)

6.4 **Use of taps and dies:**

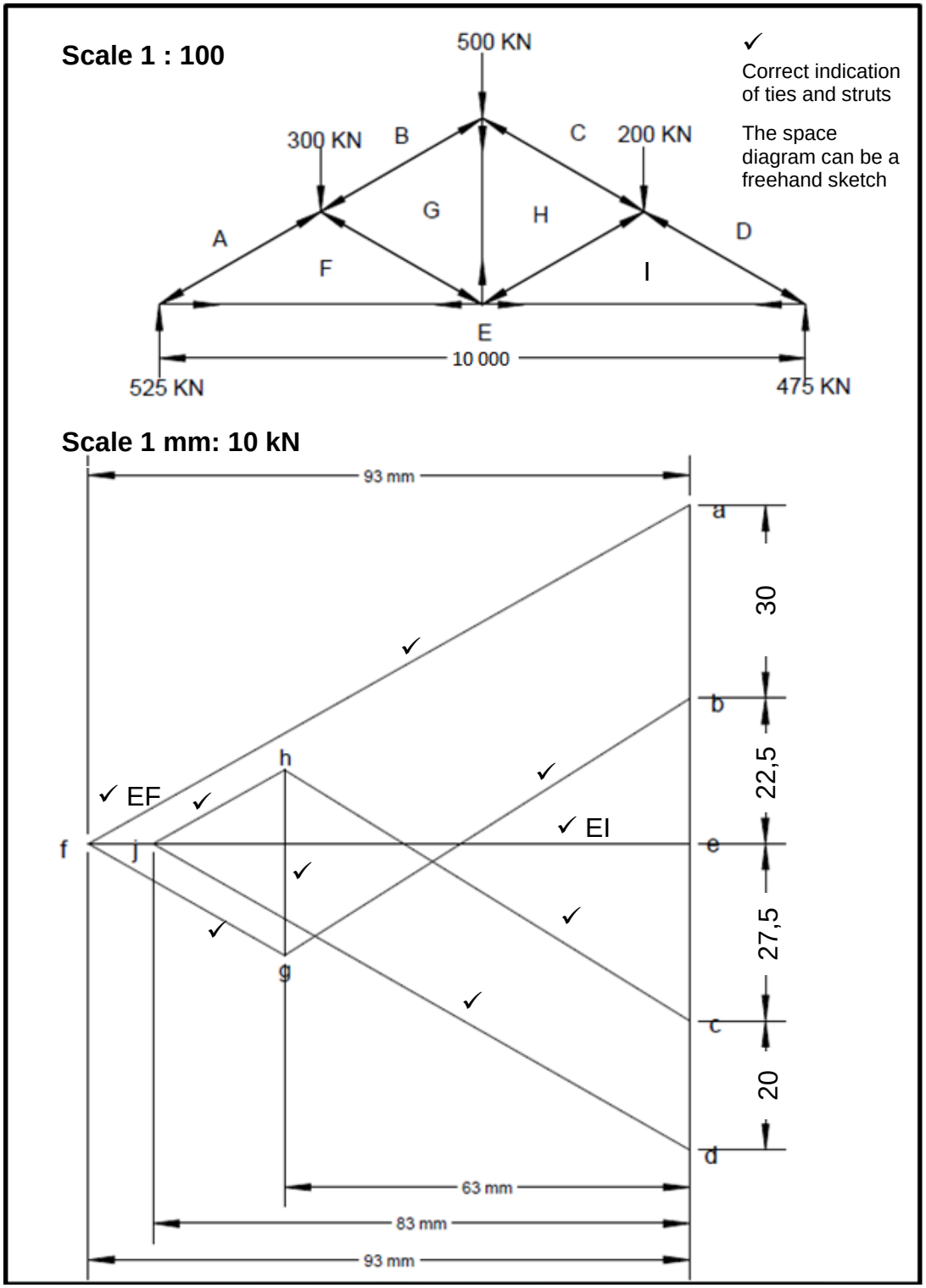
- Taps are used to cut / clean ✓ internal / nut screw threads ✓
- Dies are used to cut / clean ✓ external / bolt screw threads ✓ (4)

[18]

QUESTION 7: FORCES (SPECIFIC)

7.1 **Frameworks:**

7.1.1 **Force diagram:**



✓ Correct indication of ties and struts

The space diagram can be a freehand sketch

Markers need to draw the diagram to scale. (10)

7.1.2 **Magnitude and nature of the members:**

MEMBER	MAGNITUDE (kN)	NATURE
AF	1050 ✓ (1020 – 1080)	STRUT ✓
BG	760 ✓ (730 – 790)	STRUT ✓
CH	760 ✓ (730 – 790)	STRUT ✓
DI	960 ✓ (930 – 990)	STRUT ✓
FG	300 ✓ (270 – 330)	STRUT ✓
HI	200 ✓ (170 – 230)	STRUT ✓
FE	930 ✓ (900 – 960)	TIE ✓
GH	250 ✓ (220 – 280)	TIE ✓
IE	830 ✓ (800 – 860)	TIE ✓
	Minus 2 marks for incorrect conversion (mm to kN)	

(18)

7.2 **BEAMS:**

7.2.1 **Bending moments:**

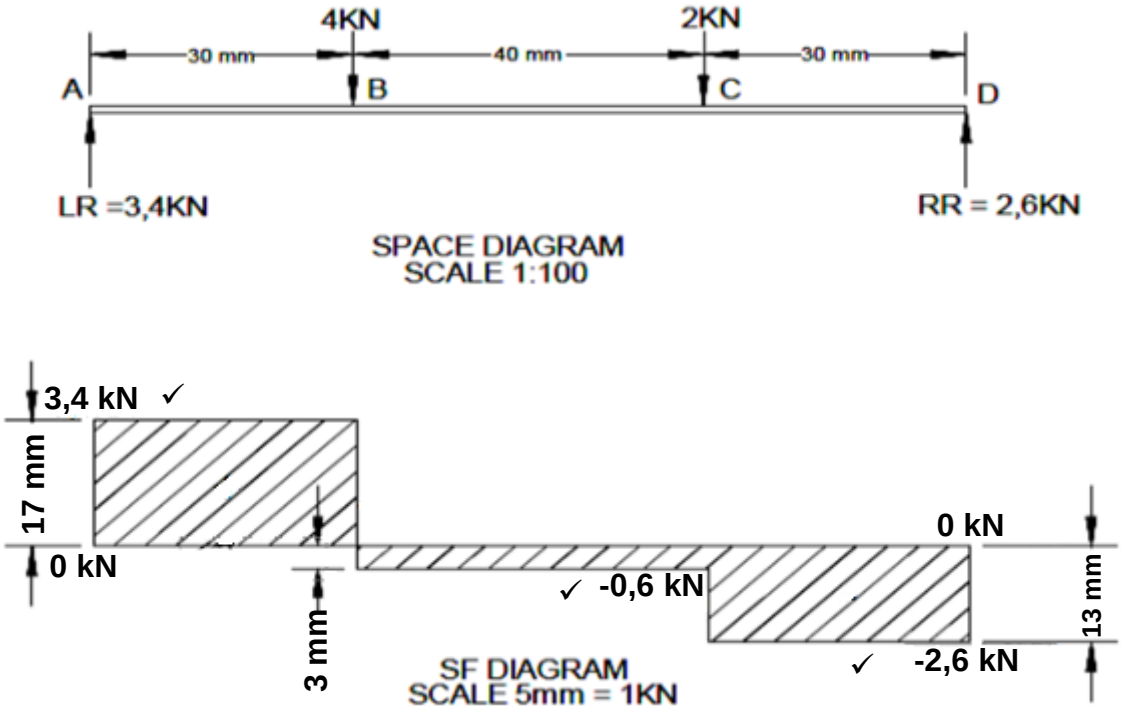
$$BM_B = (3{,}4 \times 3) \quad \checkmark$$
$$= 10{,}2 \text{ kN.m} \quad \checkmark$$

$$\overset{\checkmark}{} \qquad \overset{\checkmark}{}$$
$$BM_C = (3{,}4 \times 7) - (4 \times 4)$$
$$= 23{,}8 - 16$$
$$= 7{,}8 \text{ kN.m} \quad \checkmark$$

$$BM_D = 0 \text{ kN.m} \quad \checkmark$$

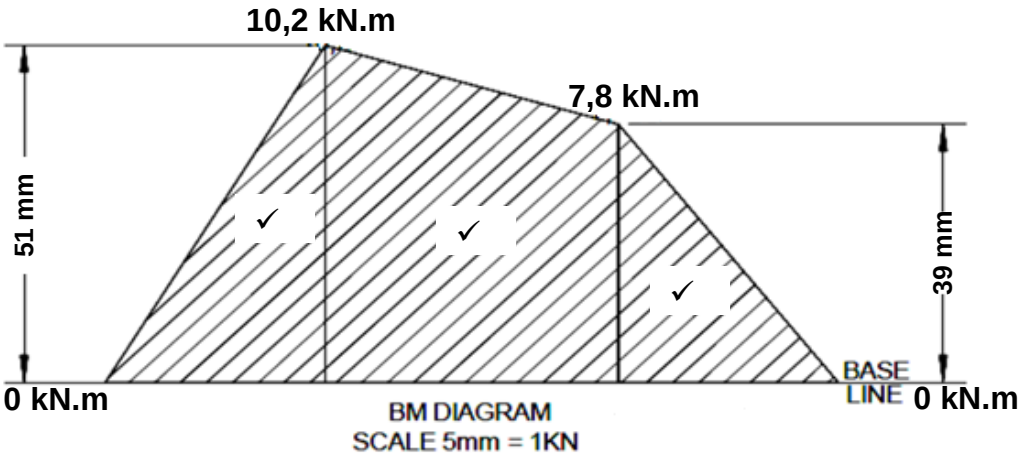
(6)

7.2.2 **Shear force diagram:**



(3)

7.2.3 **Bending moment diagram:**



Markers need to draw to scale at marking centre

SCALE 5mm =1kN.m

(3)

7.3 **Stress and Strain:**

7.3.1 **Maximum stress:**

$$\text{Maximum Stress} = \frac{\text{Maximum Load}}{\text{Area}}$$

$$= \frac{8 \times 10^{3}}{0{,}08 \times 10^{-3}} \quad \checkmark \checkmark$$

$$= 100 \times 10^{6}\ \text{Pa} \quad \checkmark$$

$$= 100\ \text{MPa}$$

(3)

7.3.2 **Safe working stress:**

$$\text{Safe Stress} = \frac{\text{Maximum Stress}}{\text{Safety Factor}}$$

$$= \frac{100 \times 10^{6}}{4} \quad \checkmark$$

$$= 25 \times 10^{6}\ \text{Pa} \quad \checkmark$$

$$= 25\ \text{MPa}$$

(2)
[45]

QUESTION 8: JOINING METHODS (INSPECTION OF WELDS) (SPECIFIC)

8.1 **Welding spatter:**

- Too high current / Amperage too high ✓
- Too long arc / Arc blow ✓
- Not using anti-spatter spray ✓
- Electrode angle too small ✓
- Welding speed too fast ✓
- Wet electrodes ✓
- Gas-flow too high (gas welding) ✓
- Incorrect polarity for electrode type ✓

(Any 4 x 1) (4)

8.2 **Gas cutting:**

8.2.1 **Nozzle too high from surface:**

- Excessive melting of the top edge. ✓
- Undercut at the top of the cut face with lower part square and sharp bottom corner. ✓ (2)

8.2.2 **Nozzle too close to the surface:**

- Top edge slightly rounded and heavily beaded. ✓
- Cut face usually square with fairly sharp bottom corner. ✓ (2)

8.3 **Causes of weld defects:**

8.3.1 **Porosity:**

- Dirty weld surface ✓
- Wet welding electrodes ✓
- Rust in the MIG wire electrode ✓
- Interruption of shielding gas supply ✓
- Welding in windy conditions where effectiveness of shielding gas is compromised ✓
- Wrong gas used on the specific metal ✓
- Weld ability of parent metal not good ✓
- Wrong electrode used on the specific metal ✓
- Too high temperature ✓ **(Any 2 x 1)** (2)

8.3.2 **Poor penetration:**

- Welding current is too low ✓
- Travel speed is too fast ✓
- Incorrect electrode angle ✓
- Poor edge preparation ✓
- Insufficient root gap ✓
- Gas flow too low (gas welding) ✓ **(Any 2 x 1)** (2)

8.4 **Heat Affected Zone (HAZ) Cracks:**

- Excessive hydrogen ✓
- High residual stress levels (work piece cooled too fast) ✓
- High carbon content on the base metal ✓

(Any 2 x 1) (2)

8.5 **Visual inspection:**

- Shape of the profile ✓
- Uniformity of the surface ✓
- Overlap ✓
- Undercutting ✓
- Penetration bead ✓
- Root groove ✓
- Surface cracks ✓

(Any 3 x 1) (3)

8.6 **Ultrasonic test:**

- Gel should be put on the surface of the work piece. ✓
- The sender/receiver is moved in a zigzag motion across the weld to broaden its detection range. ✓
- A high frequency sound wave is send into the metal. ✓
- When the wave is stopped, the sender serves then as a receiver. ✓
- The receiver monitors the waves as it is reflected through the metal. ✓
- Each wave is visually represented on an oscilloscope. ✓
- The calibrated oscilloscope will then indicate the deviations in the waves which represents the defects in the metal. ✓

(Any 6 x 1) (6)

[23]

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

9.1 **Residual stress:**
Residual stresses are stresses that exist in a metal ✓ after cooling. ✓ (2)

9.2 **Effect of hot working on steel:**
- In hot working, deformation and recrystallization occur simultaneously so that the rate of softening is greater than work hardening. ✓
- Hot-working should be finished at a temperature just above the recrystallization temperature. ✓
- To obtain a fine grain structure. ✓
- If the finishing temperature is too high, grain growth will occur while the metal is cooling above the recrystallization temperature and inferior properties will develop. ✓ (4)

9.3 **Iron-carbon diagram:**

9.3.1 Iron-carbon equilibrium diagram ✓ (1)

9.3.2 A. Temperature / Degrees Celsius ✓
B. Austenite ✓
C. Austenite and Cementite ✓
D. Ferrite and Pearlite ✓
E. Carbon content ✓ (5)

9.4 **Result when metal is cooled rapidly:**
- The metal sets up internal and external stresses. ✓
- Causes cracks on the surface of the metal. ✓
- Causes deformation. ✓
- Hardness increases. ✓
- Martensite forms. ✓

(Any 2 x 1) (2)

9.5 **Quenching media:**
- Water ✓
- Brine ✓
- Oil ✓
- Air ✓
- Metal / Molten salts ✓
- Lime ✓
- Sand ✓
- Ash ✓

(Any 4 x 1) (4)
[18]

QUESTION 10: MAINTENANCE (SPECIFIC)

10.1 **Types of maintenance:**

- Preventative ✓
- Reliable centred ✓
- Predictive ✓
- Routine ✓
- Corrective ✓
- Condition based ✓
- Reactive maintenance ✓

(Any 2 x 1) (2)

10.2 **Lockout on machines:**

To ensure that nobody can turn on ✓ the machine while maintenance is being carried out. ✓ (2)

10.3 **Rules to be observed before machine start up:**

- Check if there is lock out tag ✓
- Confirm that the machine is safe and operational. ✓
- Check that all guards and safety devices are in position and operative. ✓
- Inform workers that the machine is being brought back into service. ✓
- Check that the area surrounding the machine is clear and that turning it on will not endanger anyone. ✓
- Check that all relevant fasteners have been properly tightened. ✓
- Check that all lockout devices have been removed. ✓
- Turn on the machine's power supply. ✓
- Know where the stop switch or emergency switch is located. ✓

(Any 2 x 1) (2)

10.4 **Factors to be observed when selecting the cutting speed of a drilling machine:**

- Type of material ✓
- Diameter of drill bit ✓
- Material of which the drill bit is made ✓
- Type of drill bit ✓
- Firmness with which the work is clamped ✓
- Condition of the machine ✓
- Use of cutting fluids ✓
- Rate of feed ✓

(Any 3 x 1) (3)
[9]

QUESTION 11: DEVELOPMENT (SPECIFIC)

Square-to-round transition:

11.1 **The true length FG:**

$IK = 300 (2 units)$

$IH = 150 (1 unit)$

$HK = 1\sqrt{3}\ (1 unit \times \sqrt{3})$

The true length FG:

Plan length $FG = FK - GK$ ✓

$= 400 - 300$

$= 100\ mm$ ✓

The true FG is equalto H'F

$CG^2 = C'F^2 + FG^2$

$= 400^2 + 100^2$ ✓

$C'G = \sqrt{170000}$ ✓

$CG = 412,31\ mm$ ✓

True length $C'G = \sqrt{412,31^2 + 800^2}$ ✓

$= 900 mm$ ✓ (7)

11.2 **Length CI, the sides CE and EI of triangle CEI must be calculated:**

$$CE = CF - EF$$
$$= 400 - 150 \quad ✓$$
$$= 250\,mm \quad ✓$$

$$But\ EI = FH$$
$$HK = 1\,unit \times \sqrt{3}$$
$$= 150\sqrt{3} \quad ✓$$
$$= 259,81\,mm \quad ✓$$

$$FH = FK - HK$$
$$= 400 - 259,81 \quad ✓$$
$$= 140,19\,mm \quad ✓$$

$$CI^2 = CE^2 + EI^2$$
$$= 250^2 + 140,19^2 \quad ✓$$
$$= \sqrt{82153,24}$$
$$CI = 286,62\,mm \quad ✓$$

$$True\ length\ CI^2 = CI^2 + (Perpendicular\ Height)^2$$
$$= 286,62^2 + 800^2 \quad ✓$$
$$= \sqrt{722151,02}$$
$$= 849,79\,mm \quad ✓$$

(10)

11.3 **JI is one-twelfth of the circumference:**

$$True\ Length\ of\ JI(Circumference) = \pi \times \frac{MD}{12} \quad ✓$$
$$\frac{1}{12} Circumference = \frac{1884,9}{12} \quad ✓$$
$$= 157,08\ mm \quad ✓$$

(3)

[20]

GRAND TOTAL: 200