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Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE/ NATIONAL SENIOR CERTIFICATE

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:**

$$\begin{aligned}
 \text{Mean } \theta &= \text{Outside } \theta - \text{plate thickness} \\
 &= 280 - 12 \quad \checkmark \\
 &= 268 \text{ mm} \quad \checkmark
 \end{aligned}$$

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

(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. ✓✓

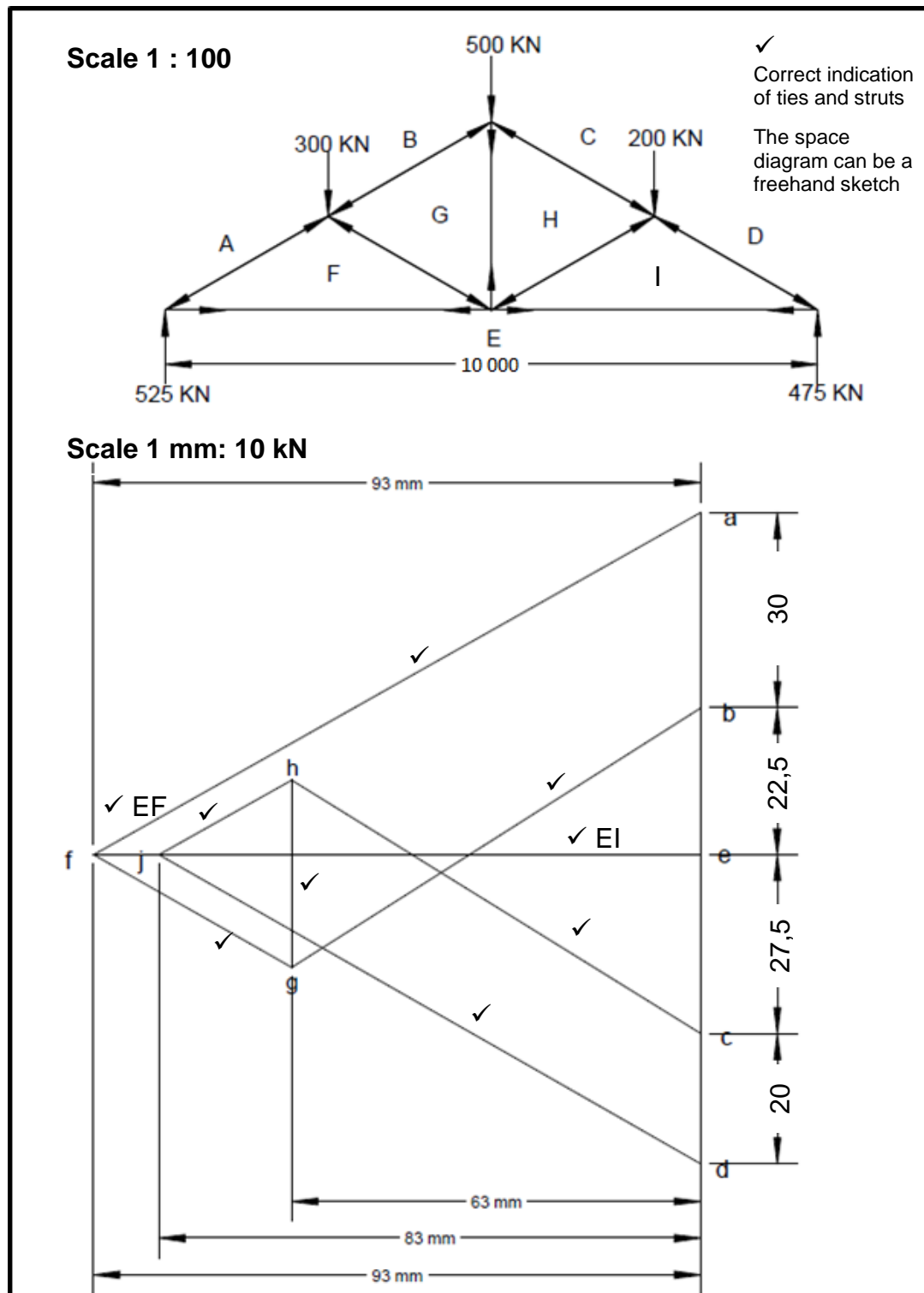
(3)

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:****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:**

$$BM_B = (3,4 \times 3) \quad \checkmark$$

$$= 10,2 \text{ kN.m} \quad \checkmark$$

$$BM_C = (3,4 \times 7) - (4 \times 4) \quad \checkmark \quad \checkmark$$

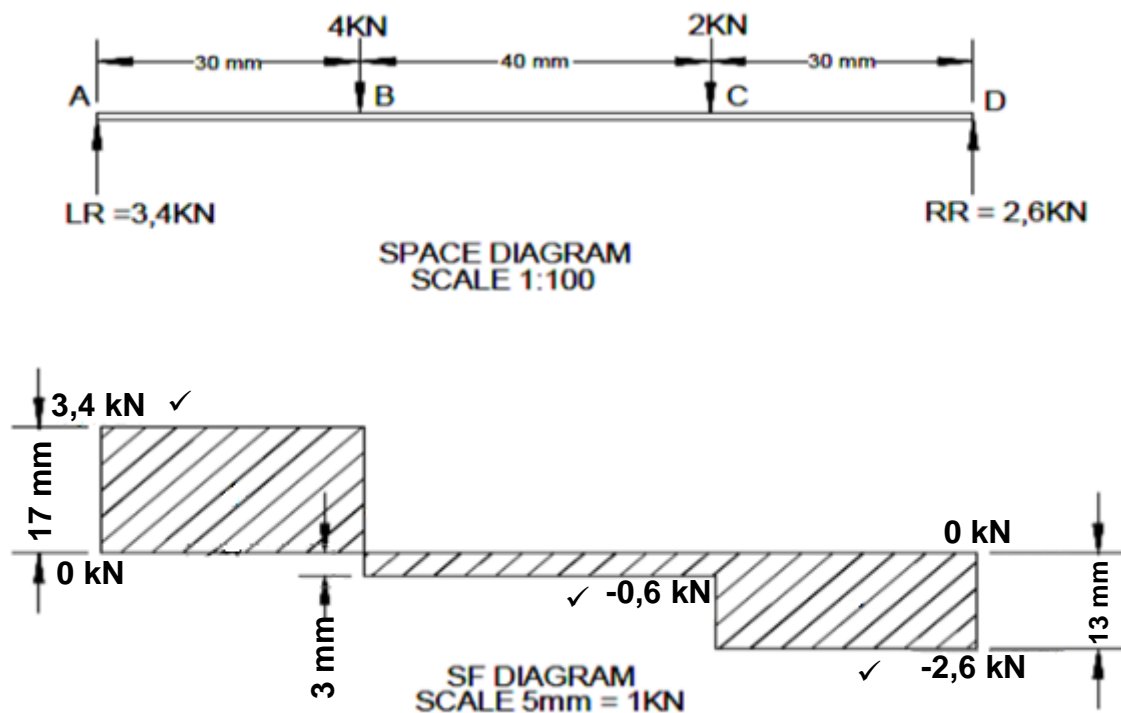
$$= 23,8 - 16$$

$$= 7,8 \text{ kN.m} \quad \checkmark$$

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

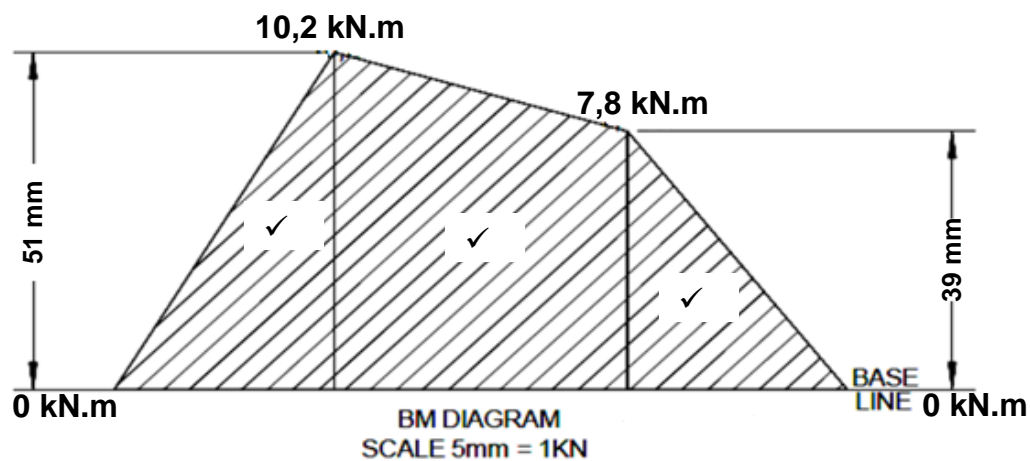
(6)

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:**

$$\begin{aligned}\text{Maximum Stress} &= \frac{\text{Maximum Load}}{\text{Area}} \\ &= \frac{8 \times 10^3}{0,08 \times 10^{-3}} \quad \checkmark \\ &= 100 \times 10^6 \text{ Pa} \quad \checkmark \\ &= 100 \text{ MPa} \quad (3)\end{aligned}$$

7.3.2 Safe working stress:

$$\begin{aligned}\text{Safe Stress} &= \frac{\text{Maximum Stress}}{\text{Safety Factor}} \\ &= \frac{100 \times 10^6}{4} \quad \checkmark \\ &= 25 \times 10^6 \text{ Pa} \quad \checkmark \\ &= 25 \text{ MPa} \quad (2)\end{aligned}$$

[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:**

$$IK = 300(2\text{units})$$

$$IH = 150(1\text{unit})$$

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

The true length FG:

$$\begin{aligned} \text{Plan length FG} &= FK - GK && \checkmark \\ &= 400 - 300 \\ &= 100 \text{ mm} && \checkmark \end{aligned}$$

The true FG is equal to H'F

$$\begin{aligned} CG^2 &= C'F^2 + FG^2 \\ &= 400^2 + 100^2 && \checkmark \end{aligned}$$

$$C'G = \sqrt{170000} \quad \checkmark$$

$$CG = 412,31 \text{ mm} \quad \checkmark$$

$$\begin{aligned} \text{True length C'G} &= \sqrt{412,31^2 + 800^2} && \checkmark \\ &= 900 \text{ mm} && \checkmark \end{aligned}$$

(7)

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

$$CE = CF - EF$$

$$= 400 - 150 \quad \checkmark$$

$$= 250 \text{ mm} \quad \checkmark$$

$$\text{But EI} = \text{FH}$$

$$\text{HK} = 1 \text{ unit} \times \sqrt{3}$$

$$= 150\sqrt{3} \quad \checkmark$$

$$= 259,81 \text{ mm} \quad \checkmark$$

$$\text{FH} = \text{FK} - \text{HK}$$

$$= 400 - 259,81 \quad \checkmark$$

$$= 140,19 \text{ mm} \quad \checkmark$$

$$\text{CI}^2 = \text{CE}^2 + \text{EI}^2$$

$$= 250^2 + 140,19^2 \quad \checkmark$$

$$= \sqrt{82153,24}$$

$$\text{CI} = 286,62 \text{ mm} \quad \checkmark$$

$$\text{Truelength CI}^2 = \text{CI}^2 + (\text{Perpendicular Height})^2$$

$$= 286,62^2 + 800^2 \quad \checkmark$$

$$= \sqrt{722151,02}$$

$$= 849,79 \text{ mm} \quad \checkmark$$

(10)

11.3 JI is one-twelfth of the circumference:

$$\text{True Length of JI (Circumference)} = \pi \times \frac{\text{MD}}{12} \quad \checkmark$$

$$\frac{1}{12} \text{ Circumference} = \frac{1884,9}{12} \quad \checkmark$$

$$= 157,08 \text{ mm} \quad \checkmark$$

(3)

[20]**GRAND TOTAL:****200**