Province of the
EASTERN CAPE
EDUCATION

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2019

MECHANICAL TECHNOLOGY: WELDING AND METALWORK MARKING GUIDELINE

MARKS: **200**

This marking guideline consists of 18 pages.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)

1.1 C ✓ (1)

1.2 A ✓ (1)

1.3 B ✓ (1)

1.4 D ✓ (1)

1.5 A ✓ (1)

1.6 C ✓ (1)

[6]

QUESTION 2: SAFETY (GENERIC)

2.1 **Reasons for wearing a helmet:**
Protects your eyes from ultra violet rays and infra-red rays. ✓✓ (2)

2.2 **Angle grinder safety:**
- Safety guard must be in place before grinding. ✓
- Protective shields must be placed around the object being ground to protect passers-by. ✓
- Use the correct grinding disc for the job.
- Do not use excessive force while grinding and cutting.
- Make sure there are no cracks on the disc before you start a job.
- Protective clothing and eye protection are essential. (Any 2) (2)

2.3 **Maximum gap – bench grinder:**
3 mm ✓ (1)

2.4 **Band saw safety:**
- Wear safety glasses or a face shield. ✓
- Wear protective footwear when required. ✓
- Make sure all guards are in place. ✓
- Check for correct tension on the blade.
- Use blades that are sharp, properly set and suitable for the job.
- Keep the floor clean and free of obstructions or clutter. (Any 3) (3)

2.5 **Gas cylinder safety precautions:**
- Always store and use gas cylinders in an upright position. ✓
- Never stack cylinders on top of one another. ✓
- Do not bang or work on the cylinders.
- Never allow cylinders to fall.
- No oil and grease should come into contact with gas cylinders or fittings.
- Keep the caps on the cylinders for protection. (Any 2) (2)

[10]

QUESTION 3: MATERIALS (GENERIC)

3.1 **Quenching:**

- Quenching means to cool the heated material rapidly. ✓
- Cooling the material to room temperature. ✓
- Water is normally used for low and medium carbon steels. ✓
- Oil is used on high carbon and alloy steel.
- Extreme cooling brine is used. (Any 3) (3)

3.2 **Difference between brine and salt water:**

- Brine hardens steels better than fresh water, salt inhibits the water from dissolving into atmospheric gas. ✓
- Salt water does not vaporise as quickly as fresh water. ✓ (2)

3.3 **Purpose for case-hardening:**

- It hardens the surface. ✓
- It provides a wear resistant surface. ✓
- Strengthens core to withstand applied loads. ✓ (3)

3.4 **Methods of case-hardening:**

- Mild steel can be surface hardened by heating to its critical range and immersing in case hardening compound. Carbon is absorbed into surface layer of steel. ✓✓
- Mild steel can be heated in an atmosphere of nitrogen called Nitriding. ✓✓

(Any 1 x 2) (2)

3.5 **Difference between *annealing* and *normalising*:**

Annealing requires steel to cool down over an extended period thus resulting in an internal structural change in the steel, making it softer. ✓✓
Normalising merely removes work-related stresses. ✓✓ (4)

[14]

QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)

4.1 C ✓ (1)

4.2 D ✓ (1)

4.3 A ✓ (1)

4.4 B ✓ (1)

4.5 A ✓ (1)

4.6 C ✓ (1)

4.7 A ✓ (1)

4.8 B ✓ (1)

4.9 C ✓ (1)

4.10 C ✓ (1)

4.11 A ✓ (1)

4.12 B ✓ (1)

4.13 A ✓ (1)

4.14 C ✓ (1)

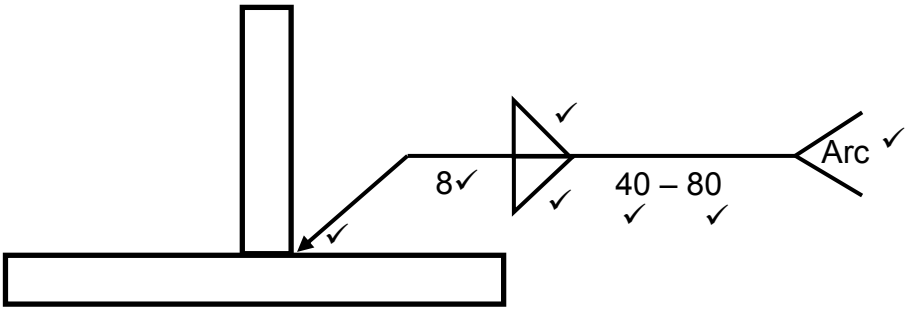
[14]

QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)

5.1 **Roof truss:**

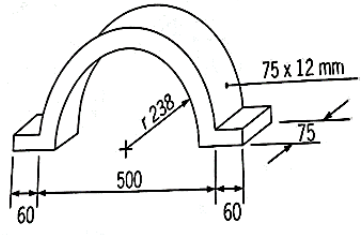
A – Purlins ✓
B – Internal bracing member/s ✓
C – Ridging ✓
D – Roof covering ✓
E – Rafter ✓ (5)

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



(7)

5.3 **Dimensions of the material:**



Average Ø = inside Ø + sheet thickness ✓
Average Ø = 476 mm + 12 mm
Average Ø = 488 ✓

Average perimeter = π x Average Ø
Average perimeter = (π x 488 mm) ÷ 2
Average perimeter = 766,54 mm ✓

Total length needed = 766,54 + 60 mm + 60 mm ✓
Total length needed = 886,55 mm ✓

Round off to 887 mm ✓ (6)

5.4
- Flange templates ✓
- Web templates ✓
- Strip templates ✓ (3)

5.5
- Hand saws ✓
- Chisels ✓
- Plane
- Cordless drill and drill bits
- Steel tap
- Straight edge
- Compass, trammels
- Squares
- Protractors
- Chalk lines etc.

(Any 2) (2)

[23]

QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

6.1 **Danger of oil – Oxy-Acetylene:**
It can catch alight. ✓ (1)

6.2 **Uses of a bench grinder:**
- To sharpen cutting tools and drill bits. ✓
- To remove rough edges. ✓
- To remove excess material. ✓ (3)

6.3 6.3.1 **Spot welding equipment:**
Uses the heating effect, ✓ which occurs when a current flows through a resistance, ✓ to fuse two plates together. ✓ (3)

6.3.2 **Punch and shearing machine:**
Are being used for cutting steel profiles ✓✓ and punching holes into steel plates. ✓✓ (4)

6.4 **Types of rolling machines:**
- Horizontal pyramid rolls ✓
- Off-set pinch rolls ✓
- Vertical rolls ✓ (3)

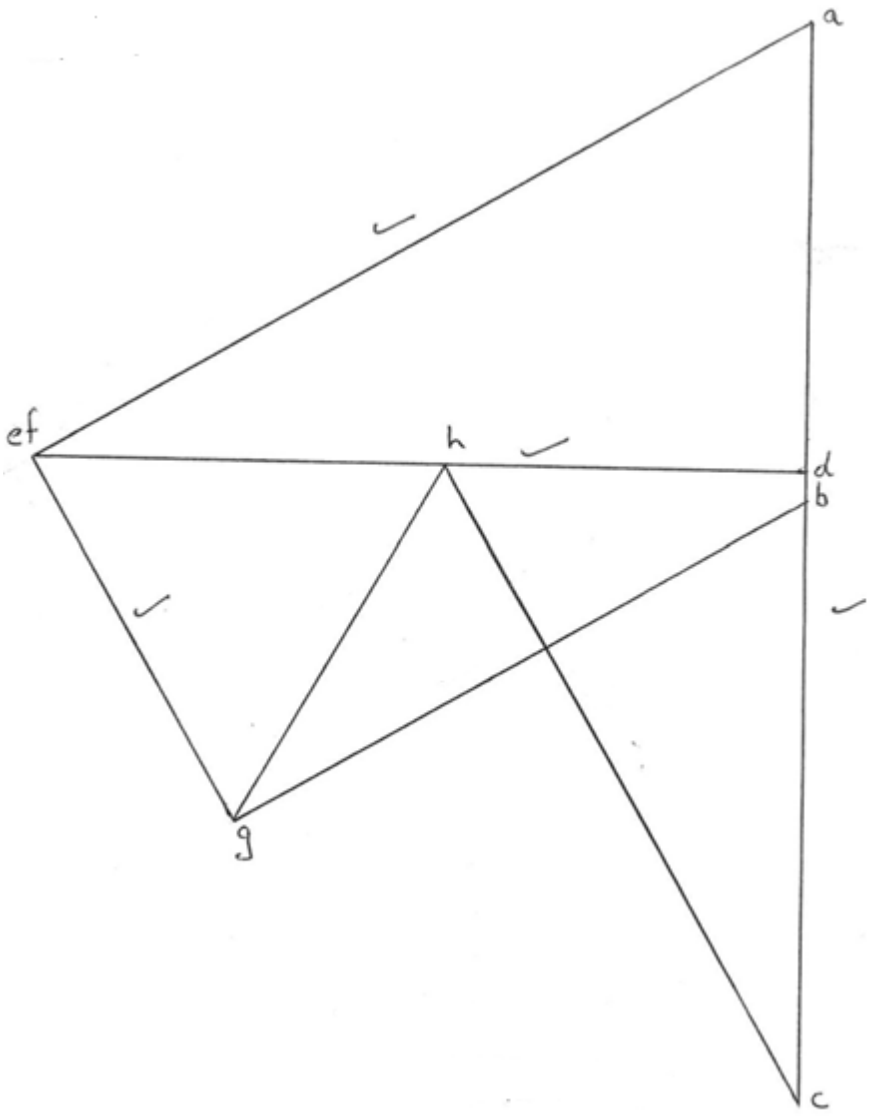
6.5
- Centre screw used to adjust the die. ✓
- Two side screws used to secure the die. ✓ (2)

6.6 **Consequences of soft material-bench grinder:**
The soft material lodges in the pores of the wheel and expands. ✓
Pieces can dislodge when the wheel is revolving at high speed causing injury. ✓ (2)

[18]

QUESTION 7: FORCES (SPECIFIC)

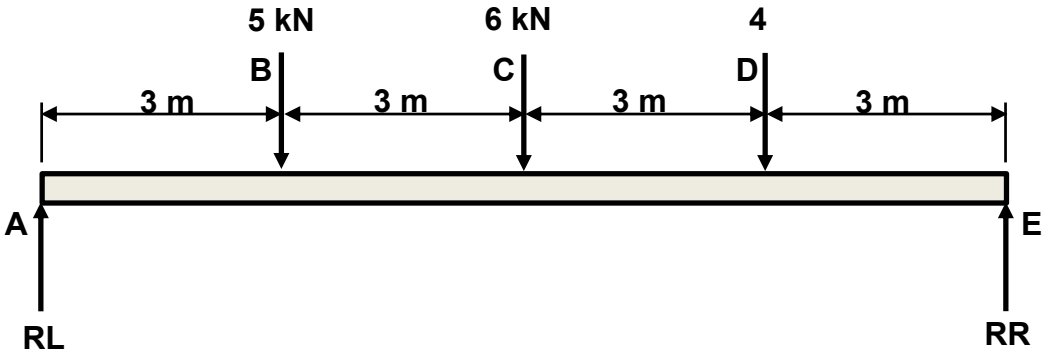
7.1



MEMBER	STRUT	TIE	FORCE	
AE	✓		15,3 N	✓
BG	✓		11,3 N	✓
CH	✓		12,2 N	✓
FG	✓		6,9 N	✓
EF				
DE		✓	13,25 N	✓
DF		✓	13,25 N	✓
DH		✓	6,2 N	✓
GH		✓	7 N	✓

(20)

7.2



7.2.1 **Reactions at the supports RL and RR**
Moments about RR
RL x 12 = (5 x 9) + (6 x 6) + (4 x 3) ✓
RL x 12 = 45 + 36 + 12
RL = $\frac{93}{12}$ ✓
RL = 7,75 N ✓

Reactions about RL
RR x 12 = (4 x 9) + (6 x 6) + (5 x 3) ✓
RR x 12 = 36 + 36 + 15
RR = $\frac{87}{12}$ ✓
RR = 7,25 Kn ✓ (6)

7.2.2 **Shear forces:**
SF_A = 0 Kn ✓

SF_B = 7,75 – 5

= 2,75 Kn ✓

SF_C = 7,75 – 5 – 6

= - 3, 25 Kn ✓

SF_D = 7,75 – 5 – 6 – 4

= - 7,25 Kn ✓

SF_E = 7,75 – 5 – 6 – 4 + 7,75

= 0 kN ✓ (5)

7.2.3 **Bending moments:**

$BM_A = 0$ kN.m ✓

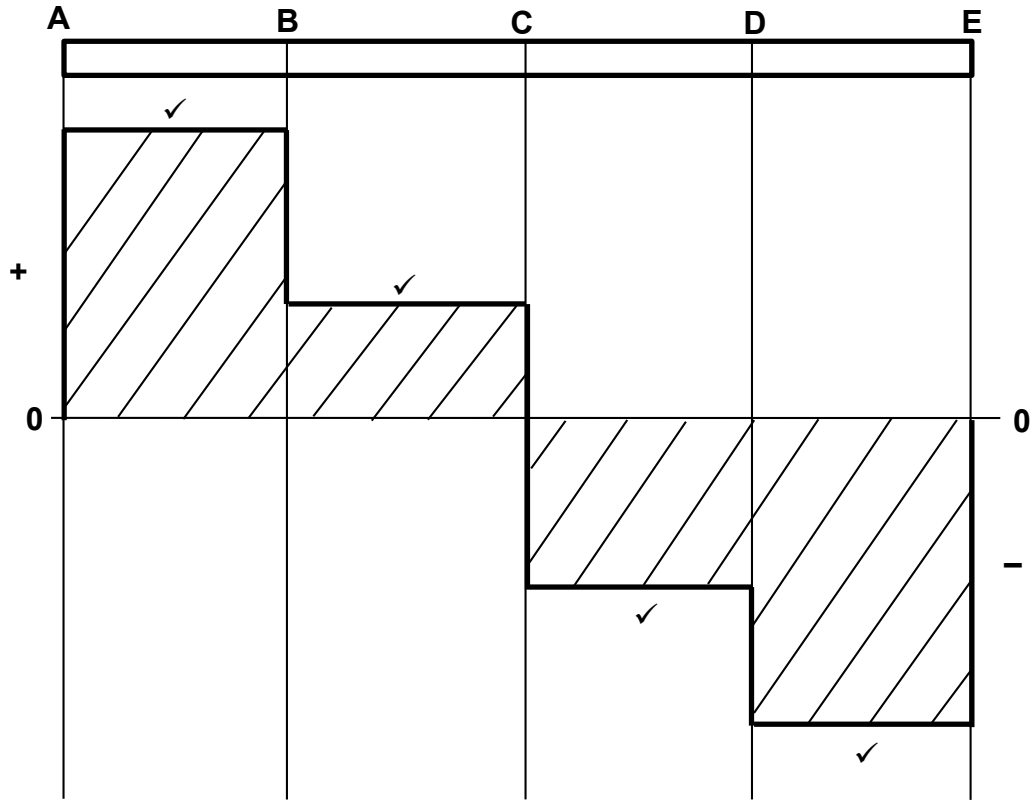
$BM_B = (7{,}75 \times 3)$
$= 23{,}25$ kN.m ✓

$BM_C = (7{,}75 \times 6) - (5 \times 3)$
$= 46{,}5 - 15$
$= 31{,}5$ kN.m ✓

$BM_D = (7{,}75 \times 9) - (5 \times 6) - (6 \times 3)$
$= 69{,}75 - 30 - 18$
$= 21{,}75$ kN.m ✓

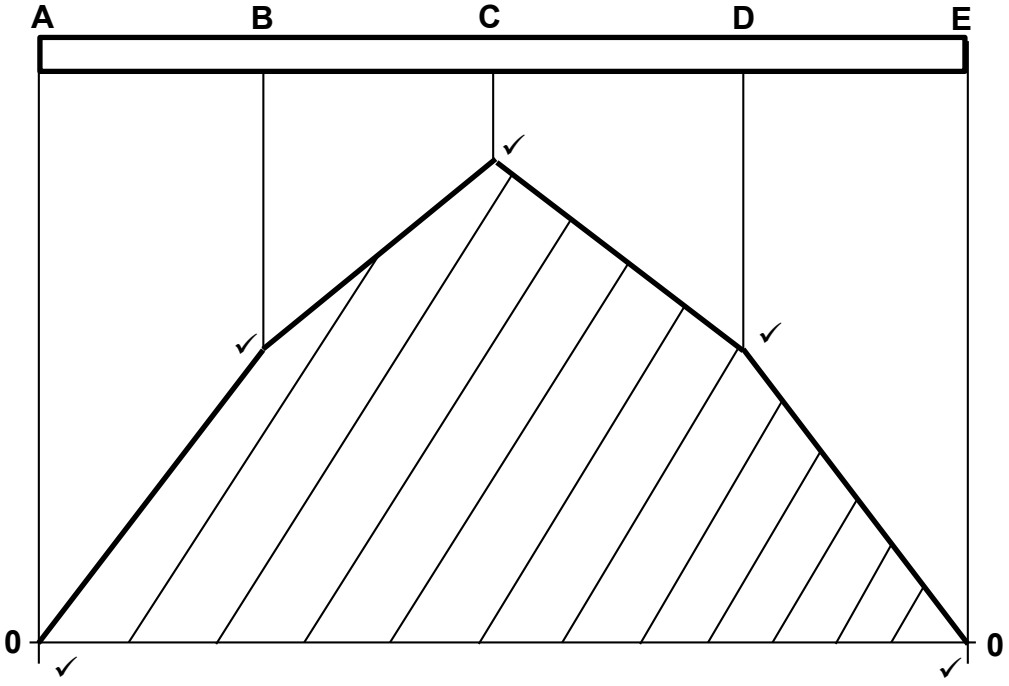
$BM_E = (7{,}75 \times 12) - (5 \times 9) - (6 \times 6) - (4 \times 3)$
$= 93 - 45 - 36 - 12$
$= 0$ kN.m ✓ (5)

7.2.4 **Shear force diagram:**



(4)

7.2.5 **Bending moment diagram:**



(5)
[45]

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

8.1 **Welding spatter:**

It is molten material that are generated at or near the welding arc. ✓

Causes: Disturbance in the molten weld pool during the transfer of wire into the weld. ✓

- Voltage too low ✓
- Amperage too high ✓ (4)

8.2 **Liquid dye test:**

- Clean the surface to be inspected and spray the liquid dye to penetrate into the surface. ✓
- Allow liquid dye to penetrate. ✓
- Remove excess dye with cleaner. ✓
- Spray a developer onto the surface to bring out the colour. ✓
- Areas where the dye has penetrated (defects) will show up clearly. ✓ (5)

8.3 8.3.1 **Undercutting:**

- Improper settings of equipment ✓
- Welding speed too fast ✓
- Current too high (Any 2) (2)

8.3.2 **Slag inclusion:**

- Incorrect current settings ✓
- Included angle too narrow ✓
- Rapid chilling
- Previous weld slag has not been removed (Any 2) (2)

8.3.3 **Porosity:**

- Atmospheric contamination ✓
- Surface contamination ✓
- Dirty or wet electrodes when arc welding
- Rusted MIG wire (Any 2) (2)

8.3.4 **Lack of fusion:**

- Poor welding technique ✓
- Travel speed is too slow ✓
- Using a very wide weld joint
- Weld current too low (Any 2) (2)

8.4

- Correct flame for the work on hand ✓
- Correct angle of blowpipe and rod ✓
- Depth of fusion and amount of penetration ✓
- Rate of progress along the joint (Any 3) (3)

8.5 **Types of cracks:**

- Heat affected zone cracks. ✓
- Centreline cracks. ✓
- Crater cracks. ✓
- Transverse cracks. ✓ (2)

8.6 **Nick-break test:**

It tests for internal welding defects. ✓ (1)

[23]

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

9.1 Weld distortion is the warping of the base plate ✓caused by heat from the welding arc / flame. ✓ (2)

9.2 **Distortion and residual stress:**
- Heat present in the weld. ✓
- Qualities of parent metal, filler rod or electrode. ✓
- Shape and size of weld. ✓
- Number of successive welds runs.
- Comparative weight of weld metal and parent metal.
- Type of welding joint used. (Any 3) (3)

9.3 **Reduce distortion:**
- Do not over weld. ✓
- Intermittent welding. ✓
- Place welds near the neutral axis. ✓
- Use as few passes as possible.
- Use back step welding.
- Anticipate the shrinkage forces.
- Planning the welding sequence.
- Using strong backs.
- Using clamps, jigs and fixtures. (Any 3) (3)

9.4 **Steel groups:**
- Low carbon steel: ✓ 0,15 – 0,30% carbon. ✓
- Medium carbon steel: ✓ 0,31 – 0,70% carbon. ✓
- High carbon steel: ✓ 0,71 – 1,5 % carbon. ✓ (6)

9.5 **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 **Locking out of large machines before maintenance:**

- Due to the danger associated with large machines ✓
- To ensure that isolation switches are switched off ✓
- To ensure that switches are locked out and tagged to inform others that maintenance work is being done
- To ensure that nobody can turn the machine on while maintenance is being done (Any 2 x 1) (2)

10.2 **Tagging plates:**

It has multiple holes so that more than one technician can lock out the machine simultaneously. ✓ (1)

10.3 **Major and minor services for power-driven guillotine:**

Major service allows for on-going service procedures that are designed to maintain the guillotines in premium working conditions. ✓

Minor service is designed to minimise major mechanical and electrical failures, by employing the principle of preventative maintenance. ✓ (2)

10.4 **Maintenance guidelines for a pedestal drilling machine:**

- Visual checks of electrical wiring, switches, etc. ✓
- Verify that all guards are secure and function correctly. ✓
- Ensure workspace is clear.
- Confirm availability and conditions of PPE.
- Lubricate moving parts.
- Use moisture-penetrating oil spray to prevent rust.
- Check for availability of specific tools.
- Check the run-out of the spindle.
- Inspect belts for wear.
- Ensure the drive belt is correctly tensioned.
- Check the condition of the rack and pinion mechanisms and lubricate.
- Ensure cuttings are removed.
- Inspect the Morse taper sleeves for burrs/scratches.
- Check the security of machine mountings. (Any 2) (2)

10.5 **Overloading a punch and shearing machine:**

- Dulling or breaking blades/punches. ✓
- Putting strain on the motor and drive mechanism. (Any 1) (1)

[8]

QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)

11.1 **Conical hopper:**

11.1.1 **Vertical height (DE):**

$$\tan\theta = \frac{\text{opposite}}{\text{adjacent}} \quad \checkmark$$

$$DE = \tan 70° \times EC$$

$$= 2{,}75 \times 1$$

$$= 2{,}75 \text{ m} \quad \checkmark$$

(2)

11.1.2 **Main radius (AC):**

$$\text{Cos } \Theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$AC = \frac{BC}{COS\ 70^{\circ}} \checkmark$$

$$= \frac{2}{0{,}34}$$

$$= 5{,}88 \text{ m} \checkmark$$

(2)

11.1.3 **Small radius (AD):**

$$\text{Cos } \Theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$DC = \frac{EC}{Cos\ 70^{\circ}} \quad \checkmark$$

$$= \frac{1}{0{,}34}$$

$$= 2{,}94 \text{ m} \checkmark$$

Now AD can be calculated.

$$AD = AC - DC$$

$$= 5{,}88 - 2{,}94$$

$$= 2{,}94 \text{ m} \checkmark$$

(3)

11.1.4 **Circumference:**

Circumference: $= \pi$ x GD

$= \pi$ X 4 ✓

= 12,57 m ✓

(2)

11.2 **Square-to-round transition piece:**

11.2.1 **The true length FG is firstly needed to draw the pattern:**

IK = 300 (2 units)
IH = 150 (1 units)

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

The true length FG:
Plan length FG = FG – GK ✓
= 400 – 300
= 100 mm ✓

The true length FG is equal to $\mathrm{H}'\mathrm{F}$
$\mathrm{H}'F^2 = H'G^2 + GF^2$ ✓
$= 800^2 + 100^2$
$H'F = \sqrt{650\,000}$ ✓

True length FG = 806 mm ✓ (5)

11.2.2 **To determine the plan length CI, the sides CE and EI of triangle CEI must be calculated.**

CE = CF – EF

= 400 – 150

= 250 mm ✓

But EI = FH

FH = FK – HK

= 400 – 259,8

= 140,2 mm ✓

True Length (CI) = $FH^2 + EI^2$ ✓

$= 250^2 + 140{,}2^2$

$= \sqrt{82156{,}04}$

= 286,63 mm ✓ (4)

11.2.3 **JI is one-twelfth of the circumference**

Circumference = π x GD

= π x 600

= 1 884,9 mm ✓

$\frac{1}{12}$ Circumference = $\frac{1884,9}{12}$ ✓

= 157,1 mm ✓

(3)
[21]

TOTAL: 200