



# basic education

Department:  
Basic Education  
**REPUBLIC OF SOUTH AFRICA**

**NATIONAL  
SENIOR CERTIFICATE**

**GRADE 12**

**MECHANICAL TECHNOLOGY: WELDING AND METALWORK**

**EXEMPLAR 2018**

**MARKING GUIDELINES**

**MARKS: 200**

**These marking guidelines consist of 18 pages.**

**QUESTION 1: MULTIPLE-CHOICE QUESTIONS (GENERIC)**

- |     |     |            |
|-----|-----|------------|
| 1.1 | A ✓ | (1)        |
| 1.2 | B ✓ | (1)        |
| 1.3 | B ✓ | (1)        |
| 1.4 | B ✓ | (1)        |
| 1.5 | C ✓ | (1)        |
| 1.6 | C ✓ | (1)        |
|     |     | <b>[6]</b> |

**QUESTION 2: SAFETY (GENERIC)**

- 2.1 **Machine safety rule:**  
Switch machine off after use. ✓ (1)
- 2.2 **Drill press safety precautions:**  
Clamp the work piece securely to the table and do not hold it by hand. ✓ (1)
- 2.3 **Hydraulic press safety rules:**
- Predetermined pressure must not be exceeded. ✓
  - Pressure gauge must be tested regularly and replaced if malfunction occurs. ✓
  - The platform must be rigid and square to the cylinder. ✓
  - Objects to be pressed must be placed in suitable jigs. ✓
  - Ensure that the direction of pressure is always at 90° to the object. ✓
  - Only prescribed equipment must be used. ✓ (Any 2 x 1) (2)
- 2.4 **Reasons for wearing surgical gloves:**
- To prevent HIV/Aids or any blood related infections. ✓
  - To prevent contamination of the open wounds. ✓ (2)
- 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 x 1) (2)
- 2.6 **Responsibility of employer:**
- Provide and maintain working systems, work area, equipment and tools in a safe condition. ✓
  - Eliminate or reduce any hazard or potential hazard. ✓
  - Produce, handle, store and transport goods safely. ✓
  - Ensure that every person employed complies with the requirements of this Act. ✓
  - Enforce measures if necessary in the interest of health and safety. ✓
  - Appoint a person who is trained and who have the authority to ensure that employee take precautionary measures. ✓ (Any 1 x 1) (1)
- 2.7 **Responsibility of employee:**
- Pay attention to your own and other people's health and safety. ✓
  - Co-operate with the employer regarding the Act. ✓
  - Carry out a lawful order given to them. ✓
  - Report any situation that is unsafe or unhealthy. ✓
  - Report all incidents and accidents. ✓
  - Do not interfere with any safety equipment or misuse such equipment. ✓
  - Obey all safety rules. ✓ (Any 1 x 1) (1)
- [10]**

### QUESTION 3: MATERIALS (GENERIC)

#### 3.1 Metal tests:

##### 3.1.1 Filing test:

Filing should be done on the tip or near the edge ✓ of the material to establish the relative hardness. ✓ (2)

##### 3.1.2 Machining test:

This test is used on two unknown samples, identical in appearance and size, which is cut with a machine tool at the same speed and feed. ✓ The ease of cutting should be compared and the chips observed for heating colour and curl. ✓ (2)

#### 3.2 Sound test on the steel:

##### 3.2.1 High carbon steel (Hard):

Loud and clear ✓✓ (2)

##### 3.2.2 Low carbon steel (Soft):

Dull sound ✓✓ (2)

#### 3.3 Heat treatment processes on steel:

##### 3.3.2 Case hardening:

To produce a hard case ✓ over a tough core. ✓ (2)

##### 3.3.3 Hardening:

To enable the steel to resist wear ✓ and indentation ✓ (2)

##### 3.3.5 Normalising:

To relieve ✓ the internal stress ✓ produced by machining. (2)

**[14]**

**QUESTION 4: MULTIPLE-CHOICE QUESTIONS (SPECIFIC)**

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

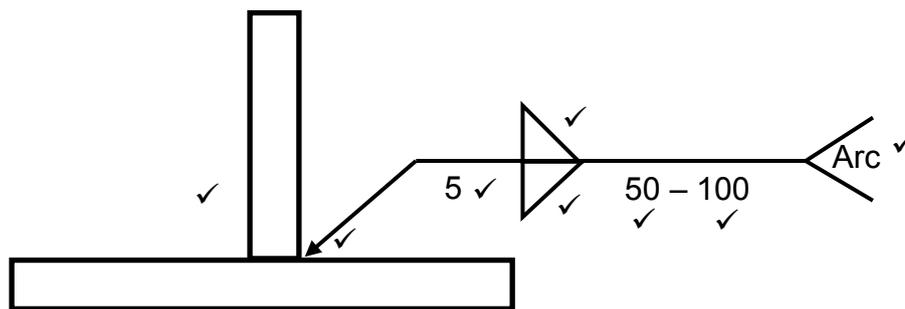
**QUESTION 5: TERMINOLOGY (TEMPLATES) (SPECIFIC)**

5.1 **Roof truss:**

- A – Principal rafter ✓
- B – Cleat ✓
- C – Purlin ✓
- D – Internal bracing members ✓
- E – Gusset plate ✓

(5)

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



(8)

5.3 **Dimensions of the material:**

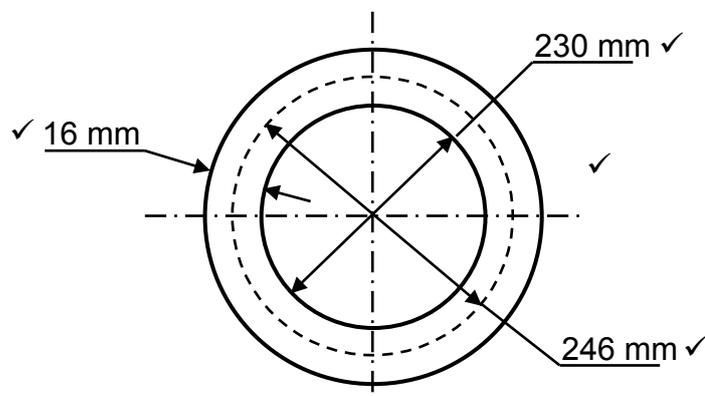
5.3.1  $\text{Mean } \phi = \text{Inside } \phi + \text{Thickness}$  ✓  
 $= 230 + 16$  ✓  
 $= 246 \text{ mm}$  ✓

$\text{Mean circumference} = \pi \times \text{Mean } \phi$  ✓  
 $= \pi \times 246$  ✓  
 $= 772,83 \text{ mm}$

Round off to 773 mm ✓

(6)

5.3.2



(4)  
 [23]

## QUESTION 6: TOOLS AND EQUIPMENT (SPECIFIC)

### 6.1 Working principle of the following machines:

#### 6.1.1 Punch and cropping machine:

Cropping machines are electrically driven ✓ and use a heavy fly wheel and clutches ✓ to engage various shearing blades/punches ✓ to shear/punch the various profiles. ✓ (4)

#### 6.1.2 Spot welding equipment:

This method uses the heating effect, ✓ which occurs when a current flows ✓ through a resistance, ✓ to fuse two plates together. ✓ (4)

#### 6.1.3 Power-driven guillotine:

An electric motor ✓ drives a fly wheel in a gearbox ✓ that is activated through the electric pedal and clutch ✓ to turn an axle that lowers the blade by eccentric motion/action. ✓ (4)

### 6.2 Uses of the bench grinder:

- To sharpen cutting tools and drill bits. ✓
  - To remove rough edges. ✓
  - To remove excess material. ✓
- (3)

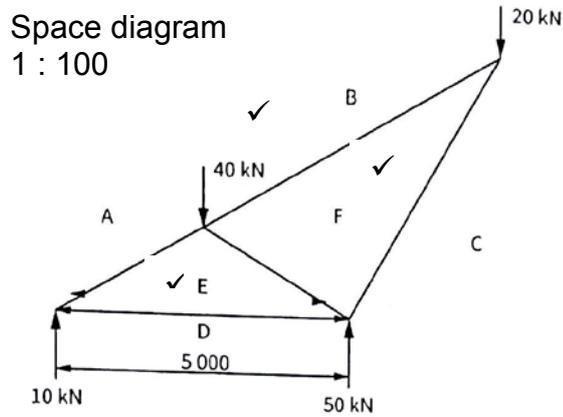
### 6.3 Types of rolling machines:

- Horizontal pyramid rolls ✓
  - Off-set pinch rolls ✓
  - Vertical rolls ✓
- (3)

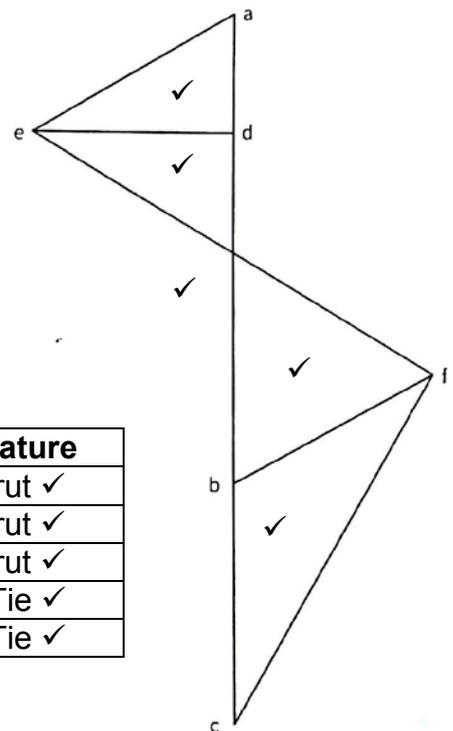
**[18]**

**QUESTION 7: FORCES (SPECIFIC)**

7.1



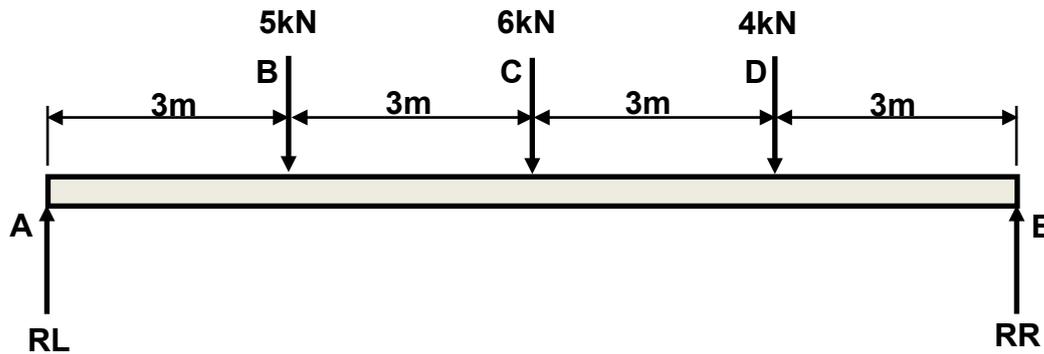
Vector diagram  
2 mm = 1 kN



Member	Force	Nature
AE	20 kN ✓	Strut ✓
EF	40 kN ✓	Strut ✓
FC	34 kN ✓	Strut ✓
BF	20 kN ✓	Tie ✓
DE	17 kN ✓	Tie ✓

(20)

7.2



7.2.1 **Reactions at supports RL and RR**

**Take moment about RR**

$$RL \times 12 = (5 \times 9) + (6 \times 6) + (4 \times 3) \quad \checkmark$$

$$RL \times 12 = 45 + 36 + 12$$

$$RL = \frac{93}{12} \quad \checkmark$$

$$RL = 7,75 \text{ kN} \quad \checkmark$$

**Take moment about RL**

$$RL \times 12 = (4 \times 9) + (6 \times 6) + (5 \times 3) \quad \checkmark$$

$$RL \times 12 = 36 + 36 + 15$$

$$RL = \frac{87}{12} \quad \checkmark$$

$$RL = 7,25 \text{ kN} \quad \checkmark$$

(6)

7.2.2 **Shear forces:**

$$SF_A = 7,75 \text{ kN} \quad \checkmark$$

$$SF_B = 7,75 - 5 \\ = 2,75 \text{ kN} \quad \checkmark$$

$$SF_C = 7,75 - 5 - 6 \\ = -3,25 \text{ kN} \quad \checkmark$$

$$SF_D = 7,75 - 5 - 6 - 4 \\ = -7,25 \text{ kN} \quad \checkmark$$

$$SF_E = 7,75 - 5 - 6 - 4 + 7,25 \\ = 0 \text{ kN} \quad \checkmark$$

(5)

7.2.3 **Bending moments:**

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

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

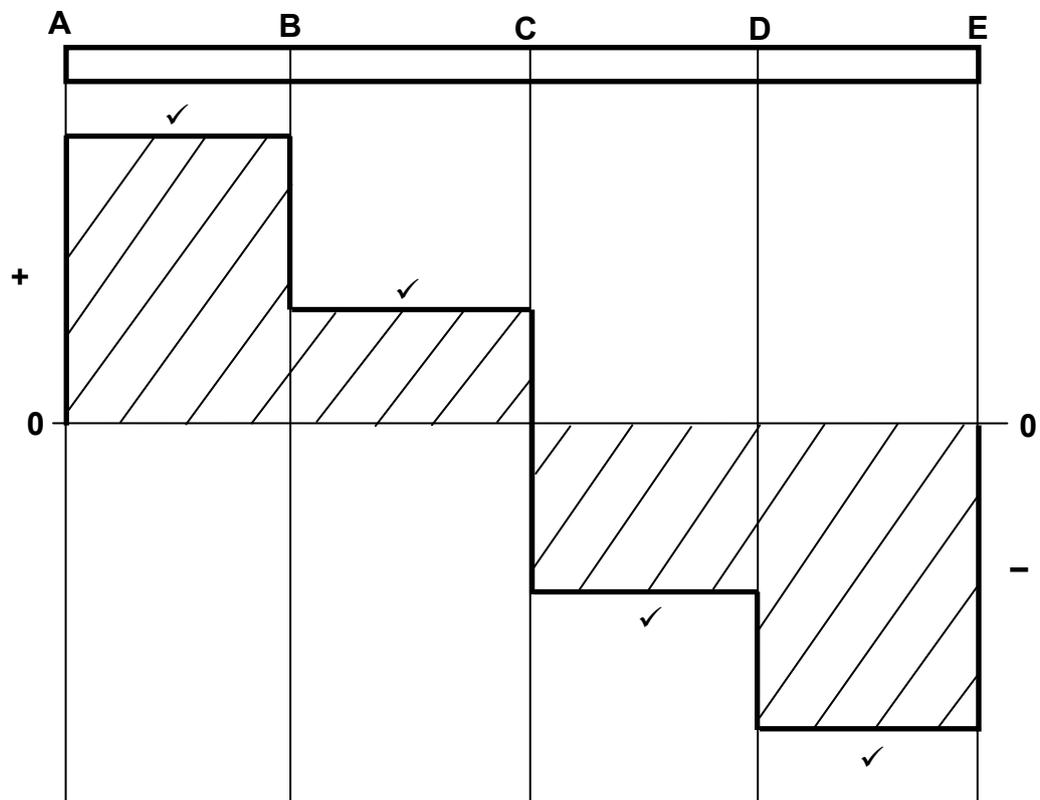
$$BM_C = (7,75 \times 6) - (5 \times 3) \\ = 46,5 - 15 \\ = 31,5 \text{ kN.m} \quad \checkmark$$

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

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

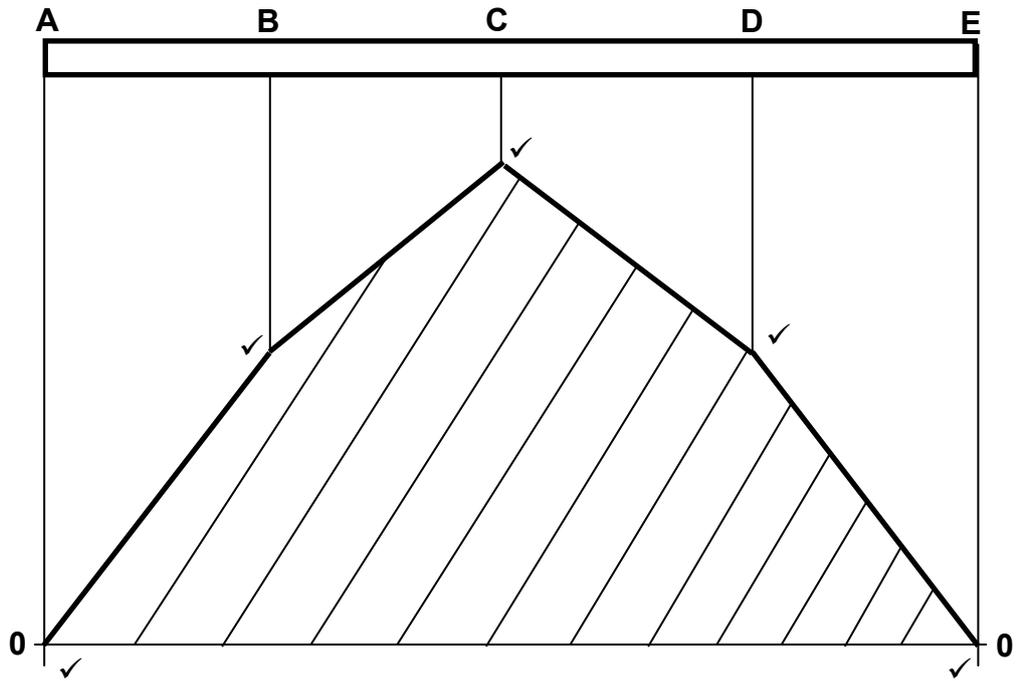
(5)

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 Inspection during arc welding:

- 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 x 1) (3)**

### 8.2 Causes of weld defects:

#### 8.2.1 Welding spatter:

- Too high current ✓
  - Too long arc ✓
  - Not applying anti-spatter spray ✓
  - Electrode angle too small ✓
  - Welding speed too fast ✓
- (Any 2 x 1) (2)**

#### 8.2.2 Incomplete penetration:

- Too low current ✓
  - Too slow welding speed ✓
  - Electrode angle too small ✓
  - Poor joint preparation ✓
  - Insufficient root gap ✓
- (Any 2 x 1) (2)**

### 8.3 Prevention of weld defects:

#### 8.3.1 Porosity:

- Ensure that the surface is clean. ✓
  - Prevent atmospheric contamination. ✓
  - Use dry electrodes. ✓
- (Any 1 x 1) (1)**

#### 8.3.2 Slag inclusion:

- Remove slag from previous run before doing the next run. ✓
  - Ensure that the surface is clean. ✓
  - Use the correct current. ✓
- (Any 1 x 1) (1)**

### 8.4 Nick-break test:

To determine the internal ✓ quality/defects ✓ of the weld metal. (2)

### 8.5 Guided bend test:

- Lack of fusion of the base metal and weld metal. ✓
  - Incomplete penetration of the weld metal. ✓
- (2)**

### 8.6 Free-bend test:

Ductility ✓ (1)

8.7 **Visual inspection process:**

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

**(Any 3 x 1)** (3)

8.8 **Liquid dye penetration test:**

- Clean the surface tested. ✓
- Spray the liquid dye penetrant onto 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. ✓

(6)  
**[23]**

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

- 9.1 **Distortion:**  
Weld distortion is the warping of the base metal ✓ caused by heat from the welding arc/flame. ✓ (2)
- 9.2 **Residual stress:**  
As the weld proceeds, ✓ the surrounding areas expand and contract ✓ at varied rates, which set up stresses ✓ in the welded joint. These stresses remain when the weld has cooled ✓ and are known as residual stresses. (4)
- 9.3 **Distortion and residual stress:**
- If expansion, which occurs when a metal is heated, is resisted then deformation occurs. ✓
  - When contraction, which occurs on cooling, is resisted then a stress will be applied. ✓
  - If the 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. ✓ (Any 3 x 1) (3)
- 9.4 **Methods to reduce distortion:**
- Do not overweld. ✓
  - Apply intermittent welding. ✓
  - Place welds near the neutral axis. ✓
  - Use as few passes as possible. ✓
  - Use back-step welding. ✓
  - Anticipate the shrinkage forces. ✓
  - Plan the welding sequence. ✓
  - Use strongbacks. ✓
  - Use clamps, jigs and fixtures. ✓ (Any 3 x 1) (3)
- 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)
- 9.6 **Factors that affect the grain size of steel:**
- The prior amount of cold work. ✓
  - The temperature and time of the annealing process. ✓
  - The composition. ✓
  - The melting point. ✓ (Any 2 x 1) (2)
- [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 on the machine 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 x 1) (2)**
- 10.5 **Overloading a punch and shearing machine:**
- Dulling or breaking blades/punches. ✓
  - Putting strain on the motor and drive mechanism. ✓
- (Any 1 x 1) (1)**
- [8]**

**QUESTION 11: TERMINOLOGY (DEVELOPMENT) (SPECIFIC)**

**11.1 Conical hopper:**

**11.1.1 Vertical height (DE):**

$$\begin{aligned}\tan\theta &= \frac{\text{opposite}}{\text{adjacent}} && \checkmark \\ DE &= \tan 70^\circ \times EC \\ &= 2,75 \times 1 \\ &= 2,75 \text{ m} && \checkmark\end{aligned}$$

(2)

**11.1.2 Main radius (AC):**

$$\begin{aligned}\cos\theta &= \frac{\text{adjacent}}{\text{hypotenus}} && \checkmark \\ AC &= \frac{BC}{\cos 70^\circ} \\ &= \frac{2}{0,34} \\ &= 5,88 \text{ m} && \checkmark\end{aligned}$$

(2)

**11.1.3 Small radius (AD):**

$$\begin{aligned}\cos\theta &= \frac{\text{adjacent}}{\text{hypotenus}} && \checkmark \\ DC &= \frac{EC}{\cos 70^\circ} \\ &= \frac{1}{0,34} \\ &= 2,94 \text{ m} && \checkmark\end{aligned}$$

Now AD can be calculated

$$\begin{aligned}AD &= AC - DC \\ &= 5,88 - 2,94 \\ &= 2,94 \text{ m} && \checkmark\end{aligned}$$

(3)

**11.1.4 Circumference:**

$$\begin{aligned}\text{Circumference} &= \pi \times MD && \checkmark \\ &= \pi \times 4 \\ &= 12,57 \text{ m} && \checkmark\end{aligned}$$

(2)

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

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

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

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

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

The true length FG:

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

The true FG is equal to H'F

$$\begin{aligned} H'F^2 &= H'G^2 + GF^2 && \checkmark \\ &= 800^2 + 100^2 && \checkmark \\ H'F &= \sqrt{650000} && \checkmark \end{aligned}$$

$$\text{True length FG} = 806 \text{ mm} \quad (5)$$

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

$$\begin{aligned} CE &= CF - EF \\ &= 400 - 150 \\ &= 250 \text{ mm} && \checkmark \end{aligned}$$

But EI = FH

$$\begin{aligned} FH &= FK - HK \\ &= 400 - 259,8 \\ &= 140,2 \text{ mm} && \checkmark \end{aligned}$$

$$\begin{aligned} \text{True length (CI)} &= FH^2 + EI^2 && \checkmark \\ &= 250^2 + 140,2^2 \\ &= \sqrt{82156,04} \\ &= 286,63 \text{ mm} && \checkmark \end{aligned}$$

(4)

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

$$\begin{aligned} \text{Circumference} &= \pi \times MD \\ &= \pi \times 600 \\ &= 1884,9 \text{ mm} \quad \checkmark \end{aligned}$$

$$\begin{aligned} \frac{1}{12} \text{Circumference} &= \frac{1884,9}{12} \quad \checkmark \\ &= 157,1 \text{ mm} \quad \checkmark \end{aligned}$$

(3)  
[21]

**TOTAL: 200**