



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE ENGINEERING SCIENCE N3

17 November 2022

This marking guideline consists of 12 pages.

QUESTION 1

1.1 D (1)

1.2 A (1)

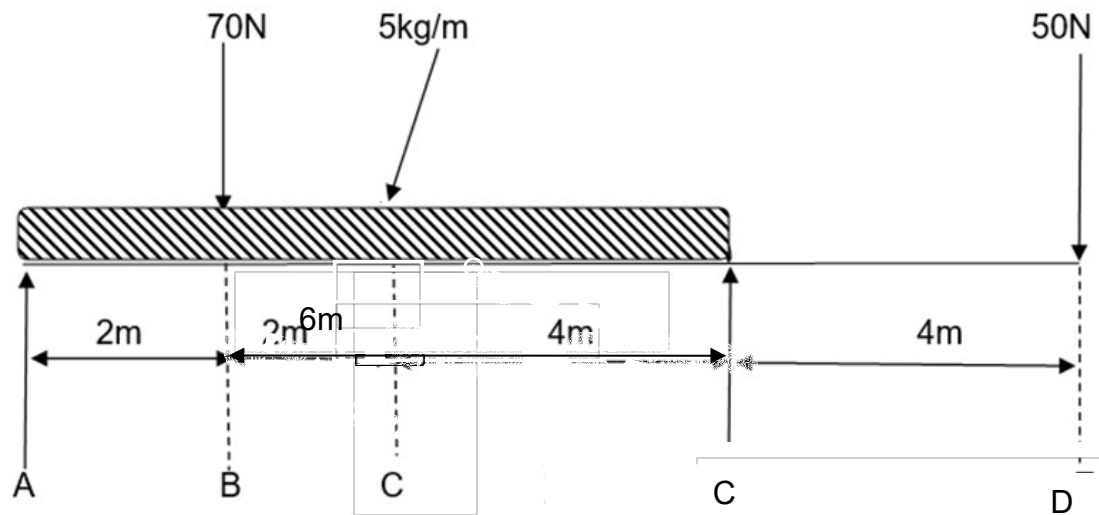
1.3 1.3.1 $S = 10(2) - 2(2)^2$
 $= 12\text{m}$ (1)1.3. $\frac{1}{2} a = -2$
2 $a = -4\text{m/s}^2$ (1)1.3. 10 m/s✓
3 (1)1.3. $8 = 10t - 2t^2$ ✓
4 $2t^2 - 10t + 8 = 0$
 $t^2 - 5t + 4 = 0$
 $(t - 4)(t - 1) = 0$ ✓
 $t \neq 4$ or $t = 1$ ✓ (3)1.4 1.4.1 $m_1u_1 + m_2u_2 = v(m_1 + m_2)$
 $3 \times 2 + (-5)(4)$ ✓ $= v(3+5)$ ✓
 $v = -1,75\text{ m/s}$ ✓**OR** $v = 1,75\text{ m/s}$ to the left or to the original direction of 5 kg mass (3)1.5 $V = u + at$
 $= 3 \times 12$
 $= 36\text{ m/s}$ (2)1.6 $T_1 : T_2$
 $T_2 = 500/5 = 100\text{ N}$ ✓
 $P = (T_1 - T_2) \times V$
 $= (500 - 100) \times 20$ ✓
 $= 8\text{ kW}$ ✓ (3)**[16]****QUESTION 2**

2.1

force	load
$F = ma$ or is the dynamic load	$F = mg$ or is a static load
It can act in any direction ✓	It can only act in the downward direction✓

(2)

2.2.1



1 mark for correct diagram
 1 mark for the correct position of UDL

(2)

$$C = 288,5 \text{ N} \checkmark$$

Taking moments about C

$$\sum \text{clockwise moments} = \sum \text{anticlockwise moments}$$

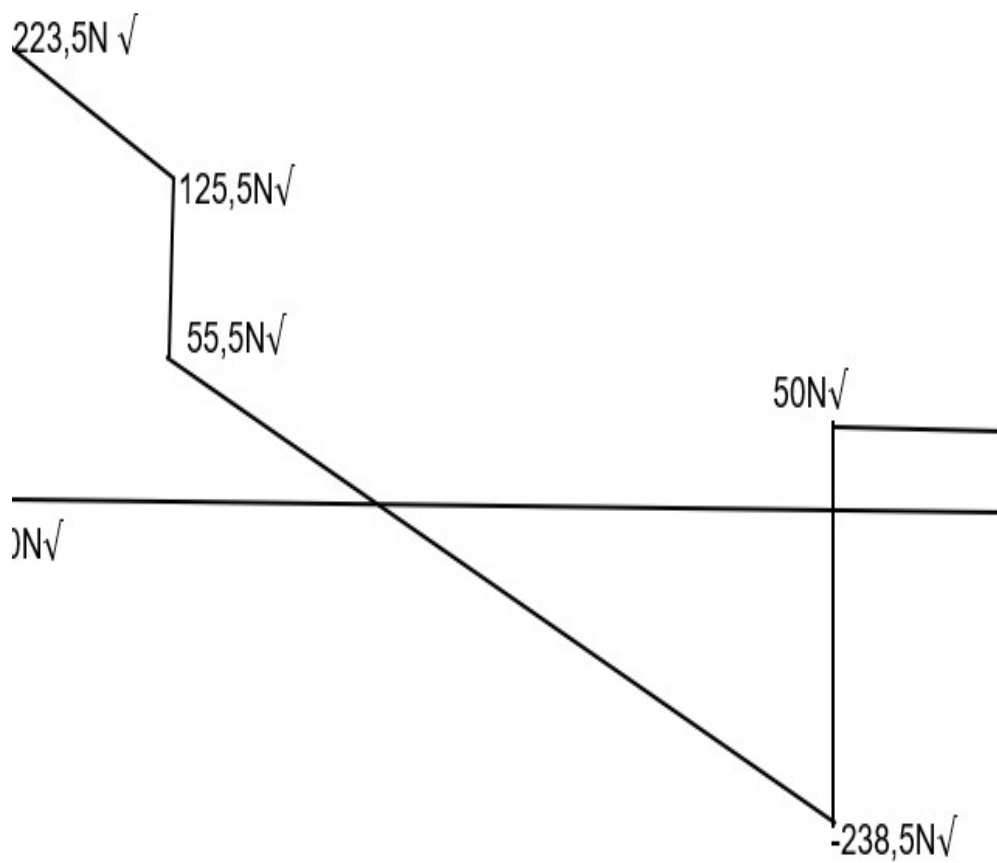
$$8A + 50 \times 4 = 392 \times 4 + 70 \times 6 \checkmark$$

$$8A = 1988 - 200$$

$$A = 223,5 \text{ N} \checkmark$$

(4)

2.2.3



1 mark for correct diagram

 $\frac{1}{2}$ mark for each correct point in the diagram

)

QUESTION 3

3.1

Algebraic sum of the components of forces in any direction is equal to zero
 Algebraic sum of the moments of the forces about any point is equal to zero
 Line of action of the forces meet at a point
 The forces or vectors are co-planar

(Any 2) (2)

(1)

$$3.2.1 \quad \sum H_x = -100 \cos 50^\circ - B \cos 60^\circ + A = 0$$

(1)

$$3.2.2 \quad \sum$$

$$3.2.3 \quad \begin{aligned} B \sin 50^\circ &= 100 \sin 50^\circ + 80 \checkmark \\ B &= 180,831 \text{ N} \checkmark \\ A &= 100 \cos 50^\circ + 180,831 \cos 60^\circ \checkmark \\ &= 154,964 \text{ N} \checkmark \end{aligned}$$

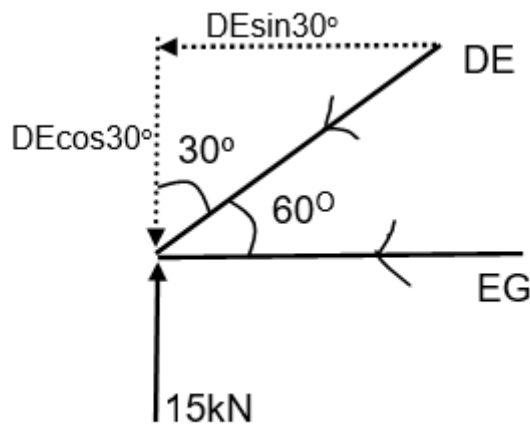
(4)

(1)

- 3.4.1 Reaction of each support = $\frac{1}{2}$ load
 $= \frac{1}{2} \times 30 \checkmark$
 $A = B = 15 \text{ kN} \checkmark$

(2)

3.4.2



$$\Sigma V_C = 0 = 15 - DE \cos 30^\circ \checkmark$$

$$DE = 17,321 \text{ kN (STRUT)} \checkmark$$

$$\Sigma H_C = 0 = -DE \sin 30^\circ - EG \checkmark$$

$$EG = -8,661 \text{ kN}$$

$$= 8,661 \text{ kN (TIE)} \checkmark$$

OR

$$\sin 60^\circ = 15/DE$$

$$DE = 17,321 \text{ kN, strut}$$

$$\tan 60^\circ = 15/EG$$

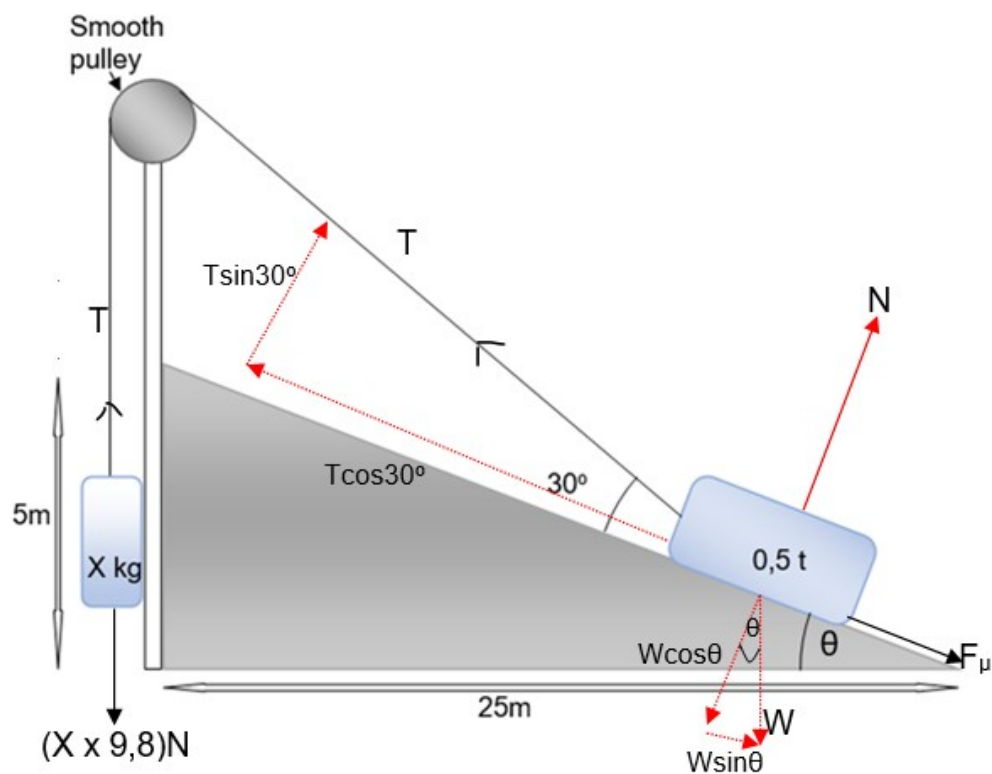
$$EG = 8,661 \text{ kN, tie}$$

(4)
[16]**QUESTION 4: FRICTION**

- 4.1
- Used to remove material, e.g., when drilling, grinding, and cleaning with sandpaper.
 - Used to transfer power, e.g., belt drives
 - Prevent slip between two contact surfaces, e.g., when machining tools and the workpiece.
 - To brake or stop moving objects, e.g., clutch of a vehicle. (Any 2 × 2)

(4)

4.2



$$\mu = 0,25$$

$$F_\mu = \mu N = 0,25 N \checkmark$$

$$N = 4F_\mu$$

$$\theta = \tan^{-1}(5/25) = 11,3^\circ \checkmark$$

$$W = 500 \times 9,8 = 4900 \text{ N} \checkmark$$

Parallel to the plane: $T \cos 30^\circ = F_\mu + 4900 \sin 11,3^\circ$

$$F_\mu = T \cos 30^\circ - 960,136 \checkmark \dots\dots\dots 1$$

Perpendicular to the plane: $N + T \sin 30^\circ = 4900 \cos 11,3^\circ$

$$4F_\mu + 0,5T = 4805,012$$

$$F_\mu = 1201,253 - 0,125 T \checkmark \dots\dots\dots 2$$

Therefore: $T \cos 30^\circ - 960,136 = 1201,253 - 0,125 T$

$$T = 2180,962 \text{ N} \checkmark$$

$$X \times 9,8 = 2916,754$$

$$X = 222,547 \text{ kg} \checkmark$$

(7)
[11]

QUESTION 5: HEAT

5.1 5.1.1 $P = 900 \text{ kPa}$ $t = 250 \text{ }^{\circ}\text{C}$

Superheated steam (1)

5.1.2 $P = 2,5 \text{ MPa}$ $h = 2700 \text{ kJ/kg}$

Wet steam✓

$$h_{\text{wet}} = h_f + xh_{fg}$$

$$2700 = 962 + 1839x \checkmark$$

Therefore $x = 0,945 \checkmark$ (3)

5.1.3 $P = 9 \text{ MPa}$ $h = 2745 \text{ kJ/kg}$

Dry saturated steam (1)

5.2.1 Area of the door frame opening = $1,2 \times 2,09 = 2,508 \text{ m}^2$ (1)

5.2.2 Change in area of the door due to temperature change:

$$\Delta A = 2A_o\alpha\Delta t$$

$$= 1,19 \times 2,08 \times 12 \times 10^{-5} \times 20 \times 2 \checkmark$$

$$= 0,0119 \text{ m}^2 \checkmark$$
 (2)

5.2.3 Final area of the door due to temperature change:

$$A_f = \Delta A + A_o$$

$$= 0,0119 + 1,19 \times 2,08$$

$$= 0,0119 + 2,475 \checkmark$$

$$= 2,487 \text{ m}^2 \checkmark$$
 (2)

5.3 5.3.1 The disadvantage of high specific heat capacity of water is that need a lot of energy is needed to heat it. ✓ The advantage that you can easily retrieve the heat from the water. ✓ (2)

5.3.2 Heat Lost = Heat gained

$$mc(t_1 - t_2) = mc(t_2 - t_1)$$

$$20 \times 390 \times (350 - t_2) \checkmark = 2 \times 4187 \times (t_2 - 15) \checkmark$$

$$t_2 = 176,556 \text{ }^{\circ}\text{C} \checkmark$$
 (3)

[15]

QUESTION 6: HYDRAULICS

6.1 The sum of the suction head ✓ and delivery head ✓ is called the static head. (2)

$$\begin{aligned}
 6.2 \quad P &= \rho \times g \times h \\
 &= 1000 \times 9,8 \times 8 \\
 &= 78,4 \text{ kPa} \checkmark
 \end{aligned}$$

$$i \frac{d}{l} = \frac{3}{4}$$

Work Done = Pressure × Volume

$$125 = 78400 \times \frac{\pi \times d^2}{4} \times \frac{4d}{3} \checkmark$$

Therefore $d = 0,115 \text{ m} \checkmark$

$$l = 0,115 \times \frac{4}{3} = 0,153 \text{ m} \checkmark$$

(4)

6.3 6.3.1 The mass lifted by the hydraulic press.

$$\text{Force exerted on the plunger} = \frac{f_p}{MA} = f$$

$$f_p = f \times MA$$

$$f_p = 25 \times 18$$

$$f_p = 450 \text{ N} \checkmark$$

$$\frac{F}{D^2} = \frac{f}{d^2}$$

$$\frac{F}{0,105^2} = \frac{450}{0,025^2}$$

$$F = i7938 \text{ N} \checkmark$$

$$\text{Mass} = \frac{7938}{9,8} = 810 \text{ kg} \checkmark \quad (3)$$

6.3.2 The distance moved by the ram after 60 working strokes

$$d^2 \times H \times \text{no. of strokes} = D^2 \times h$$

$$h = (0,025^2 \times 0,04 \times 60) / 0,105^2 \checkmark$$

$$= 0,136\text{m} \checkmark$$

(2)
[11]

QUESTION 7: ELECTRICITY

7.1

- Extraction of metals
- Refining of metals
- Production of chemicals
- Electroplating
- Electro-typing
- Electro-forming
- Electro-cleaning

R_{P1}

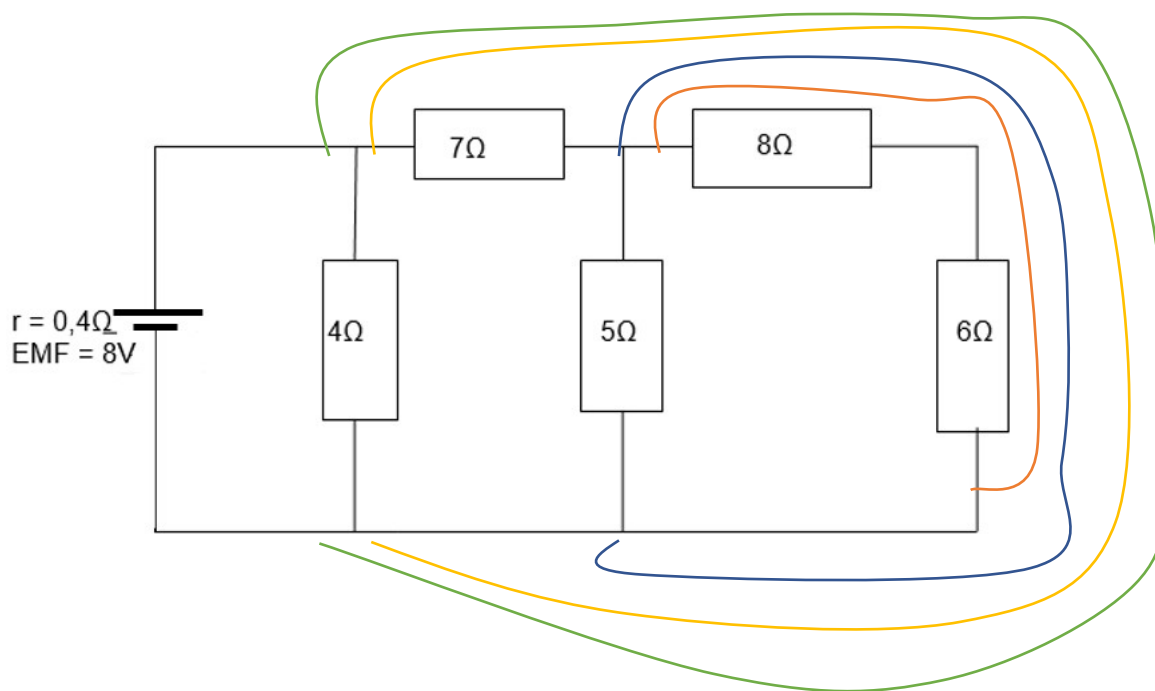
R_{S2}

R_{P2}

(Any 1)

(1)

7.2



$$7.2.1 \quad R_{S1} = 8 + 6 = 14\Omega \checkmark$$

$$R_{P1} = \frac{1}{\frac{1}{5} + \frac{1}{14}} = 3,6842 \Omega \checkmark$$

$$R_{S2} = 7 + 3,6842 = 10,6842 \Omega \checkmark$$

$$R_{P2} = \frac{1}{\frac{1}{10,6842} + \frac{1}{4}} = 2,9104 \Omega \checkmark$$

$$R_T = 2,9104 + 0,4 = 3,310 \Omega \checkmark$$

$$7.2.2 \quad I_T = \frac{EMF}{R_T} = \frac{8}{3,31} = 2,417 \text{ A}$$

$$7.2.3 \quad \begin{aligned} \text{Internal voltage drop} &= I_T \times r \\ &= 2,417 \times 0,4 \\ &= 0,9668 \text{ V} \checkmark \end{aligned}$$

$$\begin{aligned} V_{4\Omega} &= 8 - 0,9668 \\ &= 7,0332 \text{ V} = V_{RS2} \checkmark \end{aligned}$$

$$\begin{aligned} I_{4\Omega} &= \frac{7,0332}{4} \\ &= 1,7583 \text{ A} \checkmark \end{aligned}$$

$$\begin{aligned} I_{7\Omega} &= 2,417 - 1,7583 \\ &= 0,6587 \text{ A} \checkmark \end{aligned}$$

$$\begin{aligned} V_{7\Omega} &= 7 \times 0,6587 \\ &= 4,6109 \text{ V} \checkmark \end{aligned}$$

$$\begin{aligned} V_{5\Omega} &= 7,0332 - 4,6109 \\ &= 2,4223 \text{ V} \checkmark \end{aligned}$$

(4)

(2)

(6)

[13]**QUESTION 8**

8.1 D (1)

8.2 F (1)

8.3 H (1)

8.4 G (1)

8.5 B (1)

8.6 E (1)

[6]

