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 $S = 10(2) – 2(2)^2$
$= 12m$ (1)

1.3.2 $½ a = - 2$
$a = - 4m/s^2$ (1)

1.3.3 10 m/s✓ (1)

1.3.4 $8 = 10t – 2t^2$✓
$2t^2 – 10t + 8 = 0$
$t^2 – 5t + 4 = 0$
$(t – 4) (t – 1) = 0$✓
$t ≠ 4$ or $t = 1$✓ (3)

1.4 1.4.1 $m_1u_1 + m_2u_2 = v (m_1 + m_2)$
$3x2 + (-5) (4)$✓ $= v (3+5)$✓
$v = - 1,75$ m/s✓

OR

v = 1,75 m/s to the left or to the original direction of 5 kg mass (3)

1.5 $V = u + at$
$= 3 × 12$
$= 36$ m/s (2)

1.6 $T_1 : T_2$
$T_2 = 500/5 = 100$ N✓
$P = (T_1 – T_2) × V$
$= (500 – 100) × 20$✓
$= 8$ kW✓ (3)

[16]

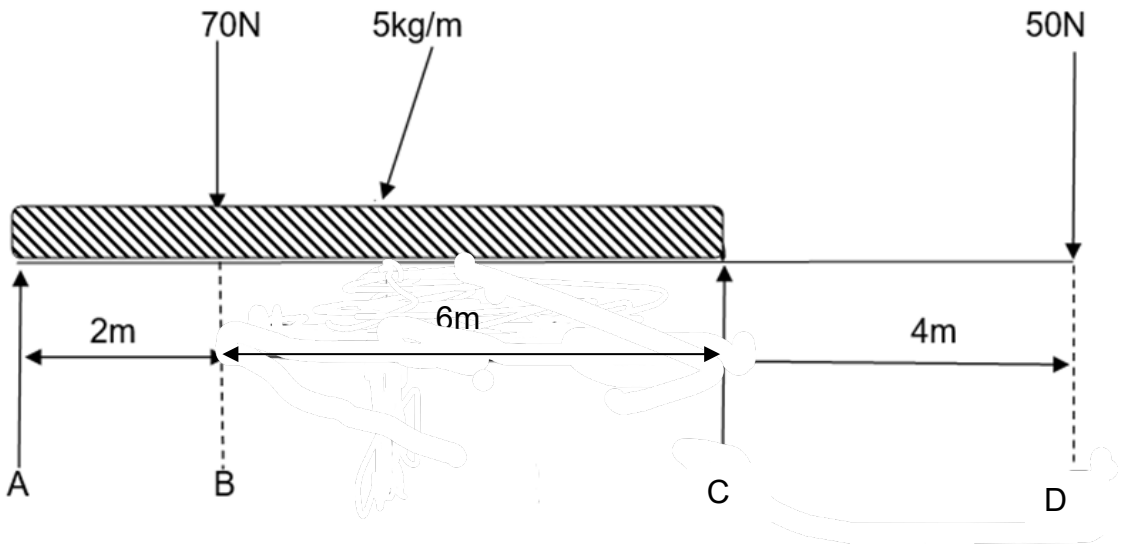
QUESTION 2

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)

2.2.2 Taking moments about A

$$\sum clockwise\ moments = \sum anticlockwise\ moments$$

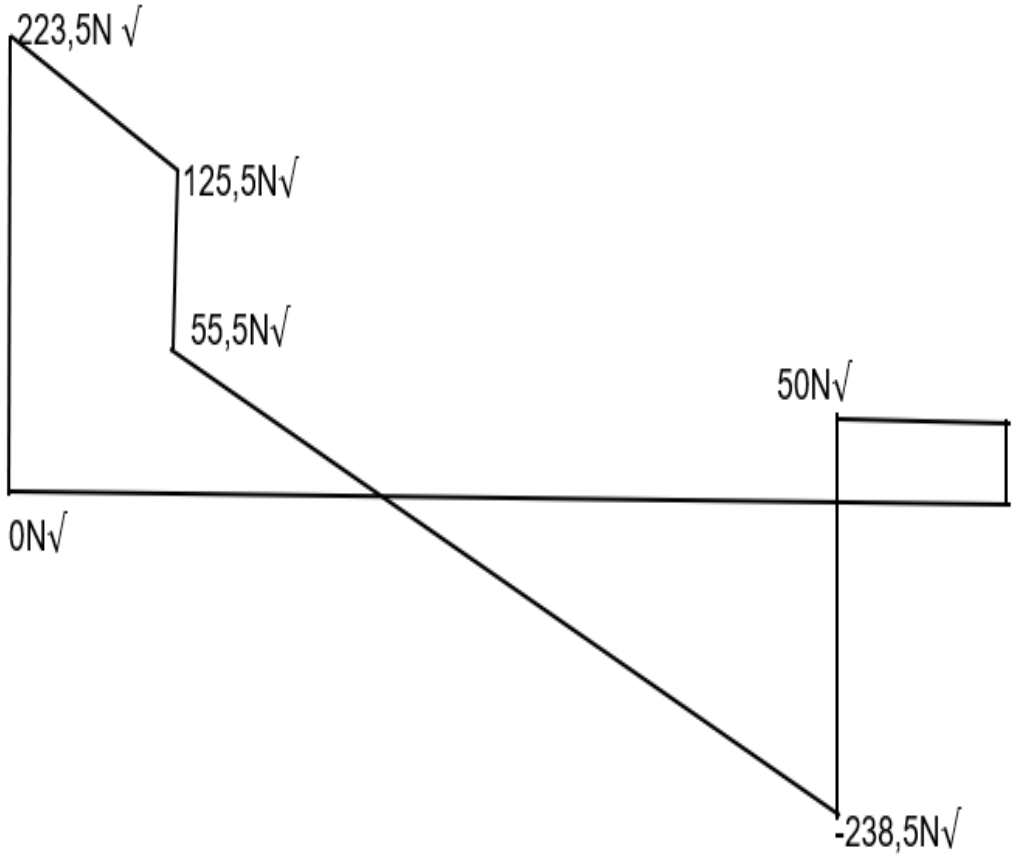
8C = 70 × 2 + 392 × 4 + 50 × 12✓
8C =2308 N
C= 288,5 N✓

Taking moments about C

$$\sum clockwise\ moments = \sum anticlockwise\ moments$$

8A + 50 × 4 = 392 × 4 + 70 × 6✓
8A = 1988 – 200
A = 223,5 N✓ (4)

2.2.3



1 mark for correct diagram
½ mark for each correct point in the diagram (4)
[12]

QUESTION 3

3.1 Vector forces form a closed triangle
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)

3.2 C (1)

3.2.1 $\sum \text{Hx} = -100\cos 50° - \text{B}\cos 60° + \text{A} = 0$ (1)

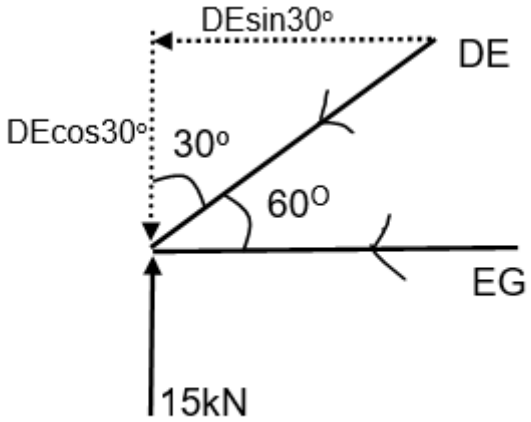
3.2.2 $\sum \text{Vy} = 80 - \text{B}\sin 60° + 100\sin 50° = 0$ (1)

3.2.3 $B\sin 60^0 = 100\sin 50 + 80$✓
$B = 180{,}831$ N✓
$A = 100\cos 50^0 + 180{,}831\cos 60^0$✓
$= 154{,}964$ N✓ (4)

3.2.4 Equilibrant = 0 N (1)

3.4.1 Reaction of each support = ½ load
= ½ × 30✓
A = B =15 kN✓ (2)

3.4.2



$\Sigma V_C = 0 = 15 - DE\ Cos30°$✓
DE = 17,321 kN (STRUT)✓

$\Sigma H_C = 0 = -DE\ Sin30° - EG$✓
EG = - 8,661 kN
= 8,661 kN (TIE)✓

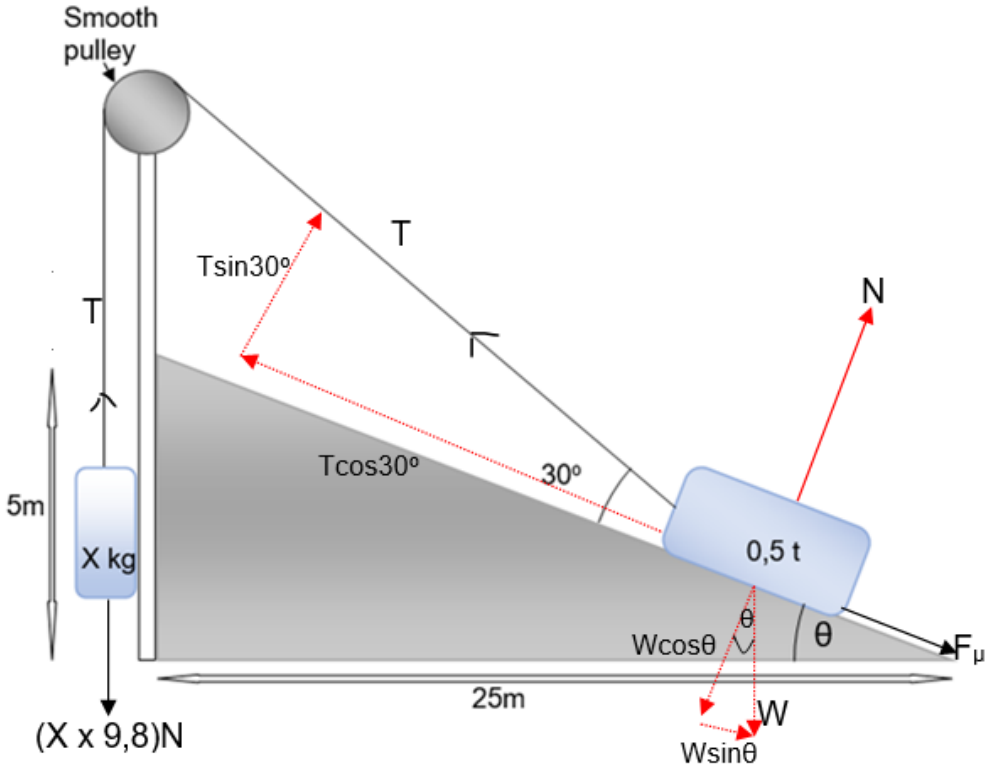
OR

Sin 60° = 15/DE
DE =17,321 kN, strut
Tan 60° = 15 /EG
EG = 8,661 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



$\mu = 0,25$

$F_\mu = \mu N = 0,25\ N$ ✓
$N = 4F_\mu$

$\theta = Tan^{-1}(5/25) = 11,3°$ ✓
$W = 500 \times 9,8 = 4900\ N$ ✓

Parallel to the plane: $T\cos30° = F_\mu + 4900\sin11,3°$
$F_\mu = T\cos30° - 960,136$ ✓ 1

Perpendicular to the plane: $N + T\sin30° = 4900\cos11,3°$
$4F_\mu + 0,5T = 4805,012$
$F_\mu = 1201,253 - 0,125\ T$ ✓ 2

Therefore: $T\cos30° - 960,136 = 1201,253 - 0,125\ T$
$T = 2180,962\ N$ ✓

$X \times 9,8 = 2916,754$
$X = 222,547\ kg$ ✓

(7)
[11]

QUESTION 5: HEAT

5.1 5.1.1 P = 900 kPa t = 250 °C

Superheated steam (1)

5.1.2 P = 2,5 MPa h = 2700 kJ/kg

Wet steam✓

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

$2700 = 962 + 1839x$✓

Therefore $= 0,945$✓ (3)

5.1.3 P = 9 MPa h = 2745 kJ/kg

Dry saturated steam (1)

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

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

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

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

$= 0,0119\ m^2$✓ (2)

5.2.3 Final area of the door due to temperature change:

$A_f = \Delta A + A_o$

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

$= 0,0119 + 2,475$✓

$= 2,487\ m^2$✓ (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

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

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

$t_2 = 176,556$ °C✓ (3)

[15]

QUESTION 6: HYDRAULICS

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

6.2 $P = \rho \times g \times h$

$= 1000 \times 9,8 \times 8$

$= 78,4$ kPa ✓

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

Work Done = Pressure × Volume

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

Therefore d = 0,115 m✓

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

(4)

6.3 6.3.1 The mass lifted by the hydraulic press.

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

$$f_p = f \times MA$$

$$f_p = 25 \times 18$$

$$f_p = 450N$$✓

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

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

$$F = 7938 \text{ N}$$✓

$$\text{Mass} = \frac{7938}{9,8} = 810 \text{ kg}$$✓

(3)

6.3.2 The distance moved by the ram after 60 working strokes

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

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

$= 0{,}136$m✓ (2)

[11]

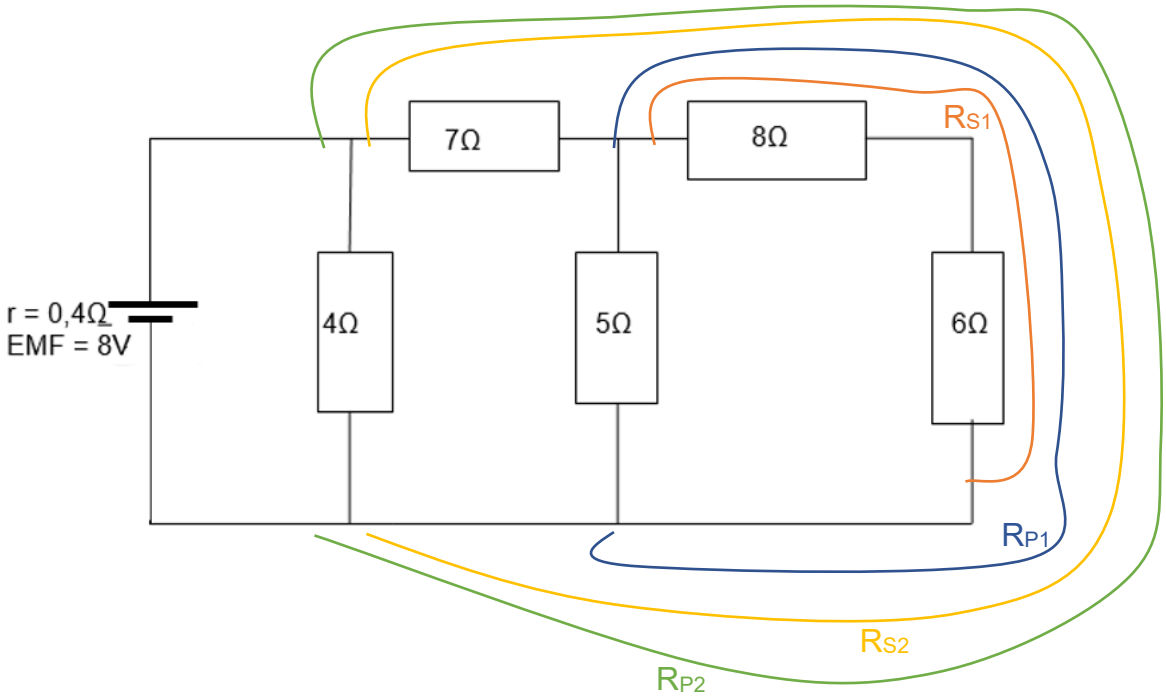
QUESTION 7: ELECTRICITY

7.1

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

(Any 1) (1)

7.2



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

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

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

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

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

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

7.2.3 Internal voltage drop = $I_T \times r$
$= 2,417 \times 0,4$
$= 0,9668$ V✓

$V_{4\Omega} = 8 - 0,9668$
$= 7,0332$V $= V_{RS2}\checkmark$

$I_{4\Omega} = \frac{7,0332}{4}$
$= 1,7583$ A✓

$I_{7\Omega} = 2,417 - 1,7583$
$= 0,6587$ A✓

$V_{7\Omega} = 7 \times 0,6587$
$= 4,6109$ V✓

$V_{5\Omega} = 7,0332 - 4,6109$
$= 2,4223$ V✓ (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]

TOTAL: 100