higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

7 April 2021

This marking guideline consists of 9 pages.

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QUESTION 1: MOTION, POWER AND ENERGY

1.1 1.1.1 (a) uniform
(b) unbalanced or external (2)

1.1.2 displacement (1)
1.1.3 Motion (1)
1.1.4 Momentum (1)

1.2 1.2.1
$s = \frac{v^2 - u^2}{2g}$ ✓
$= \frac{\mathbf{0^2 - (12)^2}}{\mathbf{2(-9.8)}}$ ✓
$= 7.347m$ ✓ (2)

1.2.2 $E_k = E_p$ ✓
$= mgh$
$= 7\text{x } 9{,}8\text{x}5$ ✓
$= 343J$ ✓ (3)

1.2.3 $E_k = E_p$
$0{,}5mv^2 = mgh$
$v = \sqrt{2x9{,}8x5}$ ✓
$= 9{,}9m/s$ ✓ (2)

1.3 1.3.1 $T = F\ x\ r$
$= 450\ x\ 0{,}2$ ✓
$= 90N.m$ ✓ (2)

1.3.2 $W = T\ x\theta$
$= 90\ x\ \frac{30}{57{,}3}$ ✓
$= 47{,}12J$ ✓ (2)
[16]

QUESTION 2: MOMENTS

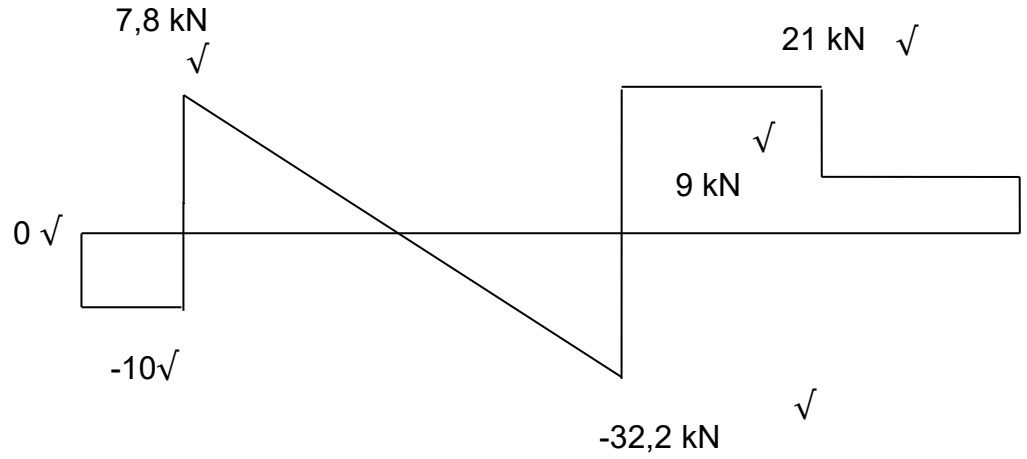
2.1 The force multiplied by the perpendicular distance ✓from the fulcrum to the line of action of the force.✓ (2)

2.2 2.2.1 Taking moment about B
Sum of the anticlockwise moment = sum of the clockwise moment
C × 5 + 10 × 2 = 40 × 2,5 +12 × 8 + 9 × 10 ✓
C × 5=100 + 96 + 90 – 20
C= 53,2 kN✓

Taking moments about C
Sum of the anticlockwise moments = sum of the clockwise moments
B × 5 + 12 × 3+ 9 × 5 = 40 × 2,5 + 10 × 7 ✓
5B = 100+70 – 36 - 45
B = 17,8 kN✓

Test
Upward force = Downward forces
B + C = 10 + 12 + 9 +40
17,8 + 53,2 = 71 kN✓
71 kN = 71 kN (5)

2.2.2



Correct shape = 1 mark (4)
[11]

QUESTION 3: FORCES

3.1
- The vectors of the forces form a closed triangle.
- The algebraic sum of the components of the forces in any direction is equal to zero.
- The algebraic sum of the moments of the forces about any point is equal to zero.
- The lines of action of the forces meet at a point.
- The forces or vectors are co-planar. (Any 3 × 1) (3)

3.2 Two or more forces acting on a point are in equilibrium when the point on which they are acting is at rest ✓or moving with constant velocity ✓ (2)

3.3
$$\Sigma F_L = \Sigma F_R$$
$$120\cos 50° + 160 + 100\cos 70 = Q\cos 35° \checkmark$$
$$77{,}135 + 160 + 34{,}2 = Q\cos 35 \checkmark$$
$$Q = 331.238\ N \checkmark$$

$$\Sigma F_{up} = \Sigma F down$$
$$W = Q\sin 35 + 100\sin 70 + 120\sin 50 \checkmark\checkmark$$
$$W = 185{,}895 + (331{,}459)(0{,}574) \checkmark$$
$$W = 376.027\ N$$

(7)

3.4 ∑ clockwise moments = ∑ anticlockwise moments

300 x 120✓ = 250 x F sin 60^0✓

36000 = 216,506 F✓

F = 166,277 N✓ (4)

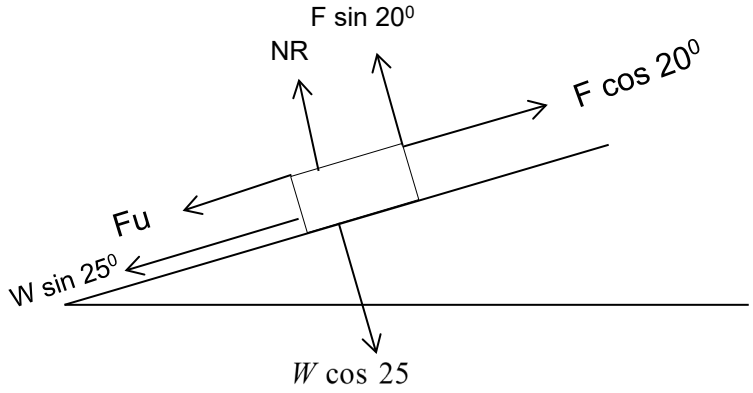
[16]

QUESTION 4: FRICTION

4.1
- Static friction opposes the initial movement.✓
  The forces required to move the object is called static friction.✓
- Kinetic friction opposes the force causing the movement after the body is in motion.✓
  The force required to keep the object in motion is called kinetic friction.✓

(2 × 2) (4)

4.2



$\sum \boldsymbol{f_{up}} = \sum F_{down}$ but W =1 600 × 9,8 =15 680 N

NR + $Fsin20^0$ =$Wcos25^0$ ✓
NR = Wco25⁰ – Fsin20⁰

$$\sum \boldsymbol{f_{left}} = \sum \boldsymbol{F_{right}}$$

F_u + Wsin25⁰ = Fcos20⁰ ✓

F_u = Fcos20 – Wsin25⁰

0,36 $= \frac{Fcos20^0 - Wsin25^0}{Wcos25^0 - Fsin20^0}$ ✓✓

$5115{,}926 - 0{,}123F = 0{,}94F - 6626{,}654$ ✓

1,063F =11742,58

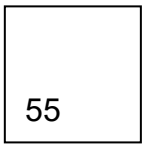
F =11,046 kN✓ (6)

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QUESTION 5: HEAT

5.1 $MxCx\Delta t = MxCx\Delta t$
$25 \times 4187 \times (t_2-t_1) = 9 \times 390 \times (t_3-t_2)$ ✓
$25 \times 4187 \times (t_2-22) = 9 \times 390 \times (200 - t_2)$ ✓
$104675 (t_2-22) = 3510 (200 - t_2)$
$104675t_2 - 2302850 = 702000 - 3510t_2$
$108185t_2 = 3004850$ ✓
$t_2 = 27.8$ °C ✓ (4)

5.2



$T_1 = 10$ °C
$\alpha = 20 \times 10^{-6}$
T2 – 100 °C

5.2.1 1 $\beta = 2 \times \alpha$
$= 2 \times 20 \times 10^{-6}$ ✓
$= 40 \times 10^{-6}$/°C (1)

5.2.2 $\Delta A = A_0 \times \beta \times \Delta t$
$= (55 \times 35)$ ✓ $\times 40 \times 10^{-6} \times (80 - 30)$ ✓
$= 3.85$ cm ✓ (3)

5.2.3 $\Delta L = \ell o \times \alpha \times \Delta t$
$= 55 \times 20\ 10^{-6} \times 50$
$= 0{,}055$ cm ✓
$L_F = Lo + \Delta L$
$= 55 + 0{,}055$
$= 55.055$ cm ✓
$\Delta L = \ell o \times \alpha \times \Delta t$
$= 35 \times 20\ 10^{-6} \times 50$
$= 0{,}035$ cm ✓
$L_F = Lo + \Delta L$
$= 35 + 0{,}035$
$= 35.035$ cm ✓ (4)

5.3 M = 1 kg
x = 0,83
Pr = 1100 × kPa

5.3.1 1100 kPa
Hf = 781kJ/kg

5.3.2 Hg = 2780 kJ/kg

5.3.3 Hfg = 1999 kJ/kg

(3 × 1) (3)
[15]

QUESTION 6: HYDRAULICS

6.1
- Centrifugal
- Rotary
- Reciprocating (Any 2 × 1) (2)

6.2 6.2.1 Volume = Area × stroke length × no of strokes × efficiency

$$= \frac{\pi(0,12)^2}{4} \times h \times 25$$

$$= \frac{\pi \times (0,12)^2}{4} \times 0,02 \times 25 \times 0,65$$

$$= 0,00368 \text{ m}^3$$

$$= 3,68 \text{ litres} \checkmark$$ (3)

6.2.2 $D^2 \times$ stroke length × no of strokes = $D^2 \times$ stroke length

$0,65 \times (0,12)^2 \times 0,02 \times 25 = (0,465)^2 \times$ stroke length ✓

$$H = 0,65 \times \frac{(0,012)^2 \times 0,2}{(0,465)^2} \checkmark$$

$$= 0,0216 \text{ m}$$ (2)

6.2.3 $$\frac{W}{D^2 \times (d)^2} = \frac{F}{}$$

$$W = \frac{F \times D^2}{d^2}$$

$$= \frac{360000 \times (0,465)^2}{(0,12)^2}$$

$W = 5405,625$ kN ✓

$$\text{Force} = W \times \frac{70}{100}$$

$= 5405.625 \times 0,7$ ✓

$= 3783.938$ kN (2)

6.2.4 $$MA = \frac{LOAD}{EFFORT}$$

$$E = \frac{L}{MA} = \frac{360}{8}$$

$= 45$ kN ✓

$$EFFORT = \frac{45 \text{ kN}}{0,7}$$

$= 64.286$ kN ✓ (2)

6.2.5 MA = LOAD/ EFFORT

= 360/64.286 ✓

= 5.6 ✓ (2)

[13]

QUESTION 7: ELECTRICITY

7.1 7.1.1

$$r = \frac{E}{I} - R$$

$$= \frac{4,5}{2} - 0,4 - 0,6 - 0,9 \quad ✓$$

$$= 0,35\,\Omega \quad ✓$$

7.1.2

$$V = IR$$

$$= 0.35X2 \quad ✓$$

$$= 0,7\ V \quad ✓$$

(2 × 2) (4)

7.2 7.2.1 Rated current (I):

$$I = \frac{P}{V}$$

$$= \frac{3,5 \times 10^3}{210} \quad ✓$$

$$= 16,67\ A \quad ✓$$ (2)

7.2.2 Resistance (R):

$$R = \frac{V}{I} \quad ✓$$

$$= \frac{210}{16,67} \quad ✓$$

$$= 12,6\ \Omega$$ (2)

7.2.3

$$I = \frac{V}{R}$$

$$= \frac{200}{12,6} \quad ✓$$

$$= 15,87\ A \quad ✓$$ (2)

7.2.4 1) T = 5 min ⟶ hours $\frac{5}{60}$

R 1,164 pk/Wh ⟶ = 0,833 h

P = 3,5 kW 3500 W ✓

Unit = kWh $= \frac{3\,500 \times 0,833}{1\,000}$

= 2,916 kWh ✓

Cost = unit × rate (cost)

=2,916 × 64 cents

= R1,86 ✓ (3)

[13]

QUESTION 8: CHEMISTRY

8.1 The amount of energy required to remove an electron from a central atom in the gaseous state (2)

8.2
- Humidity
- Soluble salts
- Oxygen
- Acidity
- Contact with bimetals
- The presence of crevices on the material (Any 4 × 1) (4)

[6]

TOTAL: 100

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