higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

23 November 2023

This marking guideline consists of 6 pages.

QUESTION 1: MOTION, POWER AND ENERGY

1.1 Uniform velocity is the constant rate of change of position, while average velocity is the rate of change of position over an interval.✓✓ (2)

1.2 1.2.1 5 m/s (1)

1.2.2 3 m/s^2 (1)

1.2.3 $S = ut + \frac{1}{2}at^2$
$= 5 \times 5 + \frac{1}{2}(3)(5)^2$✓
$= 62,5$ m✓ (2)

1.2.4 $EK = \frac{1}{2}mv^2$, but $v = 5 + 3 \times 5 = 20$ m/s✓✓
$= \frac{1}{2}(60)(20)^2$✓
$= 12\,000$ J **OR** 12 kJ✓ (4)

1.2.5 $P = m(v - u)$
$= 60(20 - 5)$✓
$= 900$ kg.m/s✓ (2)

1.3 1.3.1 $P = F_e \times v$
$36\,000 = F_e \times 20$✓
$Fe = 1\,800$ N✓

1.3.2 $Fe = T_1 - T_2$, but $T_1 = 12,5 \times 220 = 2\,750$ N

$T_2 = T_1 - Fe$
$= 2\,750 - 1\,800$✓
$= 950$ N✓

(2 × 2) (4)
[16]

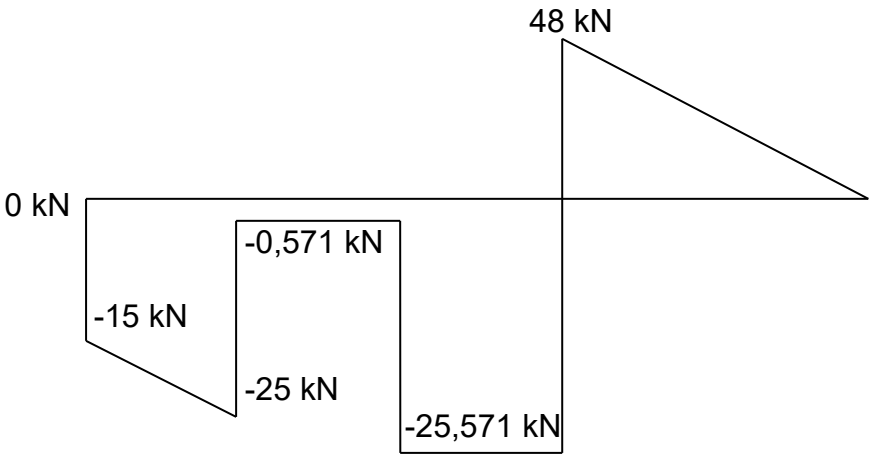
QUESTION 2: MOMENTS

2.1 A system of forces is in equilibrium when the sum of the anticlockwise moments equals the sum of the clockwise moments about the same turning point. (1)

2.2 2.2.1 Moments about B:
$\sum ACW = \sum CW$
$10 \times 1 + 15 \times 2 + 7D = 25 \times 3 + 48 \times 10$✓✓
$7D = 515$
$D = 73,571$ N✓

Moments about D:
$\sum ACW = \sum CW$
$25 \times 4 + 10 \times 8 + 15 \times 9 = 48 \times 3 + 7B$✓✓
$7B = 171$
$B = 24,429$ kN✓ (6)

2.2.2



(½ for each correct point value + 2 for correct diagram) (5)
[12]

QUESTION 3: FORCES

3.1 Single force that keeps other forces at equilibrium (1)

3.2 3.2.1 Hc = -25 + 35 + 20cos40°✓
= 24,142 kN; east✓

Vc = 100 – 60 + 20sin45°✓
= 54,142 kN; north✓ (6)

3.2.2 $R^2 = 24{,}142^2 + 54{,}142^2$✓ but $\alpha = \tan^{-1}(54{,}142/24{,}142) = 66°$✓
R = 59,281 kN; N 24° E✓✓ **OR** E 66° N (4)

3.2.3 E = 59,281 kN, S 24° W✓ **OR** W 66° S (1)
[12]

QUESTION 4: FRICTION

4.1 The maximum angle that may be reached between an inclined plane and a horizontal plane before a body starts moving freely down the incline✓✓ (2)

4.2 4.2.1 Qcos20° (1)

4.2.2 Fs = Wsin30°
= 50 × 9,8sin30°✓
= 245 N✓ (2)

4.2.3 Fc = Wcos30°
= 50 × 9,8 × cos30°✓
= 424,352 N✓ (2)

4.2.4 $Fn = W\cos30° – Q\sin20°$
$= 424,352 – Q\sin20°$✓
$F\mu = Q\cos20° – W\sin30°$✓

$\mu = F\mu/Fn$
$0,36 = (Q\cos20° – 245)/(424,352 – Q\sin20°)$✓✓
$152,767 – 0,123Q = 0,94Q – 245$
$397,767 = 1,062Q$
$Q = 374,545N$✓ (5)
[12]

QUESTION 5: HEAT

5.1 Two materials at different temperatures will give off heat to each other to a point where they will reach the same temperature.✓✓ (2)

5.2 $H_{gain} = H_{lost}$
$15 \times 4\ 187\ (t_2 – 25) = 72 \times 390 \times (200 – t_2)$✓✓
$62\ 805t_2 – 1\ 570\ 125 = 5\ 616\ 000 – 28\ 080t_2$
$90\ 885t_2 = 7\ 186\ 125$✓
$T_2 = 79,068\ °C$✓ (4)

5.3 5.3.1 $\Delta T = 45,5 – 25$
$= 20,5\ °C$✓
$= 20,5\ K$✓ (2)

5.3.2 $\Delta H = H_o \times \alpha \times \Delta T$
$= 2,4 \times 23 \times 10^{-6} \times 20,5$✓
$= 0,0011316\ m$✓
$= 1,1316\ mm$✓ (3)

5.3.3 $\Delta W = Wo \times \alpha \times \Delta T$
$= 1,4 \times 23 \times 10^{-6} \times 20,5$✓
$= 0,00066\ m$✓
$= 0,066\ cm$✓ (3)
[14]

QUESTION 6: HYDRAULICS

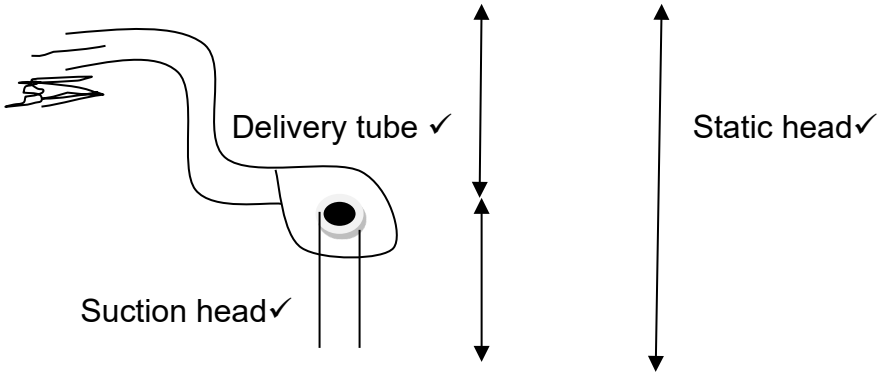
6.1 If pressure is applied at any point of an incompressible liquid, the same pressure is transmitted to all points of the liquid and the wall of the container. (1)

6.2 $F/D^2 = f/d^2$
$F/f = 0,6^2/0,24^2$✓✓
$F/f = 6,25$✓ **OR** 6,25:1 (3)

6.3 6.3.1 $W = f \times d$, but $f = mg$ and $m = pv$; $v = \pi d^2/4 \times h$
$= p \times g \times (\pi d^2/4 \times h) \times d$✓
$= 1\,000 \times 9{,}8 \times \pi \times 15^2/4 \times 5 \times 4{,}5$✓
$= 38\,965\,566{,}38$ J✓
$= 38{,}966$ MJ✓ (4)

6.3.2 $P = W/t$
$= 38\,965\,566/(6 \times 60 \times 60)$✓✓ (1 mark for conversion)
$= 1\,803{,}961$ W **OR** 1,804 kW✓ (3)

6.4



(3)
[14]

QUESTION 7: ELECTRICITY

7.1
- Stepping up and down voltage and current
- Cost effective
- Simple working and construction
- No moving parts and starting time
- Provides isolation to ground (Any 3 × 1) (3)

7.2 7.2.1 $Q = VIt$
$I = 100\,000/(210 \times 5 \times 60)$✓✓ (1 mark for conversion and substitution)
$= 1{,}587$ A✓ (3)

7.2.2 $R = V/I$
$= 210/1{,}587$✓
$= 132{,}325\ \Omega$✓ (2)

7.3 7.3.1 Is:Ip 0,8:8✓ 1:10✓

7.3.2 $Np/Ns = Ip/Is$
$Ns = 300 \times 8/0{,}8$✓
$= 3\,000$ turns✓

7.3.3 $Np/Ns = Vp/Vs$
$Vs = 3\,000 \times 220\ /300$✓
$= 2\,200$ V✓

(3 × 2) (6)
[14]

QUESTION 8

8.1 Pure substance that cannot be broken down into a simpler substance by chemical bonds (1)

8.2
- Humidity
- Soluble salts
- Oxygen
- Acidity
- Bimetallic contacts
- Crevices
- pH value
- Temperature (Any 4 × 1) (4)

8.3 H_2O_2 (1)
[6]

TOTAL: 100