higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

AUGUST EXAMINATION

ENGINEERING SCIENCE N3

1 AUGUST 2013

This marking guideline consists of 11 pages.

QUESTION 1: MOTION, POWER AND ENERGY

1.1 A scalar possesses magnitude only, while a vector possesses both magnitude and direction.✓ (1)

1.2 Distance is the total distance travelled along a route, while displacement is the straight line distance from the point where the travelling started to the point where travelling ended. ✓ (1)

1.3 1.3.1 $E_k = ½ \times m \times V^2$

$E_k = 0,5 \times 1\,900 \times (15,278)^2$ ✓

$E_k = 221\,746,419$ J

$E_k = 221,746$ kJ ✓ (2)

1.3.2 $V = U + at$

$$a = \frac{V - U}{t}$$

$$a = \frac{15,278 - 0}{25}$$

$a = 0,611$ m/s^2 ✓✓

$$s = \frac{V^2 - U^2}{2a}$$

$$s = \frac{(15,278)^2 - (0)^2}{2 \times 0,611}$$

S = 191,013 m ✓✓ (4)

1.3.3 h = Sin Ø x incline length

h = Sin18° x 191,013

h = 59,026 m ✓

Ep = m.g.h

Ep = 1 900 x 9,8 x 59,026 ✓

Ep = 1 099 064,12 J

Ep = 1 099,064 kJ ✓ (3)

1.3.4 F_a = m x a

F_a = 1 900 x 0,611 ✓

F_a = 1 160,9 N ✓ (2)

1.3.5 V = U + at

$$t = \frac{V - U}{a}$$

$$t = \frac{25 - 0}{0,611} \checkmark$$

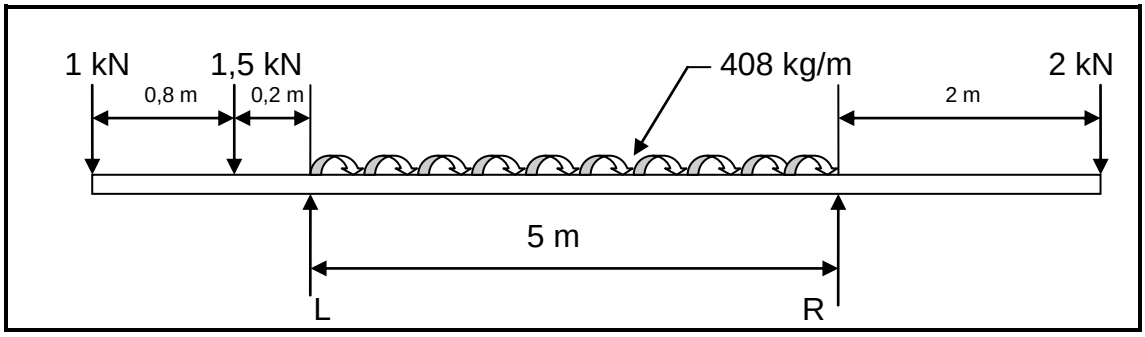
t = 40,917 sec ✓ (2)
[15]

QUESTION 2: MOMENTS

2.1 A uniformly distributed load is a load that is spread evenly over the length of a beam, ✓ or over a part of the length of a beam. ✓ (2)

2.2 An oblique force is a force that works at an angle on a turning point. ✓ The oblique force must always be converted to a perpendicular component. ✓ (2)

2.3



2.3.1 Taking moments about L

∑Anti-clockwise moments = ∑ clockwise moments

R x 5 + 1 x 1 + 1,5 x 0,2 = 20 x 2,5 + 2 x 7 ✓

5R + 1 + 0,3 = 50 + 14

5R = 64 – 1,3

$R = \frac{62,7}{5}$

R = 12,54 kN ✓

↑F = ↓F

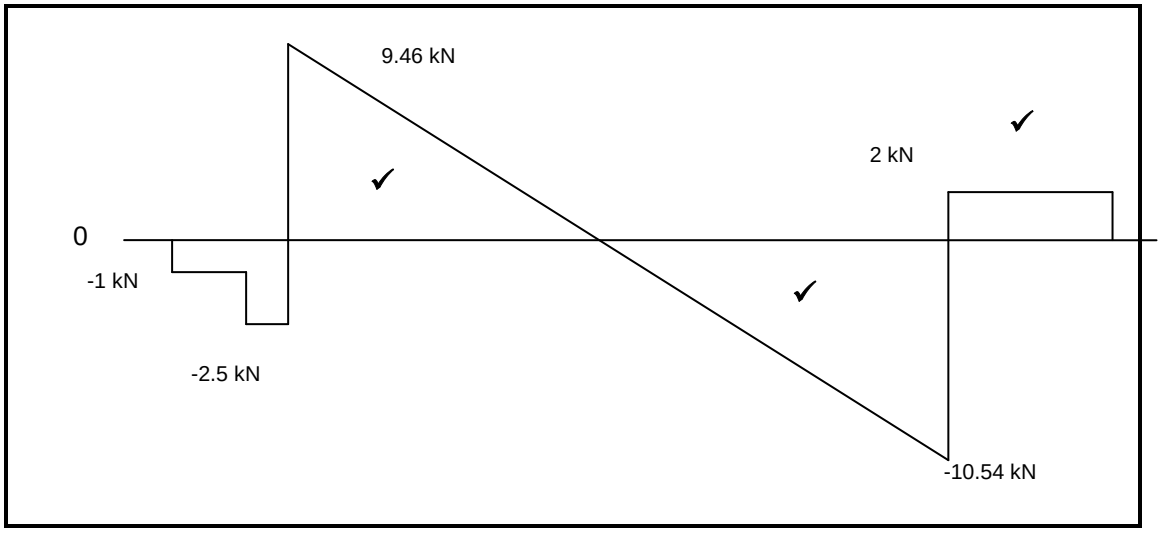
L + R = 1 + 1,5 + 20 + 2 ✓

L = 24,5 – R

L = 24,5 – 12,54

L = 11,96 kN ✓ (4)

2.3.2



(3)

2.3.3 Maximum 10,54 kN ✓
Minimum 9,46 kN ✓ (2)

[13]

QUESTION 3: FORCES

3.1 Equilibrium is when a body remains at rest when a number of forces acts upon it ✓, while equilibrant is that single force which will balance a system of forces. ✓ (2)

3.2 Tie ⟶⟵ Strut ⟵⟶

Pushing forces ✓ Pulling forces ✓ (2)

3.3 3.3.1 $\Sigma HC = 150 - 200 \text{ Cos } 50^0 + 120 \text{ Cos } 35^0$ ✓

$= 76,856$ N ✓ (2)

3.3.2 $\Sigma VC = 200 \text{ Sin } 50^0 - 120 \text{ Sin } 35^0$ ✓

$= 59,728$ N ✓ (2)

3.3.3 $R = \sqrt{(59,728)^2 + (76,856)^2}$

$= 97,336$ N ✓ (1)

3.4 $AE = 450/\sin 60^0$

$= 519.6$ kN (2)

$ED = 450/\text{Tan } 60^0$

$= 259.8$ kN (2)

$CG = 550/\text{Sin } 60^0$

$= 635.09$ kN (2)

QUESTION 4: FRICTION

4.1
- Friction depends on the nature of the surfaces in contact ✓
- Independent of the speed ✓
- Independent of the size of the area in contact ✓
- Is proportional to the perpendicular force between the surfaces ✓ (4)

4.2 4.2.1 $F \times \cos \alpha = W \times \text{Sin } Ø + \mu(W \times \cos Ø - F \times \sin \alpha)$

$F \times 0{,}966 = 1\,200 \times 9{,}8 \times \text{Sin}30° + 0{,}3(1\,200 \times 9{,}8 \times \text{Cos}30° - 0{,}259F)$ ✓

$0{,}966 \times F = 5\,880 + 0{,}3\,(10184{,}459 - 0{,}259 \times F)$

$0{,}966 \times F = 5\,880 + 3\,055{,}338 - 0{,}078 \times F$ ✓

$0{,}966 \times F + 0{,}078 \times F = 8\,935{,}338$

$1{,}044 \times F = 8\,935{,}338$

$F = \frac{8\,935{,}338}{1{,}044}$ ✓

$F = 8\,558{,}753$ N or 8,559 kN ✓ (4)

4.2.2 $\text{Cos } \alpha = \frac{a}{h}$

$A = \cos \alpha \times h$ ✓

$F = \text{Cos } 15° \times 8\,558{,}753$ ✓

$F = 8\,267{,}117$ N or 8,267 kN ✓ (3)

[11]

QUESTION 5: HEAT

5.1 $Q_{steel} = Q_{oil}$

$m \times c \times \Delta t = m \times c \times \Delta t$

$6 \times 500 \times (t_3 - t_2) = m \times c \times (t_2 - t_1)$ ✓

$3\,000 \times (210 - t_2) = 9 \times 2\,000 \times (t_2 - 40)$

$630\,000 - 3\,000\,t_2 = 18\,000\,t_2 - 720\,000$ ✓

$630\,000 + 720\,000 = 18\,000\,t_2 + 3\,000\,t_2$

$1\,350\,000 = 21\,000\,t_2$

$t_2 = \frac{1\,350\,000}{21\,000}$ ✓

$t_2 = 64{,}286\ °C$ ✓ (4)

5.2 5.2.1 $\Delta t = t_2 - t_1$

$\Delta t = 80 - 10$

$\Delta t = 70\ °C$ ✓ (1)

5.2.2 Heat energy = m x c

Heat energy = 30 x 15 ✓

Heat energy = 450 MJ ✓ (2)

5.2.3 $Q = m \times c \times \Delta t$

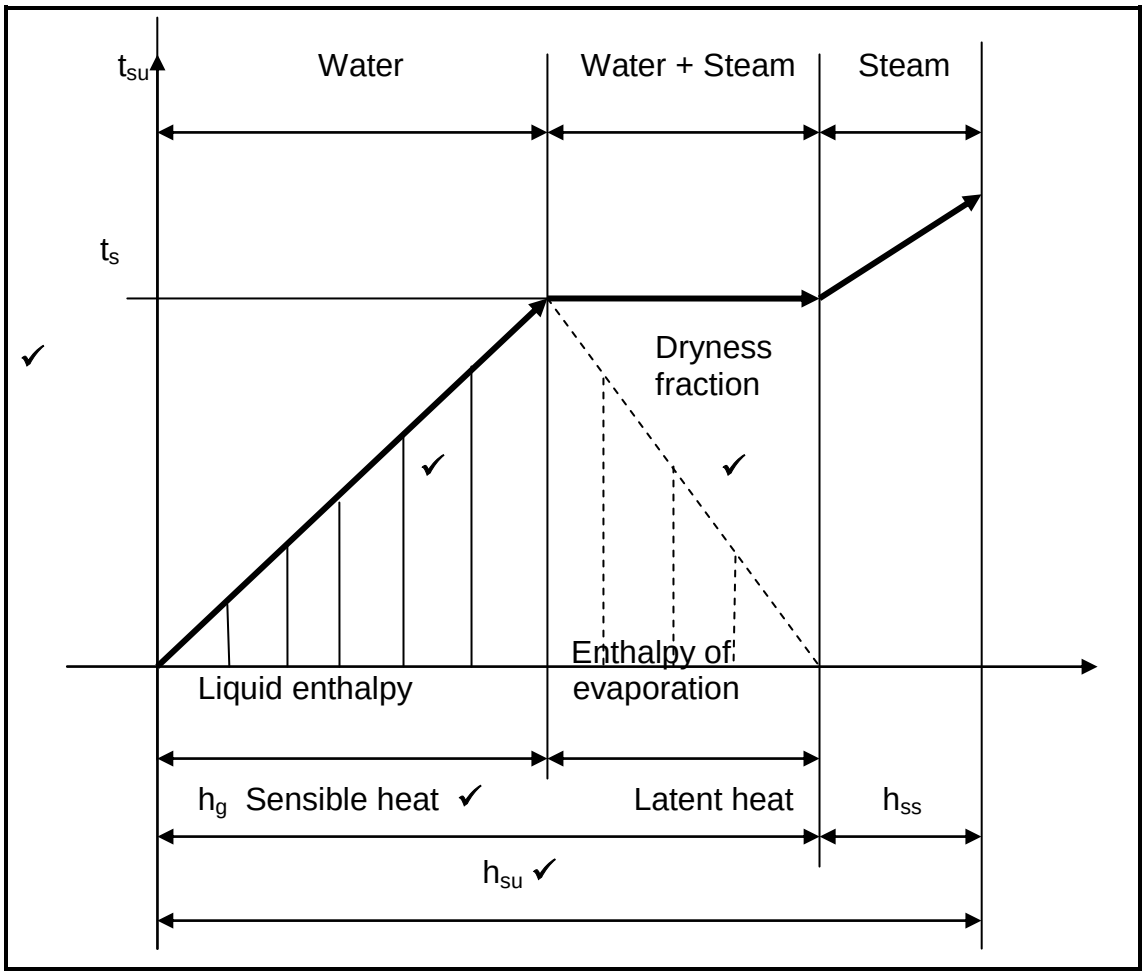
$m = \frac{Q}{c \times \Delta t}$

$m = \frac{450 \times 10^6}{4\,187 \times 70}$ ✓

M = 1 535,365 kg ✓

Volume = 1,535 m^3 ✓ (3)

5.3



(5)
[15]

QUESTION 6: HYDRAULICS

6.1
- Experiment to show that pressure in a liquid is directly proportional to depth
- Experiment to show upward and downward pressure at a point in liquid
- Experiment on the relationship between directional pressure in a liquid
- Experiment to show that pressure in a liquid is independent of the shape and size of the container

(Any 2 × 1) (2)

6.2 6.2.1 Area = $\frac{\pi d^2}{4}$

Area = $\frac{\pi \times (0{,}182)^2}{4}$

Area = 0,026 m^2 ✓

Pressure = $\frac{\text{Force}}{\text{Area}}$

Pressure = $\frac{6\,800}{0{,}026}$

Pressure = 26 1538,462 Pa or 261,538 kPa ✓ (2)

6.2.2 Volume = area x stroke length x strokes

Volume = 0,026 x 0,192 x 10 ✓

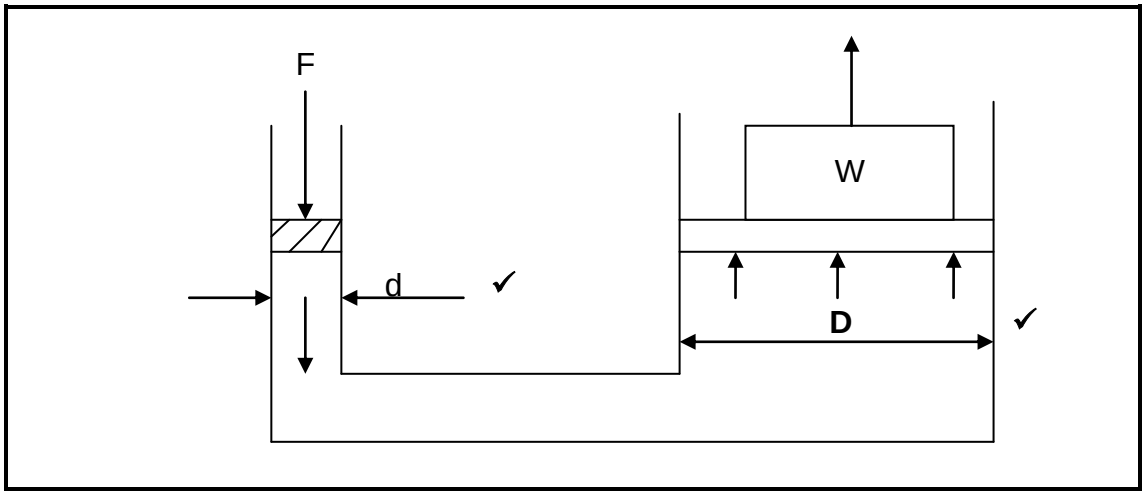
Volume = 0,04992 m^3 ✓ (2)

6.2.3 Work done = force x distance x number of strokes

Wd = 6 800 x 0,192 x 10 ✓

Wd = 13 056 J or 13,06 kJ ✓ (2)

6.3



The smaller piston (plunger) is used to apply force to the liquid and the larger piston (ram) is pushed upwards by the pressure of the liquid. ✓ (3)

[11]

QUESTION 7: ELECTRICITY

7.1 The mass of a given substance liberated at an electrode of a cell is directly proportional to the quantity passed through the cell. ✓ (1)

7.2 Electroplating occurs when an electric current is used to deposit pure metals on a negative electrode when salts of this metal are in solution in the electrolyte. ✓ (1)

7.3 7.3.1 $\frac{1}{R_p} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_p} = \frac{1}{2} + \frac{1}{3}$

$\frac{1}{R_p} = 0,5 + 0,333$ ✓

$\frac{1}{R_p} = 0,833$

$R_p = 1,2\ \Omega$ ✓

$R_T = 0,3 + 1,2 + 0,8 + 1 + 0,2$ ✓

$R_T = 3,5\ \Omega$ ✓ (4)

7.3.2 $I = V/R_T$

$I = \frac{12}{3,5}$ ✓

$= 3,429$ A ✓ (2)

7.3.3 $V = I \times R$

$V = 3,429 \times 1$ ✓

$V = 3,429$ V ✓ (2)

7.3.4 $V = IR$

$V = (3,429)(1,2)$

$V = 4,115\ V$ ✓✓

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

$I = \frac{4,115}{2}$

$I = 2,058\ A$ ✓✓ (4)

[14]

QUESTION 8: CHEMISTRY

8.1
- Atoms have a central core surrounded by electrons.
- The core exists of positive charged protons and uncharged neutrons (neutral).
- The core as a whole is positively charged and the magnitude of this charge is different for different elements.
- An electron has an equal but opposite (negative) charge to the proton.
- In a neutral atom the number of electrons are equal to the number of protons in the core
- The mass of the atom is situated totally in the core.
- The volume of the atoms is mainly contributed by the electrons.
- The mass of the proton is approximately equal to the hydrogen atom; the mass of the neutron is approximately equal to that of the proton; it is known as 1 unit (1μ); the mass of the electron is minimal.

(Any 3 × 1) (3)

8.2
- Not very hard
- Low melting point
- Inclined to form sulphate
- Inclined to form electrodes under extraordinary current conditions

(Any 3 × 1) (3)

[6]

TOTAL: 100