higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N3

28 July 2021

This marking guideline consists of 8 pages.

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QUESTION 1: MOTION, POWER AND ENERGY

1.1 Speed is the rate at which a distance is travelled. (1)

1.2 Energy cannot be created or destroyed but can be changed from one form to another. (1)

1.3 1.3.1
$$a = (v - u)/t$$
$$= (15 - 6)/20 \checkmark$$
$$= 0{,}45 \text{ m/s}^2 \checkmark$$ (2)

1.3.2
$$S = ut + 0{,}5at^2$$
$$= 6 \times 20 \checkmark + 0{,}5\ (0{,}45)(20)^2 \checkmark$$
$$= 210 \text{ m} \checkmark$$ (3)

1.3.3
$$F_S = F\sin\Omega$$
$$= 5 \times 9{,}8 \times \sin 25° \checkmark$$
$$= 20{,}708 \text{ N} \checkmark$$

$$W = F \times s$$
$$= 20{,}708 \times 210 \checkmark$$
$$= 4\ 348{,}68 \text{ J} \checkmark$$ (4)

1.3.4
$$W = F \times d$$
$$= 45 \times 210 \checkmark$$
$$= 9\ 450 \text{ J} \checkmark$$ (2)

1.3.5
$$F_{up} = 45 + 20{,}798 = 65{,}708 \text{ N} \checkmark$$

$$W = (F \times d)/t$$
$$= (65{,}708 \times 210)/20s$$
$$= 689{,}934 \text{ W} \checkmark$$ (2)

[15]

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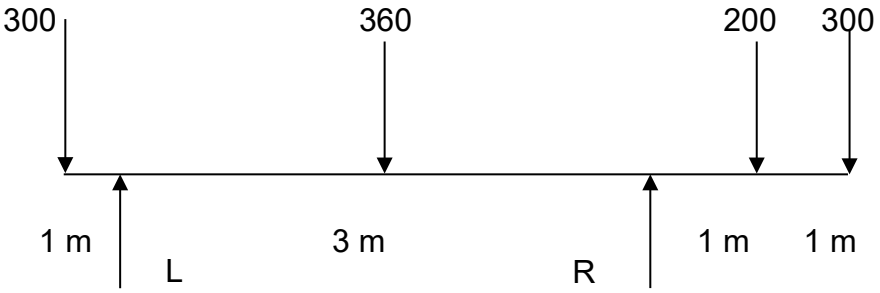
QUESTION 2: MOMENTS

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 A system is in equilibrium when the sum of the clockwise moments about any turning point equals✓ the sum of the anticlockwise moments about the same turning point.✓ (2)

2.3 2.3.1



Taking moments about L:

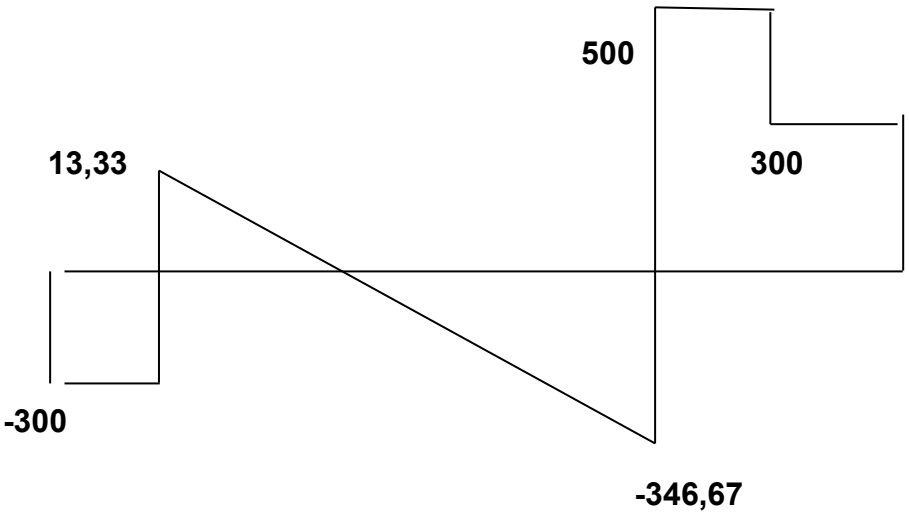
∑anticlockwise moments = ∑ clockwise moments

$F_{load} = 12{,}243 \times 9{,}8 = 120\ \text{N/m}$
$3R + 300 \times 1 = 360 \times\ 1{,}5 + 200 \times 4 + 300 \times 5$
$3R = 2\ 540$
$R = 846{,}67\ \text{N}$

Moments about R:

$L \times 3 + 200 \times 1 + 300 \times 2 = 360 \times 1{,}5 + 300 \times 4$
$3L = 940$
$L = 313{,}33\ \text{N}$ (4)

2.3.2



(½ mark for each value including the zero point) (3)

2.3.3 Maximum shear force = 346,67
Minimum shear force = 13,33 (2)

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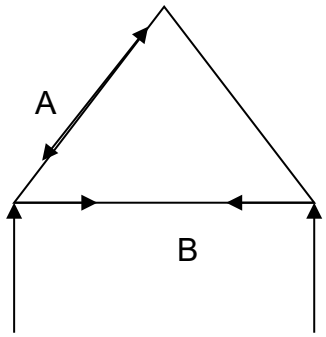
QUESTION 3: FORCES

3.1
- Same magnitude
- Measured in newton (2)

3.2



B = Tie
Pushing forces✓

A = Strut
Pulling forces✓ (2)

3.3 3.3.1 $\Sigma HC = 0$

$= 400\cos 40° + 200\cos 50° - 650$✓

$= -215{,}025$ N✓ (2)

3.3.2 $\Sigma VC = 0$

$= 400\sin 40° - 200\sin 50°$✓

$= 103{,}906$ N✓ (2)

3.3.3 $R = \sqrt{(103{,}906)^2 + (215{,}025)^2}$

$= 238{,}814$ N✓ (1)

3.4 $AE = 45/\sin 60°$✓

$= 51{,}96$ kN✓

$ED = 45/\tan 60°$✓

$= 25{,}98$ kN✓

$CG = 55/\sin 60°$✓

$= 63{,}509$ kN✓ (6)

[15]

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QUESTION 4: FRICTION

4.1
- Dependent on the nature of the surfaces in contact
- Independent of the speed
- Independent of the size of the area in contact
- Proportional to the perpendicular force between the surfaces (4)

4.2.1
$W = 2\,460 \times 9{,}8 = 24\,108\ N$
$Fu = W\sin 20° + F\cos 25°$✓
$N = W\cos 20° - F\sin 25°$ ✓

$0{,}46\ (W\cos 20° - F\sin 25°\ ) = W\sin 20° + F\cos 25°$✓
$0.46(22654.109 - 0.423F) = 0.906F + 8245.422$
$10420.89 + 0{,}195F = 0{,}906F + 8245.422$
$2175.468 = 1.101F$
$F = 1975.902\ N$✓ (4)

4.2.2
- Frictional forces enable a motor car to brake, as a result of friction between the brake pads and brake discs
- Frictional forces enable a racing car to corner at high speed as a result of friction between road and tyres
- Transfer of power is possible by means of clutches and belts
- Frictional forces enable a car to move due to friction between the tyres and the road
- Frictional forces allow a gymnast to climb a rope due to friction between the rope and the hands of the gymnast

Any 3 x 1 (3)

[11]

QUESTION 5: HEAT

5.1
$Q_{steel} = Q_{oil}$
$m \times c \times \Delta t = m \times c \times \Delta t$
$3 \times 500 \times (180 - t_2)$✓ $= 7{,}01 \times 2\,000 \times (t_2 - 50)$✓
$270\,000 - 1\,500\ t_2 = 14\,020\ t_2 - 701\,000$✓
$971\,000 = 15\,520\ t_2$
$t_2 = 62{,}56\ °C$✓ (4)

5.2 5.2.1
$\Delta t = t_2 - t_1$
$\Delta t = 540 - 300$
$\Delta t = 240\ °C$✓ (1)

5.2.2
$\text{Heat energy} = m \times c \times t$
$= (0{,}240 \times 1\,000)$✓ $\times\ 4\,187 \times (240)$✓
$= 241{,}171 MJ$✓ (3)

5.2.3
$E = m \times Hv$
$241{,}171\ MJ = m \times 30\ MJ$✓
$M = 8{,}039\ \ell$✓ (2)

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5.3
- Steam can be used repeatedly
- Steam is reasonably cheap to produce from coal (fuel) and water
- Low grade fuel can be used to keep costs low
- A steam installation has a long life

Any 3 x 1 (3)

5.4
- A steam layout must be erected where water and coal is available
- Water is lost due to evaporation
- The initial cost of the installation is very expensive
- As a result of combustion the atmosphere is contaminated

Any 2 x 1 (2)
[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 a liquid
- Experiment to show 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

$$F/D^2 = f/d^2$$

$$D/d = \sqrt{F/f}\checkmark$$

$$D/d = \sqrt{580/125}\checkmark$$

$$D/d = 2{,}154{:}1\checkmark\checkmark$$ (4)

6.2.2

$$D = d \times 2{,}154$$
$$D = 0{,}0045 \times 2{,}154\checkmark$$
$$= 0{,}00969\ m\checkmark$$ (2)

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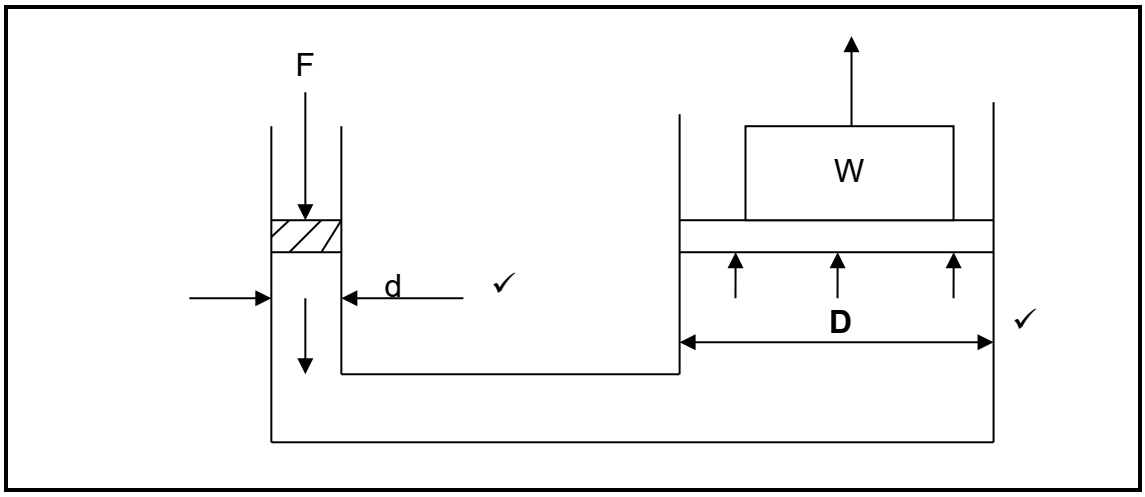
6.3



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 the substance released or deposited during electrolysis is proportional to the chemical equivalent of the element.✓ (1)

7.2 Electrolysis is the chemical separation of substance in an electrolyte by means of electric current (1)

7.3 7.3.1

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

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

$R_p = 1{,}2\ \Omega$✓

$R_T = 0{,}4 + 1{,}2 + 2 + 0{,}4 \times 3$✓✓

$R_T = 4{,}8\ \Omega$✓ (4)

7.3.2

$I = V/R_T$

$I = \frac{9}{4{,}8}$✓

$= 1{,}875\ A$✓ (2)

7.3.3

$V = I \times R$

$V = 1{,}875 \times 2$✓

$V = 3{,}75\ V$✓ (2)

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7.3.4 $V = IR$
$V = (1{,}875)(1{,}2)$✓
$V = 2{,}25\ V$✓

$I = \frac{V}{R}$
$I = \frac{2{,}25}{3}$✓
$I = 0{,}75\ A$✓ (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. (Any 3 × 1) (3)

8.2
- Calcium
- Carbon
- Oxygen (3)
[6]

TOTAL: 100

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