higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

NOVEMBER EXAMINATION

ENGINEERING SCIENCE N3

18 NOVEMBER 2013

This marking guideline consists of 10 pages.

QUESTION 1: MOTION, POWER AND ENERGY

1.1 If the point of application of a force moves in the direction in which the force acts, then work is done and the symbol is Joule (J)✓ whereas

Power is the rate of doing work and the symbol is Watts (W) ✓ (2)

1.2 When a constant force F acts for a certain time t on an object, ✓ the product Ft is called the impulse of the force for that time. ✓ (2)

1.3 1.3.1 The speed in km/h of the aircraft after the first 5 seconds

$v = u + at$

$v = 0 + 4 \times 5$ ✓

$v = 20$ m/s

$v = 72$ km/h ✓ (2)

1.3.2 The distance travelled by the aircraft at the end of 10 seconds

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

$s_1 = \frac{(20)^2 - (0)^2}{2 \times 4}$

$s_1 = 50$ m ✓

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

$s_2 = \frac{(50)^2 - (20)^2}{2 \times 6}$

$S_2 = 175$ m ✓

$s_T = s_1 + s_2$

$s_T = 50 + 175$

$s_T = 225$ m ✓

$v_2 = u + at$ $v_2 = 20 + 6 \times 5$ $v_2 = 50$ m/s✓

OR $s = ut + ½at^2$

$s_1 = (0)(5) + ½(4)(5^2)$

$s_1 = 50$ m

$s = ut + ½at^2$

$s_2 = (20)(5) + ½(6)(5^2)$

$s_2 = 100 + 75$

$s_2 = 175$ m

$s_T = s_1 + s_2$

$s_T = 50 + 175$

$s_T = 225$ m (4)

1.4 m = 200 000g = 200 kg✓

u = 0 v = 5m/s t = 10s Fμ = 90,165 N

$a = \frac{v - u}{t} = \frac{5 - 0}{10}$ ✓

a = 0,5m/s² ✓

$F_T = F_R + F\mu$

= m x a + Fμ

= 200 x 0.5 + 90,165 ✓

F_T = 190,165 N ✓ (5)

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QUESTION 2: MOMENTS

2.1 Lamina is a very thin plate where the very thin thickness of the plate is not taken into account for calculation purposes but only the area. ✓ Thus, we assume that a lamina has no mass. ✓ (2)

2.2 2.2.1 Moments about B

Σ clockwise moments = Σ anti-clockwise moments

(25 x 1,0) + (10 x 3) + 15 x 5,5 = 15 x 0,5 + 5E

25 + 30 + 82,5 = 7,5 + 5E

E = 26 kN ✓✓ (2)

Moments about E

Σ anti-clockwise moments = Σ clockwise moments

(25 x 4,0) + (10 x 2) + (15 x 5,5) = 15 x 0,5 + 5B

100 + 20 + 82,5 = 7,5 + 5B

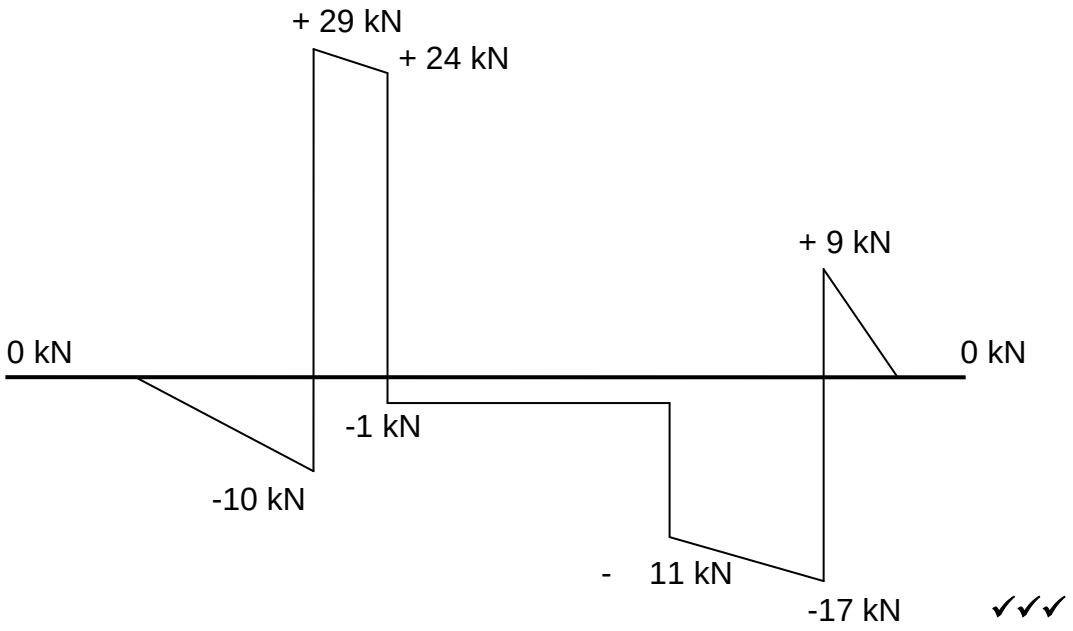
B = 39 kN ✓✓ (2)

Forces ↓ = Forces ↑

15 + 25 + 10 + 15 = 39 + 26

65 = 65 ✓ (1)

2.2.2



✓✓✓

(3)

2.2.3 The maximum shear force is -17 kN ✓
The minimum shear force is 29 kN ✓ (2)

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QUESTION 3: FORCES

3.1 The resultant of two or more forces is that single force which can replace or produce the same effects as the two or more forces ✓

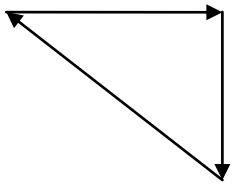
The equilibrant of two or more forces is that single force which will produce equilibrium, or balance the two or more forces. The equilibrant and resultant will have the same magnitude but acts in opposite directions to each other. ✓ (2)

3.2 3.2.1 $\Sigma F_x = 350\cos35° + 470\cos50° - 180\cos60°$

ΣF_x = 498,813 N East ✓✓✓ (3)

3.2.2 $\Sigma F_y = 350\sin35° - [470\sin50° + 180\sin60°]$

Σ Fy = 315,174 N South ✓✓✓ (3)

3.2.3 

$R = \sqrt{(498{,}813)^2 + (315{,}174)^2}$

$R = 590{,}042\ N$ ✓

$\text{Tan } \theta = \frac{315{,}174}{498{,}813}$

$\Theta = \tan^{-1}(0{,}632)$

$\Theta = 32{,}293^{\circ}$ ✓

$R = \underline{590{,}042\ N}; \underline{E\ 32{,}293^0\ S}$ ✓ (3)

3.3 $400 \times 150 = F\cos 45° \times 400$ ✓✓

$60\ 000 = 282{,}843 \times F$ ✓

$F = 212{,}132\ N$ ✓ (4)
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QUESTION 4: FRICTION

4.1 Driving of devices, components and machines example clutches
Bringing linear and rotational movement to a halt example brakes
Clamping a work piece in a vice
Clamping work pieces in a attachments and jigs **(**Any 3 × 1) (3)

4.2 4.2.1 $W.\ Cos\ \theta = 45 \times 9{,}8 \times \cos 16^0$
= <u>423,916</u> <u>N</u> ✓ (1)

4.2.2 $\mu = \frac{F\mu}{W\text{Cos}\theta^0}$

$= \frac{65N}{423.916}$ ✓

μ = 0,153 ✓ (2)

4.3 $F\mu = T\cos\theta$ $W = w - T\sin\theta$ and $F\mu = \mu W$

$T \times \cos\theta = \mu (w - T\sin\theta)$ ✓

$T \times \text{Cos } 22^0 = 0{,}36 (40\,000 \times 9{,}8 - T \text{ Sin } 22^0)$ ✓✓

$T \times 0{,}927 = 0{,}36 (392\,000 - 0{,}375T)$

$0{,}927T = 141120 - 0{,}135T$

$T = \frac{141120}{1{,}062}$ ✓

$T = \underline{132881{,}356}$ N ✓ (5)

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QUESTION 5: HEAT

5.1 $m_s = 10kg$ $v_w = 5l \rightarrow m_w = 5$ kg

Heat lost by steel = Heat gained by water

$Q_{lost} = Q_{gained}$

$m_s c_s (t_s - t_2) = m_w c_w (t_2 - t_w)$

$10 \times 500 \times (89 - t_2) = 5 \times 4187 (t_2 - 17)$ ✓✓

$5000 \times (89 - t_2) = 20\,935 (t_2 - 17)$

$445000 - 5\,000t_2 = 20935\, t_2 - 355895$

$25935t_2 = 800895$

$t_2 = 30{,}881$ °C ✓ (3)

5.2 d= 4,879 cm

$t_1 = 12\ °C$ $t_2 = 150\ ^0C$ $\Delta t = 138\ ^0C$

$$A_0 = \frac{\pi d^2}{4}$$
$$= \frac{\pi\ (4{,}879)^2}{4}$$
$A_0 = 18{,}696\ cm^2$ ✓

$\Delta A = A_0 x 2\alpha x \Delta t$

$= 18{,}696x2(54x10^{-6}) \times 138$ ✓

$\Delta A = 0{,}279\ cm^2$

$A_f = A_0 + \Delta A$

$= 18{,}696cm^2 + 0{,}279\ cm^2$ ✓

$A = 18{,}975\ cm^2$ ✓ (4)

5.3 h_{wet} =2465,563kJ and P = 2300kPa X = ?

h_f = 942 kJ/kg and h_{fg} = 1 858 kJ / kg

$h_{wet} = h_f + x.h_{fg}$

$$X = \frac{h_{wet} - h_f}{h_{fg}}$$

$$X = \frac{2465.563 - 942}{1\ 858}$$ ✓ ✓

X = 0,82 ✓ (3)

5.4 A copper plate on which is stamped the allowable steam and water pressures, the date that the boiler was first taken into service, and the dates of subsequent pressure test ✓

At least two safety valves ✓

Two pumps for pumping water into the boiler ✓

A steam pressure valve ✓

Two water level gauges to indicate the water level of the boiler ✓ (5)

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QUESTION 6: HYDRAULICS

6.1 6.1.1 V = 3000/ =3 m^3 h =100m t = 1 min

m = 3000 kg

Loss in EP = Gain in Ek

Ek = mgh

= 3000 x 9,8 x 100 ✓

Ek = <u>2,94</u> MJ ✓ (2)

6.1.2 $Power_{in} = \frac{W}{t}$

$= \frac{2,94 \times 10^6}{60}$

= 49 000 W ✓

$Power_{in}$ = 49kW

$Power_{out} = Power_{in} \times \eta$

= 49000 x $\frac{80}{100}$ ✓

= 39 200 W

= 3,92 kW ✓ (3)

6.2 D = 125 mm = 0,125m F = 1,2 ton = 1200 kg

d = 50mm = 0,05m H = 200mm = 0,2m

6.2.1 $\frac{f}{d^2} = \frac{F}{D^2}$

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

$f = \frac{1200 \times 9,8 \times (50)^2}{(125)^2}$ ✓

f = 1881,6 N ✓ (2)

6.2.2 $D^2 . h = d^2 . H$

$$h = \frac{d^2.H}{D^2}$$

$$= \frac{(50)^2 \times 200}{(125)^2} \quad ✓$$

h = 32 mm ✓ (2)

6.2.3 Wd = F x h x n

= 1200 x 9,8 x 0,032 x 10 ✓

Wd = 3763,2 J ✓ (2)

6.3 Suction head is the distance from the surface of the water to the centre of the pump ✓

Static head is the delivery head plus the suction head ✓ (2)
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QUESTION 7: ELECTRICITY

7.1 7.1.1 The total EMF of the battery = 6 V ✓ (1)

7.1.2 The total internal resistance of the battery = 3 x 0,15 = 0,45 Ω ✓ (1)

7.1.3 The total resistance of the circuit = 0,45 + 5 = 5,45 Ω ✓ (1)

7.1.4 The current flow in the circuit $I = \frac{V}{R} = \frac{6}{5,45} = 1,101$ A (1)

7.2 Electrical energy = V x I x t

= 220 x 9 x 180

= 356400 J ✓

= 0,356 MJ

Cost = tariff per kWh x number of kWh consumed

Cost = 85 x (0,356 x $\frac{1}{3,6}$) ✓

Cost = 8,406 cent ✓ (3)

7.3 m = I x t x ece

350 = 25 x t x 0,001118 ✓

t = 12522,361 sec ✓ (2)

7.4 7.4.1 The turns ratio primary to secondary

Np : Ns or Vp : Vs

240 : 60 ✓

Ratio is 40 : 1 ✓ (2)

7.4.2 The power if the power factor is 0,766

Power = VIcosθ

Power = VI(PF)

Power = 240 x 12 x 0,766 ✓

Power = 2206,08 Watts ✓ (2)
[13]

QUESTION 8: CHEMISTRY

8.1 Hydrochloric acid ✓
Sodium chloride = Salt ✓
Calcium carbonate ✓ (3)

8.2 Carbon C Oxygen O Chlorine Cl
Nitrogen N Sulphur S Hydrogen H
(Any 3 × 1) (3)
[6]

TOTAL: 100