higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

ENGINEERING SCIENCE N3

30 MARCH 2016

This marking guideline consists of 11 pages.

NOTE: ALTERNATE CORRECT ANSWERS MUST BE CONSIDERED.

QUESTION 1: MOVEMENT

1.1 1.1.1

$$V^2 = u^2 + 2as$$

$$a = \frac{v^2 - u^2}{2s}$$

$$a = \frac{(0)^2 - (20)^2}{2(50)}$$

$$= -4\ m/s^2$$

✓ Correct substitution

✓ Negative answer only (2)

1.1.2

$$v = u + at$$

$$t = \frac{v - u}{a}$$

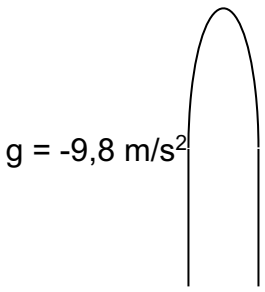
$$t = \frac{(0) - (20)}{-4}$$

$$= 5\ s$$

✓ Substitution

✓ Correct answer (2)

1.2 1.2.1



$$v = u + gt$$

$$u = v - gt$$

$$= (0) - (-9,8)(3)$$

$$= 29,4\ m/s$$

✓ u value

$$s = \frac{v^2 - u^2}{gt}$$

$$= \frac{(0)^2 - (29,4)^2}{-9,8(2)}$$

✓ Substitution

$$= 44,1\ m$$

✓ Correct answer (3)

1.2.2

$$s = 44,1 \times 2$$

$$= 88,2\ m$$

✓ Correct answer (1)

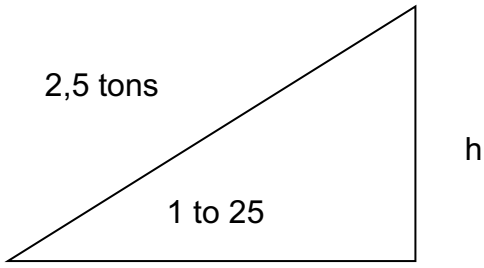
1.2.3 $u = v = 29,4\ m/s$ ✓ Correct answer (1)

1.3 $v = 55\ km/h \qquad \frac{55 \times 1\,000}{3\,600} = 12{,}278\ m/s$

$t = 3\ \text{min} \times 60 = 180\ s$

$u = 0\ m/s$

$m = 2{,}5 \times 1\,000 = 2\ 500\ kg$



1.3.1 $a = \frac{v - u}{t}$

$= \frac{15{,}277 - 0}{180}$ (✓) substitution

$= 0{,}085\ m/s$ (✓) Correct answer (2)

1.3.2 $E_K = \frac{1}{2}mv^2$

$= \frac{1}{2}(2\ 500)(15{,}277)^2$ (✓) substitution

$= 291\ 733{,}411\ J$ (✓) Correct answer (2)

1.3.3

S = ut + ½ at^2
= (0) (180) + ½ (0.085) (180)^2 (✓) s value
= 1377m

Ep = mgh (✓) Substitution

= 2500 (9.8) (1377/25)

(✓) Correct answer

= 1349460J

(3)
[16]

QUESTION 2: MOMENTS

2.1 A force is that influence which changes or tends to change the state of rest of a body.(✓) If the body is already moving, a force is that influence which brings the body to rest or changes the direction of the body.(✓) (2)

2.2 2.21 Taking moments about L:

Σ Anti-clockwise Moments = Σ Clockwise Moments

(R x 14) = (200 x 5) + (90 x 15) + (100 x 10)(✓)

E = 239,286 N(✓) (2)

Taking moment about R:

Σ Anti-clockwise moments = Σ Clockwise Moments

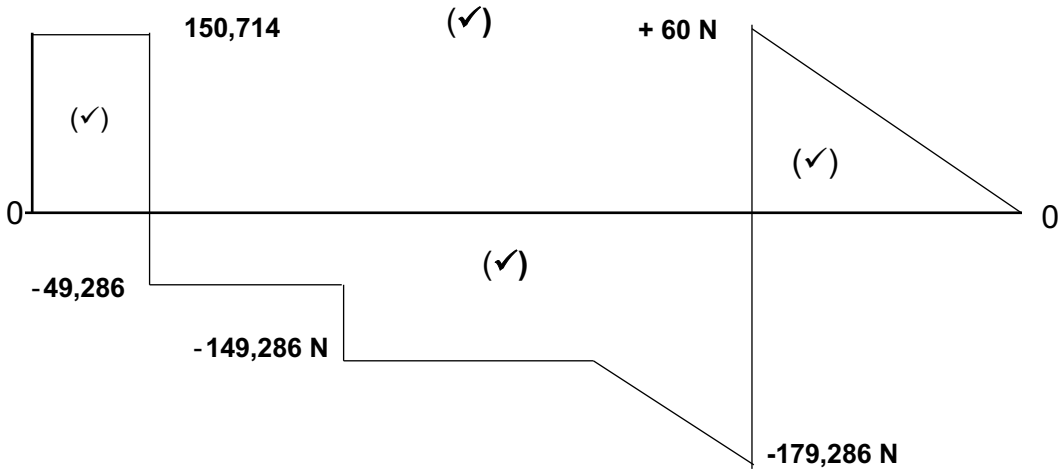
(100 x 4) + (200 x 9) = (L x 14) + (90 x 1)(✓)
L = 150,714 N (✓) (2)

Test:

Upward forces = Downward forces

239,286 +150,714 kN = 390 kN (✓) (1)

2.2.2



(4)

2.3 Cos ɵ x F x 5 m = 1,2 x 120 + 200 x 3,1 m

Cos30 x F x 5 = 144 + 620 (✓)

$F = \frac{764}{Cos30 \times 5}$

F = 176,443 N (✓) (2)

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QUESTION 3: FORCES

3.1 The equilibrant of a system of forces in the same plane(✓) is that single force which will balance the system of forces.(✓) (2)

3.2 HC = -150 + 216.506 + 141.421 = 207.927 N ✓
VC = 300 + 125 – 141.42 = 283.579 N ✓

$R = \sqrt{(207.927)^2 + (283.579)^2}$

$= \sqrt{123650.686}$

= 351.64 N ✓

$\text{Tan } \theta = \frac{283.579}{207.927}$

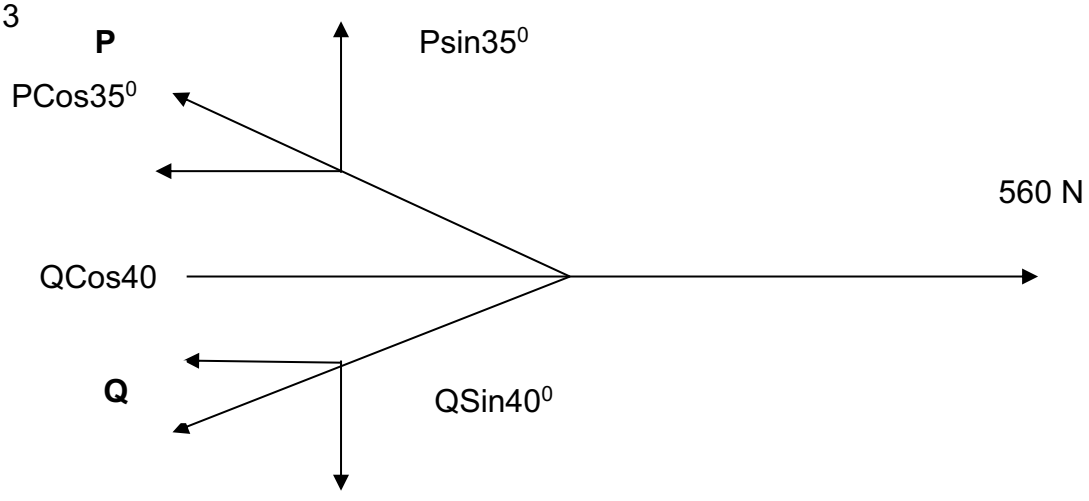
= 1.36

$\Theta = \text{Tan}^{-1} 1.36$

$= 53.67^0$

$= E\ 53.67^0$ N ✓ (4)

3.3



$V_C = \sum \downarrow F = \sum \uparrow F$

$P\,Sin\,35 = Q\,Sin\,40$ (✓) Substitution

$P = \dfrac{Q\,Sin\,40}{Sin\,35}$

$P = 1{,}1207\ Q$ ..... (1) (✓) Equation (1)

$\sum H \quad P\,Cos\,35 + Q\,Sin\,40 = 560$

$(1{,}1207Q)\,Cos\,35 + Q\,Sin\,40 = 560$ (✓) Substitution

$0{,}918\,Q + 0{,}766\,Q = 560$

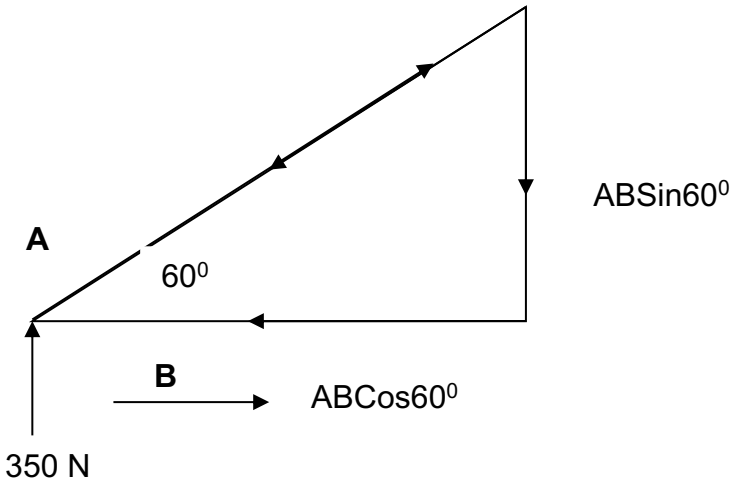
$Q = \dfrac{560}{1{,}684}$

$Q = 332{,}537\ N$ (✓) Value of Q

$P = \dfrac{295{,}82\ Sin\,40}{Sin\,35}$

$= 372{,}663\ N$ (✓) Value of P (5)

3.4



$\sum \downarrow F = \sum \uparrow F$

$AB\,Sin\,60^0 = 350$ (✓) Equation

$AB = \dfrac{350}{Sin\ 60^0}$

$= 404{,}145\,kN$ (✓) AB Value

$\sum \leftarrow F = \sum \rightarrow F$

$AB\,Cos\,60 = BC$

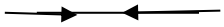
$404{,}145\,Cos\,60 = BC$

$BC = 202{,}225\ kN$ (✓) BC Value

Member	Magnitude	Nature
AB	404,145	Strut
BC	202,07	Tie

(✓) Nature

Strut 

Tie  (4)
[15]

QUESTION 4: FRICTION

4.1 Static friction opposes the initial movement. The force required to just move a body is called the static friction force.(✓)

Kinetic friction opposes the force causing the movement after the body is in motion.(✓) (2)

4.2
- Braking pads of vehicles, trains, lifts and aircraft
- Clutch engagement to transmit torque or power
- Drilling, cutting, turning made possible by friction between cutting surface and material.(✓) (Any 2 × 1) (2)

4.3

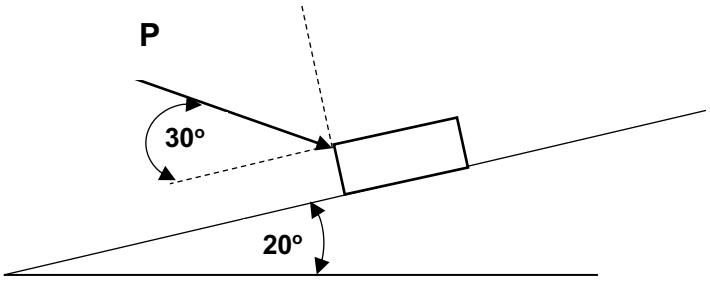


FIGURE 6

4.3.1 $F_{applied} = F\mu + W \times \sin\alpha$

$P \times \cos\theta = \mu(W \times \cos\alpha + P \times \sin\theta) + W \times \sin\alpha$ (✓)

$P \times \cos(30°) = 0,4(2\,500 \times \cos 20° + P \times \sin 30°) + 2\,500 \times \sin 20°$

$P \times 0,866 = 0,4(2500 \times 0,9397 - P \times 0,5) + 855,05$ (✓)

$P \times 0,866 = 939,7 - 0,2 \times P + 855,05$ (✓)

$P \times 0,866 - 0,2 \times P = 939,7 + 8379,494$ (✓)

$0,666 \times P = 1794,75$ (✓)

$P = 2694,82\ N$ (✓) (6)

4.3.2 $\tan = \mu$

$\mu = \tan^{-1} 0,4$

$= 21,8^0$ ✓ (1)

[11]

QUESTION 5: HEAT

5.1 Energy cannot be created or destroyed(✓) therefore heat gained is equal to heat lost by an object.(✓) (2)

5.2 $m = 45 \times 0,75 = 33,75$

$t_1 = 180\ ^0C$

$shc_{(STEEL)} = 500\ J/kg\ ^0C$

$m_{oil} = 1\ 500\ J/kg\ ^0C$

$t_2 = 20\ ^0C$

Heat lost by steel = Heat gained by oil

$m \times shc \times (T_2 - T_1) = m \times shc \times (T_3 - T_2)$ (✓)

$45 \times 0,75\ kg \times 500\ J/kg.°C \times (180 - T_2) = 5\ kg \times 1\ 500\ J/kg.°C \times (T_2 - 20)$

$16\ 875 \times (180 - T_2) = 7\ 500 \times (T_2 - 20)$ (✓)

$3\ 037\ 500 - 16\ 875 \times T_2 = 7\ 500 \times T_2 - 150\ 000$

$7\ 500\ T_2 + 16\ 875\ T_2 = 3\ 037\ 500 + 150\ 000$ (✓)

$24\ 375\ T_2 = 3\ 187\ 500$

$T_2 = 130,769\ °C$ (✓) (4)

5.3 $l = 19\ m$

$t_1 = 18\ ^0C$

$t_2 = 100\ ^0C$

$\alpha = 25 \times 10^{-6}/^0C$

5.3.1 $\Delta t = 100 - 18$
$= 82\ ^0C$ (✓) (1)

5.3.2 $\Delta\ell = \ell o \times \alpha \times \Delta t$
$\Delta\ell = 19 \times 25 \times 10^{-6} \times 82$ (✓)
$\Delta\ell = 0,03895$ m or 38,95 mm (✓) (2)

5.3.3 $L_F = \Delta\ell + \ell o$
$L_F = 0,03895 + 19$ (✓)
$L_F = 19,03895$ m (✓) (2)

5.4 5.4.1 h_f = liquid enthalpy

5.4.2 hf_g = enthalpy of evaporation

5.4.3 hg = enthalpy of dry steam

5.4.4 h_{su} = enthalpy of superheated steam

(4 × 1) (4)
[15]

QUESTION 6: HYDRAULICS

6.1 6.1.1 Hydraulics refers to the pressure(✓) and work done of fluids.(✓) (2)

6.1.2 Hydrostatics refers to fluids that are at rest. (1)

6.1.3 Fluidity is a fluid or a gas which has no form(✓) but takes up the form of a vessel in which it is captured.(✓) (2)

6.2 6.2.1 $Volume = 1,4 \times 10^{-3}\ m^3$
$F = 2,4\ kN$
$A = \pi(0,06)^2 \ \ or \ \ A = \frac{\pi d^2}{4}$ (✓) Area
$P_r = \frac{F}{A}$
$= \frac{2\ 400}{0,0113}$ (✓) Substitution
$= 212,2\ kPa$ (✓) Answer (3)

6.2.2 $$Stroke\ length = \frac{Volume}{Area}$$

$$= \frac{1{,}4\times10^{-3}\,m^3}{0{,}0113\,m^2}$$ (✓) Substitution

$$= 0{,}1238\ m\ or\ 123{,}8\,mm$$ (✓) Answer (2)

6.2.3 $$WD = P \times v$$

$$= 212\ 200 \times 1{,}4 \times 10^{-3}$$

$$= 297\ J/stroke$$ (2)

[12]

QUESTION 7: ELECTRICITY

7.1 Power factor ($\cos\alpha$) is the ratio of actual power or watts to volt amps.(✓)
The smaller the phase angle the higher the efficiency and vice versa.(✓) (2)

7.2 7.2.1 $$Rp = \frac{R_1 + R_2 + R_3}{R_1R_2 + R_1R_3 + R_2R_3}$$

$$= \frac{8 \times 5 \times 5}{8 \times 5 + 8 \times 5 + 5 \times 5}$$ (✓) Substitution

$$= \frac{200}{105}$$ (✓) R_P=1,905Ω

$$= 1.905\ \Omega$$ (✓) R_T=9.505Ω

$$Rt = 1.905 + 0.6 + 0.5 + 4.5 + 2$$

$$= 9.505\ \Omega$$ (3)

7.2.2 Emf = 4 x 4 = 16 V
Rt = 4 x 05 = 0.6 Ω

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

$$= \frac{16}{9.505 + 0.6}$$ (✓) Substitution

$$= 1.583\ A$$ (✓) Current

V = IR
= 1.583 x 2
= 3.166 V (✓) Volt drop (3)

7.3 7.3.1

$$\frac{N_P}{N_S} = \frac{V_P}{V_S} = \frac{I_S}{I_P}$$

$$V_S = \frac{N_S V_P}{N_P}$$

$$= \frac{50 \times 220}{600} \; OR \; \frac{1 \times 220}{12}$$

(✓) Substitution

$$= 18{,}33 \; V$$

(✓) Solution (2)

7.3.2

$$I_P = \frac{N_S \times I_S}{N_P} \; OR \; \frac{V_S \times I_S}{V_P}$$

$$= \frac{50 \times 20}{600} \; OR \; \frac{18{,}33 \times 20}{220}$$

(✓) Substitution

$$= 1{,}667 \; A$$

(✓) Solution (2)
[12]

QUESTION 8: CHEMISTRY

8.1
- By painting the metal
- By applying oil or grease
- By electroplating with zinc or tin
- By galvanising
- By using plastic film

(Any 2 × 1) (2)

8.2 8.2.1 Limestone (Marble) =$CaCO_3$

8.2.2 Caustic soda = NaOH

(2 × 1) (2)

8.3 Carbon (1)

8.4
- Low melting point
- Soft
- Good adhesion to other metals

(Any 1 × 1) (1)
[6]

TOTAL: 100