higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ENGINEERING SCIENCE N4

30 JULY 2018

This marking guideline consists of 14 pages.

QUESTION 1: GENERAL

1.1 1.1.1 Resultant velocity: a single velocity that represents two or more velocities acting on a point, and has the same effect as these velocities.

1.1.2 Shear force: the sum of all forces to the left or right of a section on a beam.

(2 × 1) (2)

1.2 Newton's second law of motion: the rate of momentum is directly proportional and is in the same direction as the applied force. (2)

1.3 1.3.1 This is at the moment the spring is elastic.
OR
This is the moment the spring returns to its original shape or size when the external force is removed. (1)

1.3.2 Elastic limit: this is the point where the spring will not go back to its original shape or size when the external force is removed before permanent deformation. (2)

1.4 South 45 degrees east OR S45° E. (1)

1.5 1.5.1 The amount liquid slipped from press.

1.5.2 The higher the pressure the higher the depth of the volume.

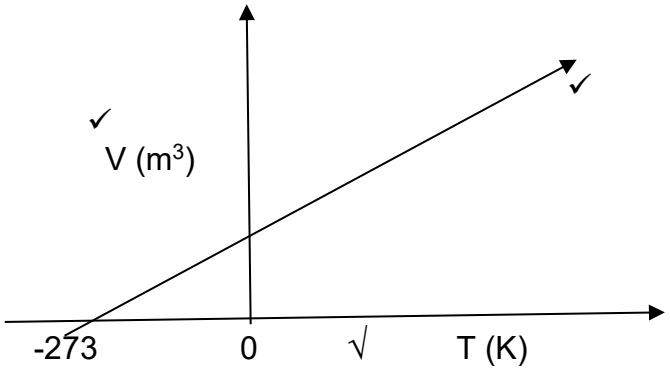
(2 × 1) (2)

1.6 Functional hydraulics: to accumulate hydraulic energy and expend it intermittently. (2)

1.7 Charles' gas law: at a constant pressure the volume of gas is directly proportional to the temperature.✓

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \checkmark$$

Velocity-temperature



(4)
[16]

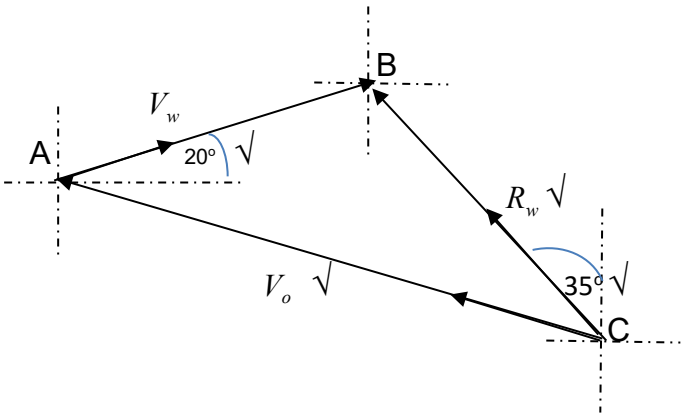
QUESTION 2: KINEMATICS

2.1 $V_o = 300Km/h$

$V_w = 100Km/h\ E20^0 N\ V_w$

$R_v = ?\qquad N35^0W$

2.1 2.1.1



(2)

2.1.2 $B = 35^o + 70^0$

$= 105^0$

$$\frac{SinC}{c} = \frac{SinB}{b}$$

$$C = \sin^{-1}(\frac{cSinB}{a})$$

$$= \sin^{-1}(\frac{100Sin105}{300})$$

$= 18.782^0$ √

$A = 180^o - (105^o + 18.782^o)$

$= 56.218^0$ √

$$a = \sqrt{b^2 + c^2 - 2bc\cos A}$$

$$= \sqrt{(300)^2 + (100)^2 - 2(300)(100)Cos105}$$

$= 339.896km/h$ ✓

$\therefore R_v = 339.896km/h\ \ N35^0W$ ✓

(3)

2.1.3 The direction of flight

$\beta = 90^o - (25^o + 18.782^o)$

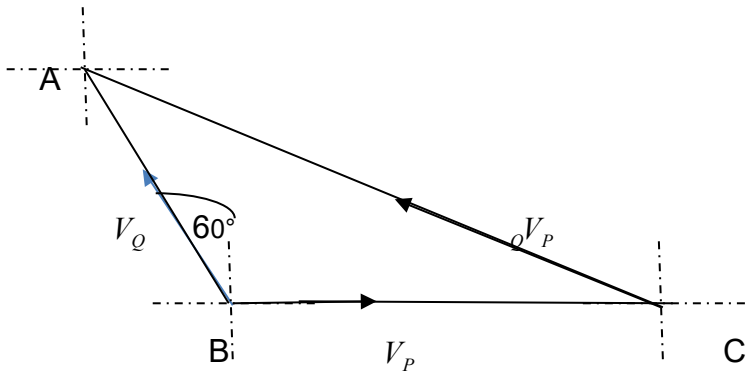
$= 36.218^0$

Direction of flight = W 36.218°N✓ OR N 53.782° N✓ (1)

2.2 $V_P = 220km/h \ \ E$

$V_Q = 220km/h \ W30^0 N$

${}_PV_Q = ?$



$B = 60^o + 90^o$

$= 150^0$

$B = \sqrt{a^2 + c^2 - 2acCosB}$

$= \sqrt{(220)^2 + (220)^2 - 2(220)(220)Cos150}$ ✓

$= 425.007km/h$ ✓

$$\frac{SinC}{c} = \frac{SinB}{b}$$

$$C = \sin^{-1}(\frac{cSinB}{a})$$

$$= \sin^{-1}(\frac{220Sin150}{425.007})$$ ✓

$= 15^0$ ✓

${}_QV_P = 425.007km/h \ \ W15^0 N$ (4)

2.3 $S_h = 210m$

$V = 730km/h$

$t = 3s$

$S_h = t.V.Sin\theta$ ✓

$$Sin\theta = \frac{S_h}{t.V.}$$

$$\theta = \sin^{-1}(\frac{S_h i}{t.V})$$

$$\theta = \sin^{-1}(\frac{210}{3(202.778)})$$ ✓

$= 20.194^0$ ✓ (3)

[13]

QUESTION 3: ANGULAR MOTION

3.1 B
3.2 C
3.3 B
3.4 D

(4 × 2) **[8]**

QUESTION 4: DYNAMICS

4.1 4.1.1

$m = 780kg$
$slope = 7\%$
$S = 25m$

$\theta = \tan^{-1}(\frac{7}{100})$
$= 4.004^0$ √

$E_p = mgh$

$= 780kg(9.8m/s2)25Sin(4.004)$

$= 13343.771J$ √

$E_{k(bottom)} = E_{p(top)}$ √
$= 13343.771J$
$V = \sqrt{\frac{4(13343.771)}{789}}$ √

$= 8.225m/s$ ✓ (3)

4.1.2

$V^2 = u + 2aS$
$a = \frac{0^2 - (8.225m/s)^2}{2(35)}$ ✓

$= -0.966m/s^2$ ✓ (2)

4.1.3 $E_K = 0$ m/s✓ (1)

4.2 4.2.1

$m = 1.8ton$
$plane = horizontal$
$S = 35m$
$f_u = 110N/ton$
U = 20 m/s
V = 0 m/s✓

$V^2 = u^2 + 2aS$

$a = \dfrac{0^2 - (20m/s)^2}{2(35)}$ ✓

$= -5.714m/s^2$ ✓

4.2.2

f_{brake}
$f_{app} = -(f_B + f_u)\surd$
$f_{app} = 1800kg(-5.714m/s^2)$
$= -10285.714N\surd$
$f_u = 1.8ton(110N/ton)$
$= 198N\surd$
$f_B = -f_{app} - f_u)$
$= -(-10285.714N) - 198N\surd$
$= 10087.714N$ ✓

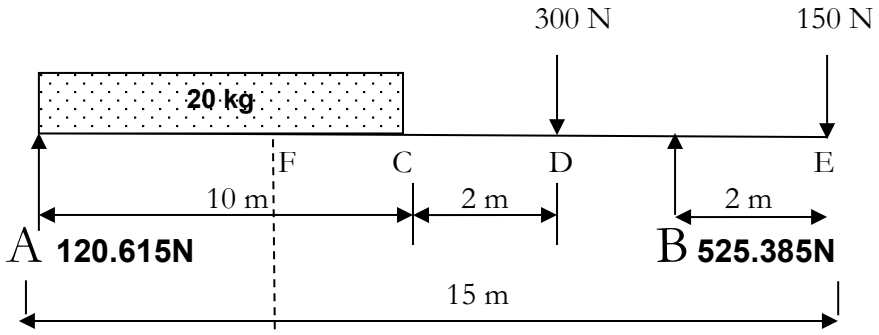
(2 × 3) (6)
[12]

QUESTION 5: STATICS

5.1 5.1.1

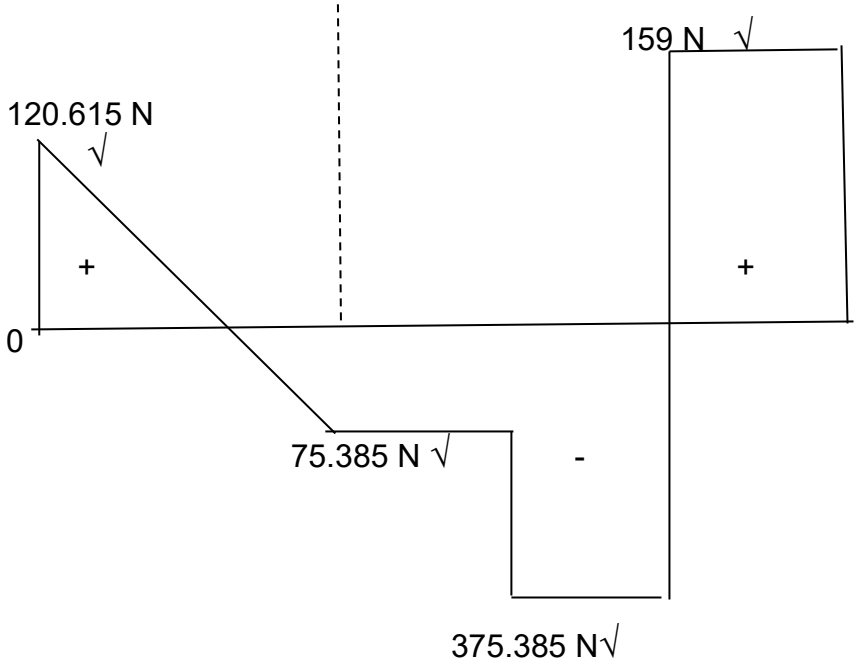
$spring = (20Kg)(98m/s^2)$
$f_{spring} = \dfrac{(20Kg)(98m/s^2)}{10m}$
$= 19{,}6N/m$
Δ≅A
$\sum F_\perp .S(ac) = \sum F_\perp .(c)$
$B(13m) = 196N(5m) + 300N(12m) + 150N(15M)$
$B \Rightarrow \dfrac{6830\ Nm}{13\ m} = 525{,}385\ N$ ✓
Δ≅B
$\sum F_\perp .S(ac) = \sum F_\perp .(c)$
196 N(8 m) + 300 N(1 m) =150 N(2 m)+A(13 m)
$A \Rightarrow \dfrac{1568\ \ Nm}{13\ m} = 120.615\ N$ ✓

(2)



Calculate:

5.1.2



(2)

5.1.3 $BM_{A\rightarrow}$(120.615N).(o m) = 0

$BM_{C\rightarrow}$(120.615N).(10 m)-(196N).(5m) =226.15 Nm✓

$BM_{D\rightarrow}$(120.615N).(12 m)-(196N).(7m) =75.38 Nm✓
$BM_{B\rightarrow}$(120.615N).(13 m)-(196N).(8m)-300 N(1 m) =-300.005Nm✓

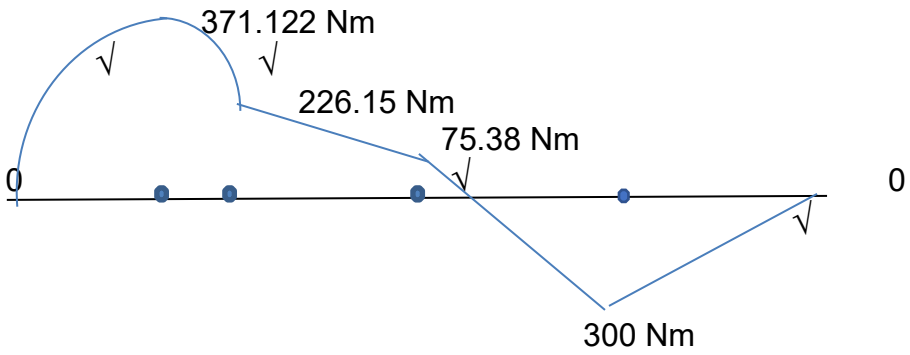
$BM_{E\rightarrow}$(120.615N).(15 m)-(196N).(10m)-
(300 N).(3 m)-(130 N).(0 m) = 0

$$\sum f_s = 0$$
$$120.615N - (19.6N/m).x = 0$$
$$x = \frac{-120.615N}{-19.6N/m}$$
$$= 6.154m \checkmark$$

$BM_{F\rightarrow}$(120.615 N).(6.154 m)-
(19.6 N).(6.154 m)(0,5)(2,333 m)
= 371.122 Nm✓

(5)

5.1.4



(2)

5.2

Shape	V (mm³)	G (mm)	VG(mm⁴)
Cylinder A	$V_A = \frac{\pi D^2}{4} H$ $= \frac{\pi 50^2}{4} 20$ = 39269.908√	$G = \frac{H}{2}$ $= \frac{20}{2}$ =10√	39269.908(10) = 392699.08√
Cylinder B	$V_B = \frac{\pi d^2}{4} h$ $= \frac{\pi 30^2}{4} 80$ = 56548.668√	$G = H + \frac{h}{2}$ $= 20 + \frac{80}{2}$ = 60√	56548.668(60) = 3392920.066√
	$\sum v. = 39269.908 + 56548.668$ = 95818.576√	$y = \frac{\sum v.G}{\sum V}$ = 39.508 mm√	$\sum v.G = 392699.08 + 3392920.$ = 3785619.146√

(4)
[15]

QUESTION 6: HYDRAULICS

6.1 6.1.1 d=90 mm D = 180 mm
Sl = 480 mm
MA = 18
$\eta = 85\%$

f_h , m=4.2Mg $\eta = 96\%$

$\frac{W_R}{f_p} = \frac{D^2}{d^2}$ and $MA = \frac{f_p}{f_h}.\frac{100}{\eta}$

$W_R = 4.2 \times 10^3 kg(9.8m/s^2)$
$= 41160N$ √

$f_p = \frac{d^2 W_R}{D^2}$

$f_p = \frac{(0.09m)^2 41160N}{(0.18m)^2}$ ✓

$= 10290N$ √

$f_h = \frac{f_p}{MA}.\frac{100}{\eta}$

$= \frac{10290N}{18}.\frac{100}{96}$ ✓

$= 595.486N$ ✓ (5)

6.1.2 n, m = 4.2 Mg SL = 520 mm $\eta = 96\%$

$V_a = \frac{\pi.D^2 S_L.}{4}$

$= \frac{\pi(0.180m)^2(0.520m)}{4}$

$= 0.0132324m^3$ ✓

$V_s = V_a.\frac{100}{\eta}$

$= 0.0132324m^3 \frac{100}{96}$

$= 0.01378374m^3$

$\frac{\pi.d^2 sl.n.}{4} = 0.01378374m^3$

$n = 4.513 \approx 4.5$ ✓ (3)

6.2 6.2.1 N = 120 r/min
d = 150 mm
S_l = 250 mm
C = 2

V_a (Actual volume in l/s), $S_L = 300mm$

$$V_s = \frac{\pi.d^2 sl.n.C.}{4}.\frac{N}{60}$$

$$= \frac{\pi.(0{,}150m)^2.0{,}25m.1.(2)}{4}.\frac{120r/\min}{60}$$ ✓

$$= 0{,}0176715m^3/s$$ ✓

$$V_a = V_s.\frac{\eta}{100}$$

$$= 0{,}0176715m^3/s.\frac{100}{100}$$ ✓

$$= 0{,}0176715m^3/s(1000l/m^3)$$
$$= 17{,}671\ l/s$$ ✓ (4)

6.2.2 $$Slip\% = \frac{V_s - V_a}{V_s}.100$$

$$= \frac{17.671l/s - 16.789l/s}{17.671/s}.100$$ ✓

$$= 5.037\%$$ ✓
$$\approx 5\%$$ (2)
[14]

QUESTION 7: HYDRAULICS

7.1

$D_{ext} : d_{\text{int}}$

$3:1$

$F = 620kN$

$\Delta l = 0.771mm$

$E = 209GPa$

$l = 3m$

$\Delta l = 0.771mm$

$D_{ext} = ?$

$d_{\text{int}} = ?$

$\varepsilon = \dfrac{\Delta l}{l}$

$= \dfrac{0.7771mm}{3000mm}$

$= 0.000257$ ✓

$E = \dfrac{\delta}{\varepsilon}$

$\delta = E.\varepsilon$

$= 209 \times 10^9\ Pa.(0.000257)$

$= 53713000Pa$ ✓

$\delta = \dfrac{F}{a}$

$\therefore a = \dfrac{F}{\delta}$

$= \dfrac{620000N}{53713000Pa}$

$= 0.0115428m^2$ ✓

$a = \dfrac{\pi}{4}(D^2_{ext} - d^2_{\text{int}})$

$= \dfrac{\pi}{4}((3d)^2_{\text{int}} - d^2_{\text{int}})$ ✓

$= \dfrac{\pi}{4}8d^2_{\text{int}}$

$= 6.283185d^2_{\text{int}}$

$d_{\text{int}} = \sqrt{\dfrac{0.0115427m^2}{6.2831853`N}}$

$= 0.04286m$ ✓ or (42.861 mm)

(6)

$D_{ext} = 0.128583m$ ✓ or (128.583 mm)

7.2 7.2.1

$F = 38kN$

$a = 8000mm^2$

$l = 3m$

$\Delta l = 0.51mm$

$$a = \frac{800mm^2(1m^2)}{1\times10^6 mm^2}$$

$a = 0.008m^2$ ✓

$$\delta = \frac{F}{a}$$

$$= \frac{38000N}{0.008m^2}$$

$= 4750000Pa$ ✓

7.2.2 strain

$$\varepsilon = \frac{\Delta l}{l}$$

$$= \frac{0.51mm}{4000mm}$$ ✓

$= 1.275\times10^{-4}$ ✓

7.2.3 E

$$E = \frac{\delta}{\varepsilon}$$

$$= \frac{4750000Pa}{1.275\times10^{-4}}$$ ✓

$= 3.7255\times10^{10}Pa$

$= 37.255\times GPa$ ✓

(3 × 2) (6)
[12]

QUESTION 8: HEAT

8.1

$$V = 0.77m^3$$
$$\gamma = 17 \times 10^{-7} / K$$
$$\Delta T = 233K$$
$$\Delta V = V_o.\gamma.\Delta T$$
$$\Delta V = 0.77m^3.17 \times 10^{-3} / K.(233K)$$

$$= 0.00304997m^3 \checkmark$$
$$\Delta V = V_2 - V_o.$$
$$V_2 = \Delta V + V_o.$$
$$= 0.00304997m^3 + 0.77m^3$$
$$= 0.773m^3 \checkmark$$ (3)

8.2 8.2.1 A

$$V_A = 2m^3$$
$$t_A = 25^o C$$
$$P_A = 580kPa$$

$$m_B = 6kg$$
$$V_B = ?$$
$$t_A = 35^o C$$
$$P_B = 580kPa$$

R=287J/kg.K

$$t_{eqil} = 20^o C$$

$$T_A = 298K \text{ √}$$ $$T_{equi} = 293K$$ $$T_B = 308K \text{ √}$$

$$V_B = ?$$
$$P_B V_B = m_B R T_B$$
$$V_B = \frac{m_B R T_B}{P_B}$$
$$= \frac{6kg(287J/kg.K).(308K)}{580000Pa} \checkmark$$

$$= 0.914m^3$$ (3)

8.2.2 $P_{equi} = ?$

$P_{equi}V_{equi} = m_{equi}RT_{equi}$

$V_{equi} = V_A + V_B$

$= 2m^3 + 0.914m^3$

$= 2.914m^3$ ✓

$P_AV_A = m_ART_A$

$m_A = \frac{P_AV_A}{RT_A}$

$= \frac{580000Pa(2m^3)}{(287J/kg.K).(298K)}$ ✓

$= 13.563\ kg$ ✓

$P_{equi} \Rightarrow \frac{m_{equi}RT_{equi}}{V_{equi}} = \frac{13.563(287).(293K)}{2.914}$ ✓

$P_{equi} = 391.395kPa$ ✓

(4)
[10]

TOTAL: 100