higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

AUGUST EXAMINATION

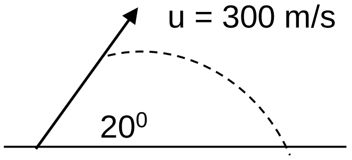
ENGINEERING SCIENCE N4

22 JULY 2015

This marking guideline consists of 13 pages.

QUESTION 1

1.1



$V_y = 300 \sin 20^0$
$= 102{,}606$ m/s

$V_x = 300 \cos 20^0$
$= 281{,}908$ m/s

1.1.1 $S_v = \frac{u^2 \text{Sin}^2 \emptyset}{2g}$

$= \frac{300^2 x \text{Sin}^2 20^0}{2 \times 9{,}8}$

= <u>537,143 m</u>

<u>An alternative method</u>

$s = \frac{v^2 - u^2}{2g}$ √

$= \frac{0^2 - (300 \sin 20^0)^2}{2 \times 9{,}8}$ √

= <u>537,143 m</u>√

<u>An alternative method</u>

$t_v = \frac{v-u}{g}$ (t_v = vertical)

$= \frac{0 - 300 \text{Sin} 20^0}{-9{,}8}$ √

= <u>10,47s</u>

$S_v = ut + \frac{1}{2} gt^2$

$= 300 \sin 20^0 \times 10{,}47 + \frac{1}{2} - 9{,}8 \times (10{,}47)^2$ √

= 1047,285 – 537,142

= <u>537,143 m</u>√ (3)

1.1.2 $S_H = u_H x\, t_H$

$= 300 \cos 20° x\ 2 \times 10{,}47$ √

$=$ <u>5 903,149 m</u> √

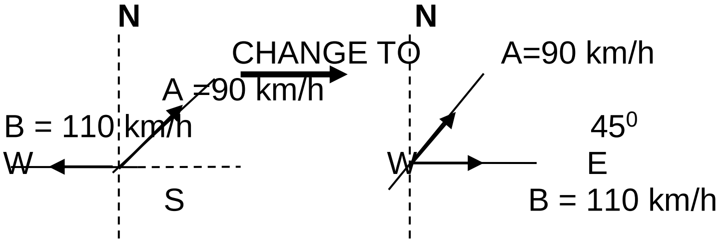
<u>An alternative method</u>

$$s_H = \frac{u^2 \mathrm{Sin} 2\emptyset}{g}$$

$$= \frac{300^2\,\mathrm{Sin}2x20^0}{9{,}8}\ √$$

$=$ <u>5 903,152 m</u>√ (2)

1.2



<u>Stop B and change its direction</u>

$\sum v = 110 km/h \sin 0^0 + 90 km/h \sin 45^0$ √

$=$ <u>63,64 km/h</u>

$\sum H = 110 km/h \cos 0^0 + 90 km/h \cos 45^0$ √

$=$ <u>173,64 km/h</u>

R $= \sqrt{63{,}64^2 + 173{,}64^2}$

$= 184{,}935$ km/h√

$\theta = \tan^{-1}\frac{63{,}64}{173{,}64}$

$= 20{,}128^0$√

$_A\nabla_B = 184{,}935$ km/hE$20{,}128^0$ √

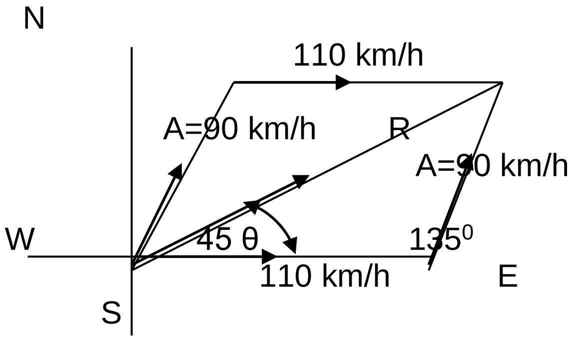
OR

$_A\nabla_B = 184{,}935$km/hN$69{,}872^0$ E

An alternative method

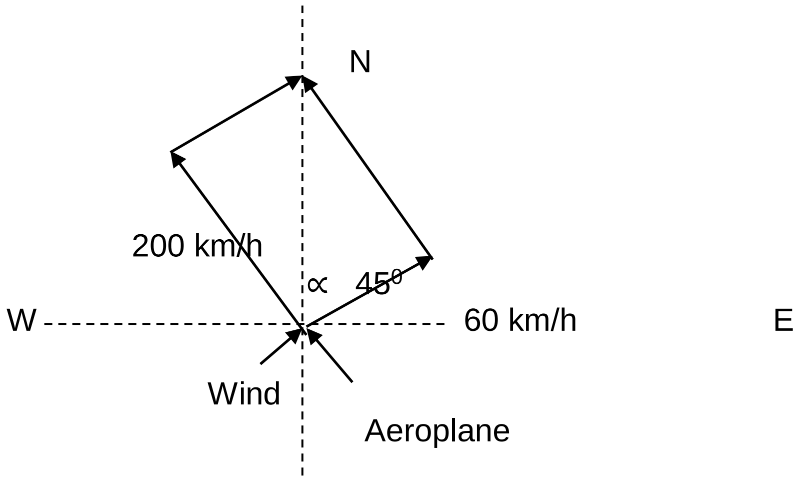
$R^2 = 90^2 + 110^2 - 2(90)(110)\text{Cos}135^0$√
$R = \sqrt{34200{,}714}$
= 184,935 km/h√

$\frac{\sin\theta}{90} = \frac{\sin 135^0}{184{,}935}$ √
$\sin\theta = 0{,}344$
$\theta = 20{,}128^0$ √



√
$_A\nabla_B$ = 184,935 km/hN69,872⁰E OR $_A\nabla_B$ = 184,935 km/hE20,128⁰N (5)

1.3



1.3.1 $\frac{\sin\alpha}{60} = \frac{\sin 45^0}{200}$√
$\sin\alpha = \frac{60x\sin45^0}{200}$
$\alpha = 12{,}247^0$ √
Direction $N12{,}247^0W$ OR Direction $W77{,}753^0N$

1.3.2 $A = 180^0 - (45^0 + 12{,}247^0)$
= 122,753°√

$\alpha^2 = b^2 + c^2 - 2bc\text{Cos}A$
$\alpha = \sqrt{200^2 + 60^2 - 2(200)(60)\text{Cos}122{,}753^0}$√
= 237,875 km/h√ (2 x 2½) (5)
[15]

QUESTION 2

2.1 Is the rate of angular displacement or (rotation). √

OR

Is the ratio between linear velocity and radius. √ (1)

2.2 N = 900 r/min
D = 40 cm = 0,4 m
R = 0,2 m

2.2.1 $\varpi = \frac{2\pi N}{60}$

$= \frac{2\pi 900}{60}$

$= \underline{94{,}248 rad/}$

2.2.2 $V = \varpi R$

$= 94{,}248 \times 0{,}2$

$= \underline{18{,}85 \text{ m/s}}$

(2 x 2) (4)

2.3 T = 50 Nm
D = 0,5 m
ϖ = 3 rad/s
t = 25s

2.3.1 $\theta = \varpi t$

$= 3 \times 25$

$= \underline{75 rad}$

$WD = T \times \theta$

$= 50 \times 75$

$= \underline{3{,}75 kJ}$

2.3.2 $P = \frac{WD}{t} \times \eta$ √

$= \frac{3750 \times 0{,}75}{25}$

$= \underline{112{,}5 W}$√

OR

$P = T\omega\eta$

$P = 50 \times 3 \times 0{,}75$ √

$= \underline{112{,}5 W}$√

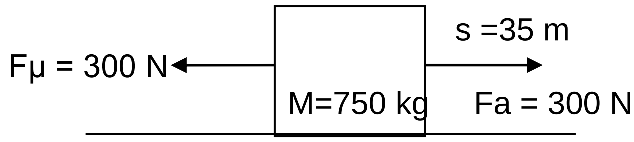
(2 x 2) (4)

[9]

QUESTION 3

3.1 An object remains at rest or continues to move in a straight line with the same velocity √unless acted upon by an unbalanced force. √ (2)

3.2 u = 54 km/h = 15 m/s



3.2.1 $a = \frac{v^2 - u^2}{2s}$

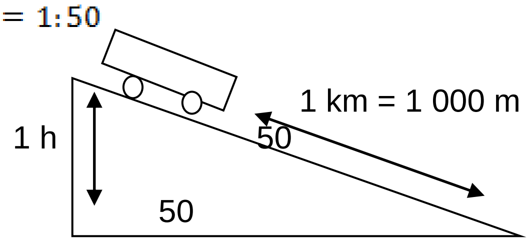
$= \frac{0^2 - 15^2}{2x35}$

$= -3{,}214 m/s^2$ (2)

3.2.2 F_T = ma (consider as +)
= 750 x 3,214
= <u>2410,714 N</u>

F_T = F_{BRAKE} + F_u
F_{BRAKE} = F_T - F_u
= 2410,714 – 300
= <u>2110,5 N</u> (3)

3.3 2% = $\frac{2}{100}$ = 1:50



$\sin\theta = \frac{1}{50}$

$\sin\theta = \frac{h}{1000}$

$h = \sin\theta x 1000 = \frac{1}{50}$ x 1000√

= <u>20 m</u>

P.E. (Lost) = mgh√
= m x 9,8 x 20
= <u>196 m</u>

Energy lost due Friction = Fu x S√

$= \frac{60m}{1000}$ x 1000

= <u>60 m</u>

Energy remained for kinetic = P.E. – Friction
= 196 m – 60 m√
= 136 m

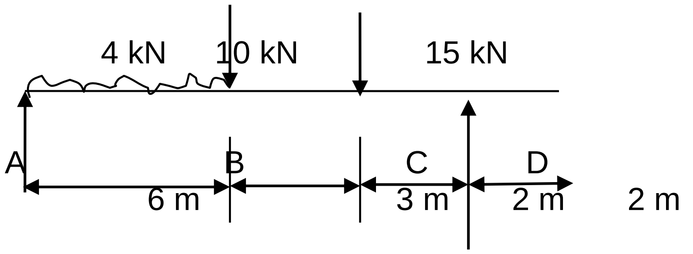
k = 0,5 mv^2

V = $\sqrt{2 \times 136}$√
= 16,492 m/s (5)

[12]

QUESTION 4

4.1



√√

(2)

4.2 Take moments about D

∑ ↷M = ∑↶M
A x 11 = 15 x 2 + 10 x 5 + 24 x 8√
A = 24,727 kN
√

Take moments about A

∑↶M = ∑↷M√
D x 11 = 24 x 3 + 10 x 6 + 15 x 9

D = 24,273 kN

OR

∑ ↑ F = ∑ ↓ F
24,727 + D = 24 + 10 + 15
D = 24,273 kN (3)

4.3 Bending moment calculations

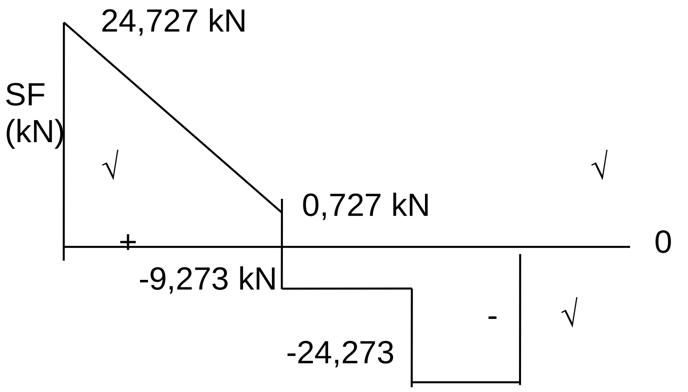
BM at B = (24,727 x 6) + (-24 x 3)
= 76,362 kNm
OR√
BM at B = (24,273 x 5) + (-15 x 3)
= 76,365 kNm

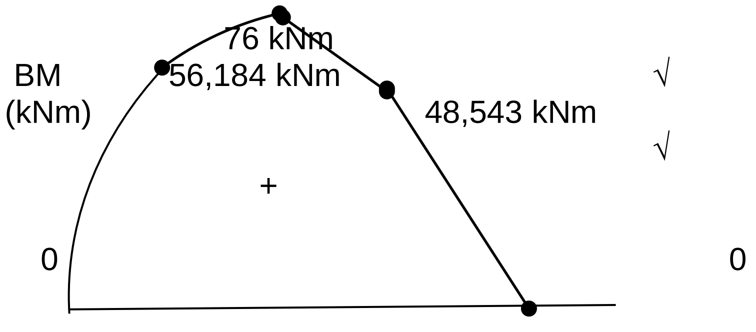
BM at C = 24,273 x 2
= 48,546 kNm
OR√
BM at C = (24,727 x 9) + (-24 x 6) + (-10 x 3)
= 48,543kNm

BM at D = 0 x 2 = 0 kNm
OR
BM at D = (24,727 x 11) + (-24 x 8) + (-10 x 5) + (-15 x 2)
= 0,003√
(say) ≈ 0 kNm

BM between A and B = (24,727 x 3) + (-12 x 1,5)
= 56,184 kNm √ (4)

4.4





NB (5)

4.5 Before calculating. Draw shear force diagram first where shear force is zero is where there is MAX BM.√
At B is MAX BM and calculated above is 76,365 kNm. (1)
[15]

QUESTION 5

5.1 For an elastic object the stress is proportional to the strain producing it.
OR
For an elastic material the deformation is proportional to the force applied. (2)

5.2 Data: D_0 = 0,025 m] Round bar
L_0 = 0,6 m]

S_s = 0,012 m]
L_s = 0,4 m] Square

σ_{MAX} = 250 Mpa

5.2.1 <u>In the square bar (section)</u>

$\sigma_{MAX} = \frac{F}{A}$

$F = \sigma_{MAX} \times A$√

$= 250 \times 10^6 \times (0{,}012)^2$

$= \underline{36 \text{ kN}}$ √

$F_{\text{applied on Round bar}}$ = Force applied on square bar

<u>In the round section</u>

$\sigma = \frac{F}{A}$√

$= \frac{36 \times 10^3 \times 4}{\pi\,(0{,}025)^2}$√

$= \underline{73{,}339 \text{ Mpa}}$ (4)

5.2.2 In the square part

$X_T = X_S + X_R$

$X_S = \frac{F \times L_S}{A_S \times E}$ √

$= \frac{36 \times 10^3 \times 0{,}4}{(0{,}012^2) \times 90 \times 10^9}$ √

= $1{,}111 \times 10^{-3}$m or 1,111 mm

In the round part

$X_R = \frac{F \times L_R}{A_R \times E}$ √

$= \frac{36 \times 10^3 \times 0{,}6 \times 4}{\pi(0{,}025^2) \times 90 \times 10^9}$ √

= $4{,}889 \times 10^{-4}$ or 0,489 mm

$X_T = 1{,}111 \times 10^{-3} + 4{,}889 \times 10^{-4}$ √

$= 1{,}6 \times 10^{-3}$ m or 1,6 mm (5)

5.3 F = 50 kN

θ = 25 Mpa

L_0 = 3 m

E = 100 Gpa

$A = \frac{F}{\sigma}$ √

$= \frac{50 \times 10^3}{25 \times 10^6}$ √

$= 2 \times 10^{-3}$ m²

$\frac{\pi D^2}{4} = 2 \times 10^{-3}$

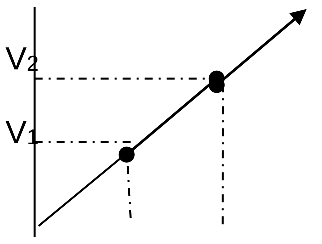
$D = \frac{\sqrt{4 \times 2 \times 10^{-3}}}{\pi}$ √

= $50{,}463 \times 10^{-3}$ m (50,463 mm) (3)

[14]

QUESTION 6

6.1 The volume of a given mass of gas is directly proportional to temperature when√ pressure is kept constant.√



(4)

6.2 $V_1 = 0,5\ m^3$
$T_1 = 29^0C = 29 + 273 = 302\ K$
$P_1 = 209\ kPa$
$V_2 = ?$
$T_2 = -17^0C = 273 - 17 = 256\ K$
$P_2 = 95\ kPa$

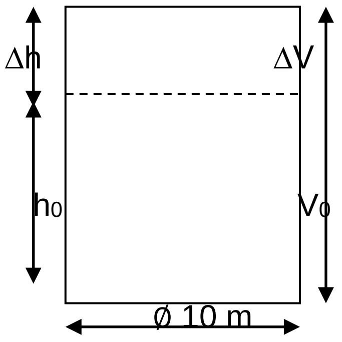
$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1T_2}{T_1P_2} \surd$$

$$= \frac{209 \times 0{,}5 \times 256}{95 \times 302} \surd$$

$= \underline{0{,}932\ m^3}$√ (3)

6.3 Data:



$\Delta t = 45 - (-10)$
$= 55^0C$

√

$V_T = V_0 + \Delta V$
$V_T = A \times h_T$

$$= \frac{\pi 10^2}{4} \times 25 \surd$$

$= \underline{1963{,}495\ m^3\ \ \text{(container volume)}}$

$V_0 + \Delta V = V_T = 1963{,}495\ m^3$
$V_0 + (V_0 x\ \gamma x \Delta_T) = 1963{,}495$√
$V_0 + 0{,}0114V_0 = 1963{,}495$√
$1{,}0114V_0 = 1963{,}495$
$\underline{V_0 = 1941{,}363\ m^3}$√

$A \times h_0 = V_0$
$h_0 = \frac{V_0}{A}$√
$\frac{1941{,}36 \times 4}{\pi \times 10^2}$√√
$h_0 = \underline{24{,}718\ m}$ (8)
[15]

QUESTION 7

7.1 A liquid has definite volume.√
A liquid takes the shape of its container.
Liquids such as water and hydraulic fluid√ can be used to do work and can be used repeatedly.√ (3)

7.2 d = 0,02 m
L = 0,14 m
Fp = 350 N
D = 0,075 m

7.2.1 $V_p = n \times A \times L$√
$= 10 \times \frac{\pi (0{,}02)^2}{4} \times 0{,}14$√
$= \underline{439{,}823 \times 10^{-6}\ m^3}$

OR
$= \underline{0{,}440 \times 10^{-3}\ m^3}$ (2)

7.2.2 $V_{RAM} = V_{PLUNGER}$√
$\frac{\pi 0{,}075^2}{4} \times H = 439{,}823 \times 10^{-6}$
H = 0,0996 m√
OR 99,6 mm
H = $\underline{0{,}100\ m}$ (2)

7.2.3 WD = Fram x H √ W=F×s

Fram = $\frac{D^2}{d^2}$ x Fp√

= $\frac{0{,}075^2 \times 350}{0{,}02^2}$

= 4921,875N√

WD = 4921,875 x 0,0996

= <u>490,219J</u> (3)

7.3 C = 3 cylinders
D = 0,2 m
L = 0,6 m
N = 1 800 r/min

7.3.1 V_s = A x L x C x N_{60} x η (slip)√

$= \frac{\pi(0{,}2^2)}{4} \times 0{,}6 \times 3 \times \frac{1800}{60} \times 0{,}95$ √

= $1{,}612\ m^3/s$

= 5 803,2 kl/h √ (3)

7.3.2 H = 32m√

P = pg $\frac{V}{s}$ x H√

= 1 000 x 9,8 x 1,612 x 32√

= 505,523 kW

$P_{out\ of\ pump}$ = $\frac{505{,}523 \times 100}{90\%}$ = 561,692 kW √ (4)

7.4 P = $\frac{W}{A}$√

$= \frac{2000 \times 9{,}8 \times 4}{\pi(0{,}45^2)}$ √

= 123,237 kPa√ (3)

[20]

TOTAL: 100