10

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

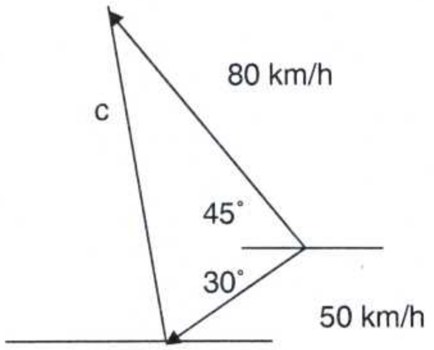
ENGINEERING SCIENCE N4

27 MARCH 2013

This marking guideline consists of 10 pages.

QUESTION 1

1.1



Alternative solution:

$c^2 = a^2 + b^2 - 2ab\cos 75°$
$= 802 + 502 - 2x80x50\cos 75°$
$= 6829{,}445$
$C = 82{,}64$ km/h

$\frac{\sin C}{c} = \frac{\sin A}{a}$

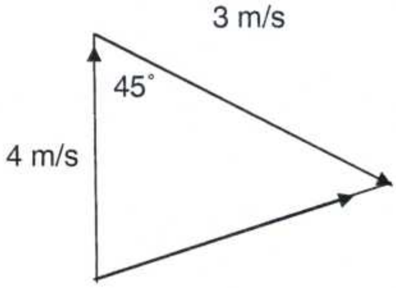
sin A = (a sin C) ÷ c
sin A = (80 sin 75°)/(82,64)
= 0,935
A = 69,24°

HC = $-80\cos 45° + 50\cos 30°$
$= 81{,}569\ km/h$
VC = $80\sin 45° + 50\sin 30°$
$= -13{,}267\ km/h$
R = $\sqrt{(81{,}569^2) + (-13{,}267^2)}$
= 82,641 km/h

Therefore Angle: 30˚ + 69,24˚ - 90˚ = 9,24˚

The velocity of the "Sunshine" relative to "The Carrier" is 82,64 km/h North 9,24˚ West. (5)

1.2



Alternative solution:

$c^2 = a^2 + b^2 - 2ab\cos 45°$

$= 4^2 + 3^2 - 2 \times 4 \times 3\cos 45°$

$= 8{,}029$

$C = 2{,}834$ m/s

$\frac{\sin B}{b} = \frac{\sin C}{c}$

$\sin B = (3 \sin 45°) \div 2{,}834$

$= 0{,}748$

$B = 48{,}463°$

$HC = 3\cos 45°$

$= 2{,}1213$ m/s

$VC = 4 - 3\sin 45°$

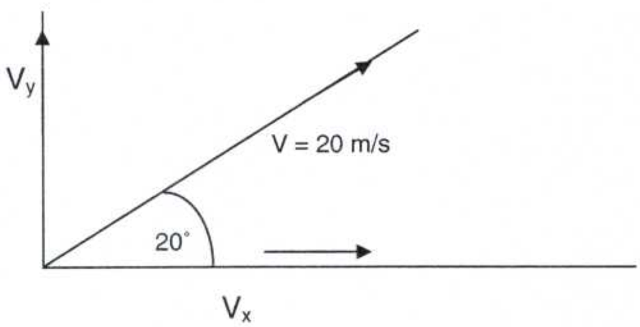
$= 1{,}8787$ m/s

$R = \sqrt{(2{,}1213^2) + (1{,}8787^2)}$

$= 2{,}834$ m/s

Resultant velocity of the canoeist is 2,834 m/s North 48,463° East (5)

1.3



Resolve the velocity into the vertical and horizontal components:

$V_x = 20 \times \cos 20° = 18{,}794$ m/s

$V_y = 20 \times \sin 20° = 6{,}84$ m/s

Alternative solutions:

1.3.1 $v = u + at$ - therefore $t = (v - u) \div a$
$= (0 - 6{,}84) \div (-9{,}8)$
$= 0{,}698$ seconds

Alternative: $t_h = u\sin\propto \div g$
$= 20\sin 20° \div 9{,}8$
$= 0{,}698\text{s}$ (2)

1.3.2 $s(\text{height}) = (v^2 - u^2) \div 2a$
$= 0 - (6{,}84)^2 \div 2(-9{,}8) \div 2(9{,}8)$
$= 2{,}387$ meter

Alternative: $h_{max} = u^2\sin^2\propto \div 2g$
$= 20^2(\sin 20°)^2 \div$
$= 2{,}387$ m (2)

1.3.3 $s(\text{horizontal}) = Vx \times t$
$= 18{,}794 \times 2 \times 0{,}698$
$= 26{,}236$ meter

Alternative: $L = u2\sin 2^{\propto} \div g$
$= 202\sin 40° \div 9{,}8$
$= 26{,}236$ m (3)
[17]

QUESTION 2

2.1 Angular velocity is the rate of change of angular displacement about an axis and is measured in radians per second.
Linear velocity is the rate of change of linear displacement and is measured in metres per second. (2)

2.2.1 $\omega 1 = V/3{,}6 \div r$
therefore $\omega 1 = 108/3{,}6 \div 0{,}4$
$\omega 1 = 75$ rad/s
$\omega 2 = 126/3{,}6 \div 0{,}4$
$= 87{,}5$ rad/s (2)

2.2.2 $\alpha = (\omega_2 - \omega_1)/t$
$= (87{,}5 - 75)/50$
$= 0{,}25$ radians/s^2 (2)

2.2.3 $\Theta = \omega 1t + 1/2\ \alpha t2$
$= 75 \times 50 + ½ \times 0{,}25 \times 50 \times 50$
$= 3750 + 312{,}5$ rad
$= 4062{,}5$ rad

Alternative solution:
$\theta = \frac{\omega_1 + \omega_2}{2} \times t$
$= \frac{75 + 87.5}{2} \times 50$
$= 4062{,}5$ rad (2)

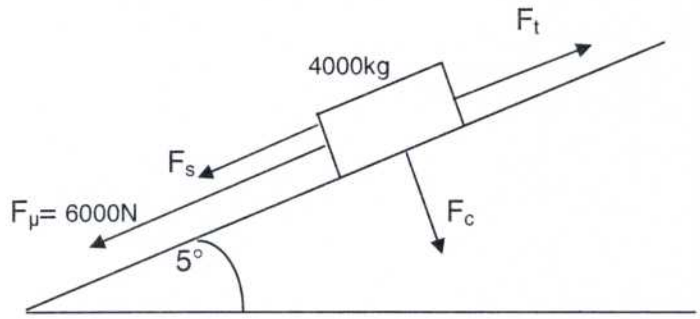
2.3 2.3.1 $T = F \times r$
$= 50 \times 0{,}15$
$= 7{,}5$ N.m (2)

2.3.2 $W = T \times \theta$ $\theta = 2\pi n$
$= 7{,}5 \times 0{,}785$ $= 2\pi(\frac{45}{360})$
$= 5{,}89$ J $= 0{,}785$ rad (3)
[13]

QUESTION 3

3.1 The change in momentum of a body is proportional to the force applied to the body and takes place in the direction of the applied force. (2)

3.2



$F_s = mg \times \sin\Theta$
$= 4000 \times 9{,}8 \times \sin 5^\circ$
$= 3416{,}505$ N

$F_t = F_s + F_\mu$
$= 3416{,}505 + 6000$
$= 9416{,}505$ N

$P = F \times v$
$= 9416{,}505 \times 36/3{,}6 \times 100/75$
$= 125\ 553{,}4\ W = 125{,}553\ kW$ (5)

3.3 3.3.1 $a = (v^2 - u^2) \div 2s$

$= (0 - 100)/2x100$

$= -0,5\ m/s^2$ (2)

3.3.2 $F = ma - 5$

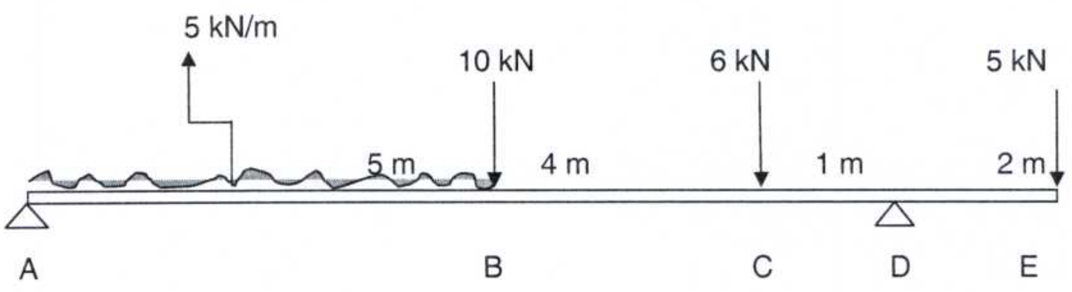
$= (75 \times 0,5) - 5$

$= 32,5\ N$ (3)

[12]

QUESTION 4

4.1



(1)

4.2 Take moments about D:

$\sum CWM = \sum ACWM$

$(A \times 10) + (5 \times 2) = (25 \times 7,5) + (10 \times 5) + (6 \times 1)$

$A = 23,35\ kN$

Take moments about A:

$\sum ACWM = \sum CWM$

$(5 \times 12) + (6 \times 9) + (10 \times 5) + (25 \times 2,5) = D \times 10$

$D = 22,65\ kN$

Test: $\sum\uparrow F = 23,35 + 22,65 = 46\ kN$ (3)

And $\sum\downarrow F = 25 + 10 + 6 + 5 = 46\ kN$

4.3 BM at A = 0

BM at B = -(5 x 7) – (6 x 4) + (22,65 x5) = 54,25 kNm

BM at C = - (5 x 3) + (22,65 x 1) = 7,65 kNm

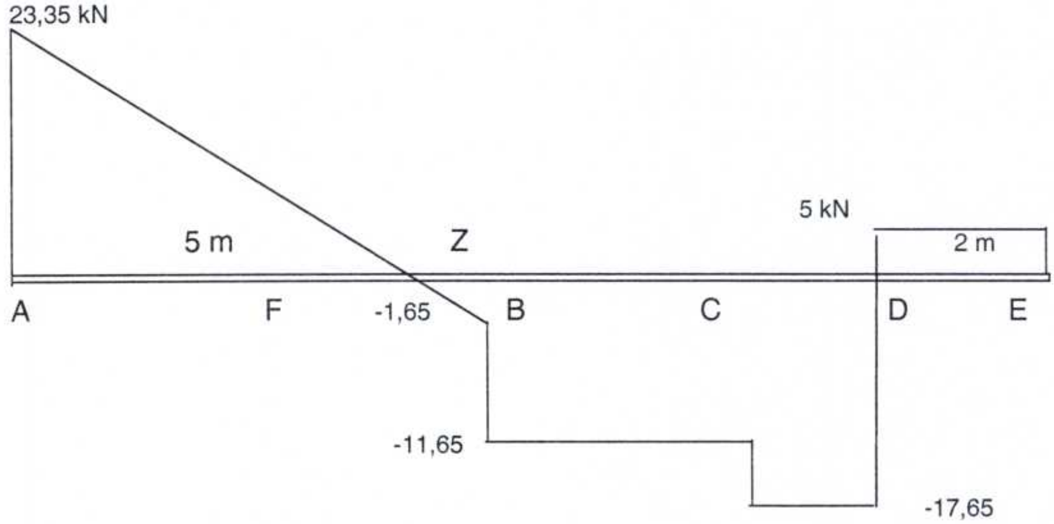
BM at D = - 10 X 1 = - 10 kNm

BM at F (point half way between A and B)

= -(5 x 9,5) – (6 x 6,5) - (10 x 2,5) + (22,65 x 7,5) – (5 x 2,5 x 1,25)

= 42,75 kNm (3)

4.4



(3)

4.5 Let the maximum bending moment be at z

Shear forces at z = 0

Therefore – (5 x z) + 23,35 = 0

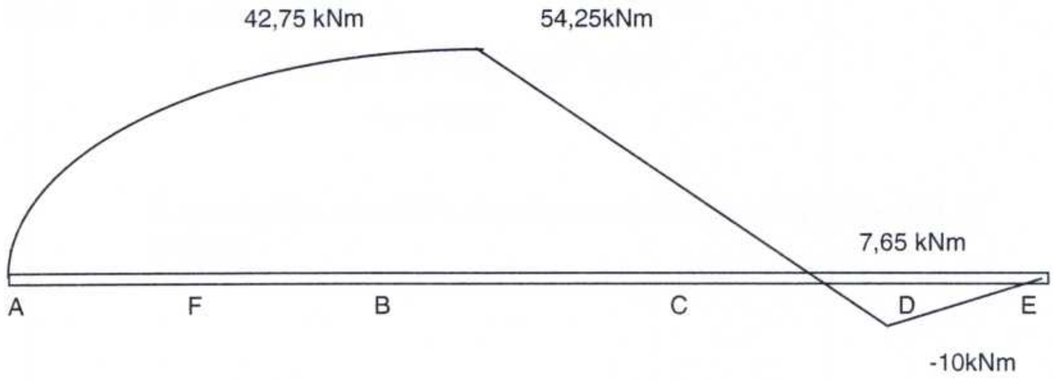
z = 4,67 metres

therefore maximum bending moment is 4,67 metres from the left

Maximum bending moment at z = (23,35 x 4,67) - (5 x 4,67 x 4,67/2)

= 54,523 kNm (4)

4.6



(2)
[16]

QUESTION 5

5.1 The pressure exerted when a force of 1 Newton acts upon an area of 1 m^2 is known as the Pascal. (1)

5.2 5.2.1 $V = \pi D^2/4 \times h \times 3$

$= \pi \times (0{,}06)^2/4 \times 0{,}2 \times 3$

$= 1{,}697 \times 10^{-3}\ m^3$

Power = Pressure x Volume

$= 1{,}2 \times 10^6 \times 1{,}697 \times 10^{-3} \times 150/60 \times 100/75$

= 6788 Watt

= 6,788 kW (5)

5.2.2 Volume = $1{,}697 \times 10^{-3}$ x speed of pump

$= 1{,}697 \times 10^{-3} \times 150 \times 98/100$

$= 0{,}25\ m^3$

= 250 litres (3)

5.3 5.3.1 $F/D^2 = f/d^2$

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

$= 9800 \times 0{,}02^2 \div 0{,}1^2$

= 392 N

Effort on lever = (392 ÷ 15) x 100/80

= 32,667 N (3)

5.3.2 $D^2 \times H = n \times d^2 \times h$

$(0,1)^2 \times 0,5 = n \times (0,02)^2 \times 0,04$

$n = 312,5$

But there is a slip of 6% therefore n = 312,5 x 106/100 = 331,25 strokes (3)

[15]

QUESTION 6

6.1 Shear stress, compressive stress and tensile stress. (2)

6.2 $P = F/A$

$F = P \times A$

$= 8 \times 10^6 \times \pi(0,4)^2/4$

$= 1005309,649$ N

$= 1005,31$ kN (3)

6.3 6.3.1 $P = F/A$

$A = F/P$

$= 50\ 000/300000$

$= 0,167\ m^2$

$A = l \times l$

$l = \sqrt{A}$

$= 0,408$ m $= 40,8$ cm (3)

$\epsilon = x/l = 0,002/20 = 0,0001$

6.3.2 (2)

6.4 6.4.1 $C = r$ (1)

6.4.2 $V = l^3$ therefore $G = \frac{l}{2}$ for all 3 dimensions (2)

[13]

QUESTION 7

7.1 The volume of a given mass of gas is inversely proportional to the pressure , provided that the temperature is kept constant. Thus for a given mass of gas p x V = constant. Therefore $P_1V_1 = P_2V_2 = $ constant (2)

7.2 The volume of a given mass of gas is directly proportional to its thermodynamic temperature, provided that the pressure is kept constant.

So for a given mass of gas V/T = constant and $V_{1/}T_1 = V_{2/}T_2$ (2)

7.3 $\Delta V = V_o \times 3\alpha \times \Delta t$

$0{,}6 = 50 \times 3 \times 12 \times 10^{-6} \times \Delta t$

$\Delta t = 333{,}333.\ ^\circ C$

$t_f = 333{,}333 + 20 = 353{,}333\ ^\circ C$ (3)

7.4 $P_1V_{1/}T_1 = P_2V_{2/}T_2$ but the pressure remains constant

$V_{1/}T_1 = V_{2/}T_2$

$40/293 = V_2/323$

$V_2 = 44{,}096\ cm^3$ (3)

7.5 STP implies that T = 273 Kelvin and P = 101,3 kPa

Density = 1,42 kg/m^3 implies that 1,42 kg of the gas has a volume of 1 m^3

Therefore $P_2V_2 = mRT_2$

$0{,}9 \times 10^5 \times V_2 = 1{,}42 \times 261{,}311 \times 303$ – the mass remains constant

$V_2 = 1{,}249\ m^3$

Density of oxygen = m/V = 1,42/1,249 = 1,137 kg/m^3 (4)

[14]

TOTAL: 100

