(10)

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

AUGUST EXAMINATION

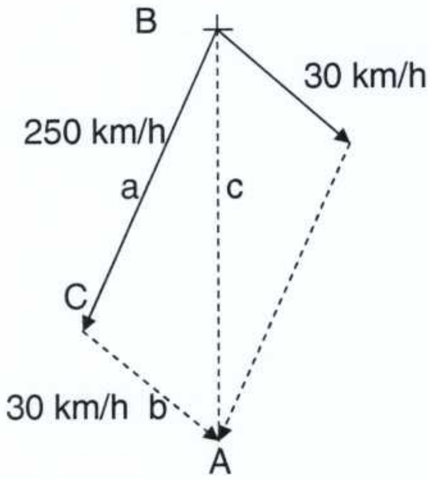
ENGINEERING SCIENCE N4

27 JULY 2012

This marking guideline consists of 10 pages.

QUESTION 1

1.1



$$\frac{\sin B}{b} = \frac{\sin A}{a}$$

sin B = 30sin45°/250

B = 4,868°

C= 180° - (45° + 4,868°)

= 130,13°

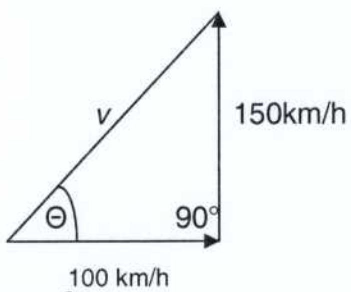
$c^2 = a^2 + b^2 - 2ab\cos C$

$= 250^2 + 30^2 - 2(250)(30)\cos 130{,}13°$

c = 270,31 km/h

The pilot must steer South 4,868° West OR West 85,132° South (4)

1.2



$V^2 = 150^2 + 100^2$

V = 180,28 km/h

$\Theta = \tan^{-1} 150/100$

= 56,31°

Direction of aeroplane is East 56,31° North OR North 33,69° East (4)

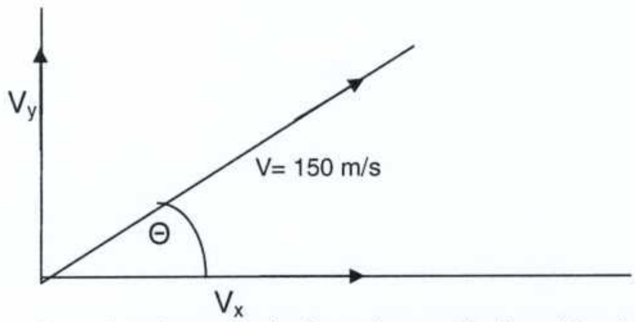
1.3 1.3.1

$v = u + gt$
$0 = 50 - 9{,}8 \times t$
$t = 5{,}1$ sec (upwards)
total $t = t(up) + t(down)$
$= 10{,}2$ sec (2)

1.3.2

$s = ut + 1/2gt^2$
$= 50(5{,}1) + ½ (-9{,}8)(5{,}1)^2$
$= 255 - 127{,}45$
$= 127{,}55$ meter (2)

1.4



Resolve the velocity into the vertical and horizontal components:
$V_x = 150 \times \cos\Theta$
$V_y = 150 \times \sin\Theta$

Time for vertical displacement:

$v = u + gt$
therefore $t = (v - u) \div g$
$= (0 - 150 \sin\Theta) \div (-9{,}8)$
$= 15{,}306 \sin\Theta$ seconds

s(height) $= (v^2 - u^2) \div 2g$
$= 0 - (150 \times \sin\Theta)^2 \div 2(-9{,}8)$
$= 1147{,}96 (\sin\Theta)^2$ meter

s(horizontal) $= 3 \times V_y$
$= 3 \times 1147{,}96 (\sin\Theta)^2$
But $s = V_x \times t$
$= 150 \times \cos\Theta \times 2 \times 15{,}306 \sin\Theta$

Therefore: $3 \times 1147{,}96 (\sin\Theta)^2 = 150 \times \cos\Theta \times 2 \times 15{,}306 \sin\Theta$

Simplify: $\sin\Theta/\cos\Theta = 4591{,}8/3443{,}88$
$\tan\Theta = 1{,}333$
$\Theta = 53{,}13°$ (5)

[17]

QUESTION 2

2.1 Angular displacement is the distance travelled on a circular route, measured in radians (2)

2.2 2.2.1 $v = u + at$

therefore $\omega_2 = \omega_1 + \alpha t$

$\alpha = (\omega_2 - \omega_1)/ t$

$= (10 - 4)/20$

$= 0{,}3 \text{ rad/s}^2$ (2)

2.2.2 $\Theta = (\omega_2)^2 - (\omega_1)^2/2\alpha$

$= (100 - 16)/ (2 \times 0{,}3)$

$= 140$ radians (2)

2.2.3 $\Theta = 2\pi n = (\omega_2 - \omega_1)/ \alpha$

$n = \Theta/2\pi$

$= 140/2\pi$

$= 22{,}28$ rev (2)

2.3 $P = F_e \text{ x } v$

$= F_e \text{ x } \omega r$

$= 400 \text{ x } (500\text{x}2\pi)/60 \text{ x } 0{,}18$

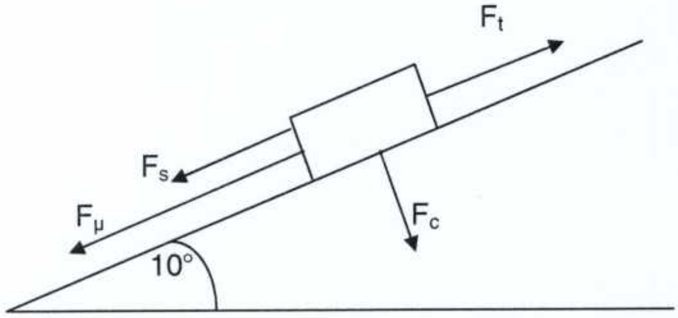
$= 3769{,}92$ Watt (4)

[12]

QUESTION 3

3.1 Whenever an object exerts a force on another object, the second object will exert an equal, but opposite force on the first object. ie: For every action there is an equal and opposite reaction force. (1)

3.2



$F_s = mg \times \sin\Theta$

$= 9,8 \times 150\ 000 \times \sin 10°$

$= 255\ 262,82$ N

$P = F_t \times v$

$= (F_R + F_S) \times v$

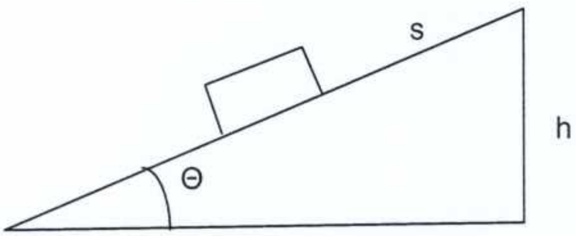
$= (8000 + 255\ 262,82) \times 20$

$= 5\ 265\ 256,42$ Watt

$= 5,265$ MW

(3)

3.2



$\Theta = \tan^{-1}(1/5)$

$= 11,31°$

Kinetic energy at the bottom $= \frac{1}{2} mv^2$

$= \frac{1}{2} \times 1 \times 1,5^2$

$= 1,125$ J

Loss in kinetic energy is equal to gain in kinetic energy:

Potential energy = $m \times g \times h$

$h = E_k/mxg$
$= 1,125/1x9,8$
$= 0,1148$ m

Distance up the incline: $h/s = \sin\Theta$

$s = h/\sin\Theta$

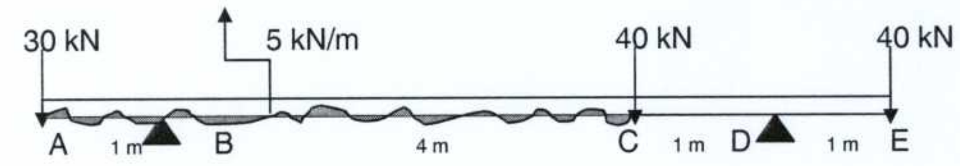
$= 0,1148/\sin 11,31°$

$= 0,585$ metre

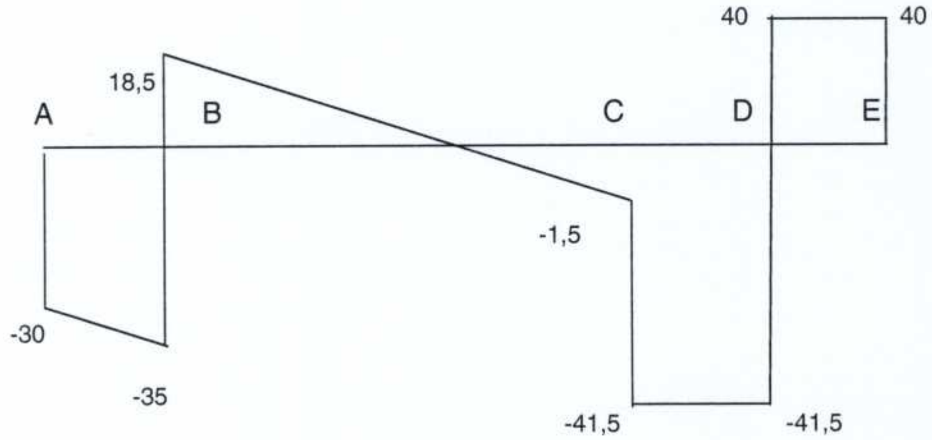
(5)
[9]

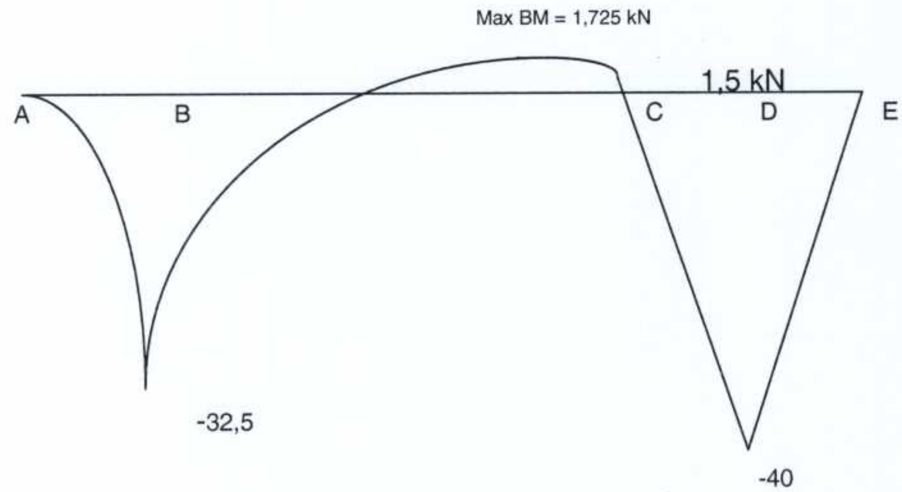
QUESTION 4

4.1 4.1.1



(1)





(1)

4.1.2 Take moments about B:

$\sum$ CWM = $\sum$ ACWM

(40 x 4) + (40 x 6) + (25x1,5) = (30 x 1) + 5 x D

D = 81,5 kN

Take moments about D:

$\sum$ ACWM = $\sum$ CWM

(40 x 1) + B x 5 = (30 x 6) + (25 x 3,5) + (40 x 1)

B = 53,5 kN

Test: $\sum\uparrow$ F = 81,5 + 53,5 = 135 kN

And $\sum\downarrow$ F = 30 + 25 + 40 + 40 = 135 kN (3)

4.1.3 BM at A = 0

BM at B = -(20 x 23) – (40 x 4) – (40 X 6) + (81,5 X 5) = - 32,5 kNm

BM at C = - (40 X 2) + (81,5 X 1) = 1,5 kNm

BM at D = - 40 X 1 = - 40 kNm

BM at E = 0 (3)

4.1.4 See attached (5)

4.1.5 Let the maximum bending moment be at z

Shear forces at z = 0

Therefore - 30 + 53,5 - 5 x x= 0

x = 4,7 meter

therefore maximum bending moment is 4,7 meter from the left

Maximum bending moment at z: - (30 x 4,7) + (53,5 x 3,7) – (5 x 4,7 x 2,35)

= 1,725 kNm (4)

4.2 4.2.1 = 1/3 x *h* (1)

4.2.2 G: $\bar{x}$ = r and $\bar{y}$ = ¼ x *h* (1)

[18]

QUESTION 5

5.1 The density of a substance is the mass per unit volume of the substance and is measured in kg/m^3 (1)

5.2 Pressure has the same magnitude in all directions at any point in a liquid.
The pressure in a liquid is the same at all points on the same horizontal plane in its container.
The pressure in a liquid is independent of the size and shape of its container
Pressure in a liquid increases with depth, and is directly proportional to the depth
Pressure exerted by a fluid depends on the density of the fluid, the greater the density the greater the pressure exerted.
When pressure is exerted on the surface of the fluid, then the pressure is propagated at the same magnitude in all directions by the liquid. (any two) (2)

5.3 5.3.1 Cross sectional area of plunger = 30/100 x 0,2 = 0,06 m^3

Volume = a x h x n

= 0,06 x 0,2 x 12

= 0,144 m^3 (2)

5.3.2 A x H = n x a x h

0,06 x 0,2 = 0,2 x H

H = 0,06 m

H = 60 mm (2)

5.3.3 F/A = f/a

F = (0,2 x 600)/0,06

F = 2 000 N (2)

5.3.4 MA = F/f

= 2000/600

= 3,333 (2)

5.3.5 Pressure = f/a OR Pressure = F/A

= 600/0,06 = 2000/0,2

= 10 kPa = 10 kPa (2)

5.4 5.4.1 $V = \pi d^2/4 \times h \times 2$

$= \pi \times (0{,}08)^2/4 \times 0{,}3 \times 2$

$= 0{,}00302\ m^3$

Power = Pressure x Volume

$= 1 \times 10^6 \times 0{,}00302 \times 200/60 \times 100/85$

$= 11\ 843{,}14$ Watt

$= 11{,}843$ kW (4)

5.4.2 Volume = $\pi d^2/4 \times h$ x speed of pump

$= 0{,}00302 \times 200$

$= 0{,}604\ m^3$ (2)

[20]

QUESTION 6

6.1 Tensile stress is produced when an object is subjected to a tensile load and it may cause the object to elongate and with a reduction in cross-sectional area.
Compressive stress is produced when an object is subjected to a compressive load and it may cause the object to shorten and with an increase in cross-sectional area. (2)

6.2 $P = F/A$
$F = P \times A$
$= 5 \times 10^6 \times \pi(0{,}6)^2/4$
$= 1{,}414$ MN (3)

6.3 6.3.1 $\sigma = F/a$
$= 100 \times 10^3/0{,}025^2$
$= 160$ MPa (2)

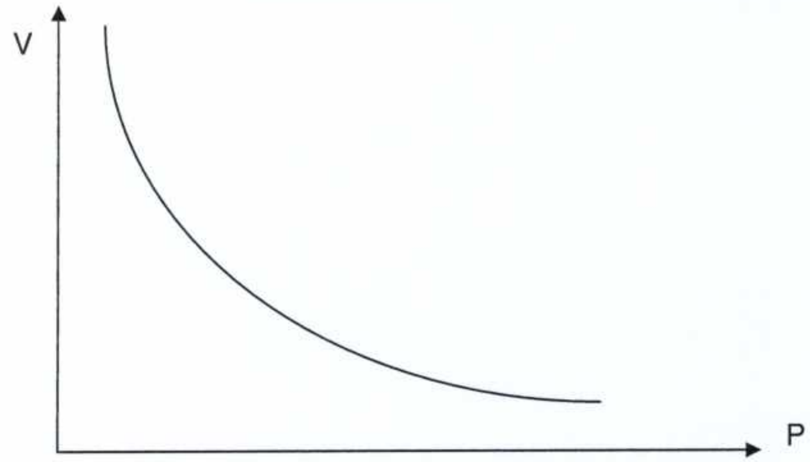
6.3.2 $\epsilon = x/l = 0{,}3 \times 10^{-3}/330 \times 10^{-3} = 0{,}909 \times 10^{-3}$ (2)

6.3.3 $E = \sigma/\epsilon = 160 \times 10^6/0{,}909 \times 10^{-3} = 176$ GPa (2)

[11]

QUESTION 7

7.1 The volume of a given mass of gas is inversely proportional to the pressure exerted on it, provided that the temperature is kept constant. Thus for a given mass of gas P x V = constant. Therefore $P_1V_1 = P_2V_2$



(5)

7.2 $\Delta l = l_o \times \alpha \times \Delta t$

$1{,}722 \times 10^{-4} = 0{,}1 \times \alpha \times 60$

$\alpha = 2{,}87 \times 10^{-5} /^\circ C$ (3)

7.3 $T_1 = 288$ K

$T_2 = 278$ K

7.3 7.3.1 $P_1V_1/T_1 = P_2V_2/T_2$

$1600 \times 10/288 = P_2 \times 10/278$

$P_2 = 1544{,}44$ kPa (3)

7.3.2 PV = mRT

m = PV/RT

$= (1600 \times 10^3) \times (10 \times 10^{-3}) / (260 \times 288)$

$= 0{,}214$ kg (2)

[13]

TOTAL: 100