(9)

higher education
& training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

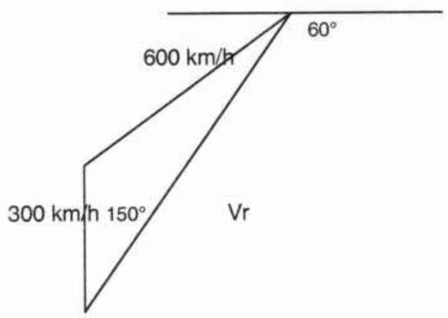
ENGINEERING SCIENCE N4

21 NOVEMBERN 2012

This marking guideline consists of 9 pages.

QUESTION 1

1.1



1.2 $V_r^2 = 300^2 + 600^2 - 2(300)(600)\cos 150°$
$= 450\ 000 - 360\ 000\ (-0{,}866)$
$= 761\ 769{,}1454$
$V_r = 872{,}794$ km/h (3)

Direction: $\dfrac{\sin\Theta}{300} = \dfrac{\sin 150°}{872{,}793}$

$\sin\Theta = 0{,}17186$
$\Theta = 10°$

Therefore, the velocity of L is relative to M 872,794 k/h West 70° South (2)

1.2

$U = 30$ ms ; $v = 0$ m/s ; $a = g = -9{,}8 m/s^2$
$U_x = 30\cos 15°$
$= 29$ m/s

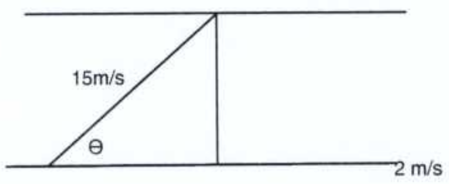
$U_y = 30\sin 15°$
$= 7{,}76$ m/s

1.2.1 $t = \dfrac{v-u}{a} = \dfrac{0-7{,}76}{-9{,}8} = 0{,}792$ seconds (3)

1.2.2 $s = ut + ½at^2$
$= (7{,}76 \times 0{,}792) + ½\ (-9{,}8)(0{,}792)^2$
$= 3{,}072$ m (2)

1.2.3 $s = ut = U_x \times 2t$
$= 29 \times 2 \times 0{,}792$
$= 45{,}936$ m (2)

1.3 1.3.1



$\cos\theta = 2/15$
$\theta = \cos^{-1}(2/15) = 82{,}338°$ with regard to the riverbank and upstream (3)

1.3.2 Resultant velocity = $\sqrt{(15^2 - 2^2)}$ = 14,866 m/s
t = s/v = 100/14,866
= 6,727 seconds (2)
[17]

QUESTION 2

2.1 Angular acceleration is the tempo of change in (2)

2.2 ω_1 = 3000 rev/min = (3000 x 2π)/60 = 314,159 rad/s
ω_2 = 1000 rev/min = (1000 x 2π)/60 = 104,719 rad/s
θ = 80 x 2π rad

2.2.1 θ = 2π N
= 2π x 80
= 502,655 rad (2)

2.2.2 $\alpha = (\omega_2^2 - \omega_1^2)/2\theta$
= $(104{,}719^2 - 314{,}159^2)/2 \times 80 \times 2\pi$
= -87,266 rad/sec (2)

2.2.3 $t = (\omega_2 - \omega_1)/\alpha$
= (104,72 – 314,59)/-87,266
= 2,4 seconds (2)

2.3 2.3.1 T = F x r
= 450 x 0,3
= 135 Nm (2)

2.3.2 W = T x θ
= 135 x 60 x 2π /360
= 141,372 J (3)
[13]

QUESTION 3

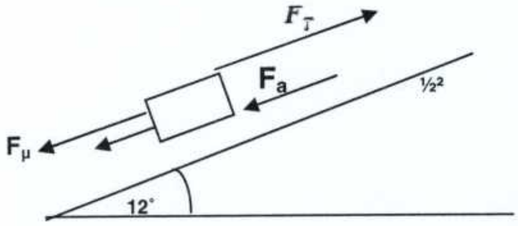
3.1 u = 108 km/h = 30 m/s; v = 0 m/s; s = 100 meter

3.1.1 $a = (v^2 - u^2)/2s$
$= (0 - 30^2)/(2 \times 100)$
$= -900/200$
$= -4,5\ m/s^2$ (2)

3.1.2 $t = (v - u)/a$
$= 0 - 30/-4,5$
$= 6,667$ sec (2)

3.1.3 $F = ma - F_{\square}$
$= 4000 \times 4,5 - 2500$
$= 15\ 500$ N (2)

3.2



V = 72 km/h = 20 m/s

3.2.1 $a = v - u/t$
$= 20 - 0/20$
$= 1\ m/s^2$

$F_t = F_s + F_a + F_u$
$= mg\sin\Theta + ma + 600$
$= 1000 \times 9,8 \times \sin 12° + 1000 \times 1 + 600$
$= 3637,535$ N (4)

3.2.2 $s = ut + ½at^2$
$= (0 \times 20) + ½(1)(20^2)$ $s = ut + ½at^2$
$= 200$ m $= (0 \times 20) + ½(1)(20^2)$
$P = W/t$ $= 200$ m
$= 3637,53 \times 200/2 \times 100/80$
$= 45469,182$ Watt
$= 45,469$ kW (3)

[13]

QUESTION 4

4.1 See the sketch and other diagrams

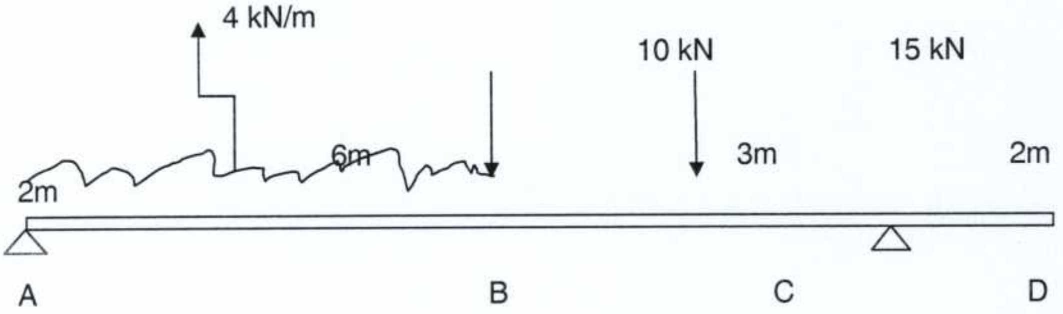
4.2 Take moments around A:

ΣCWM = ΣACWM
(4 x 6 x 3) + (10 x 6) + (15 x 9) = D x 11
D = 24,273 kN (2)

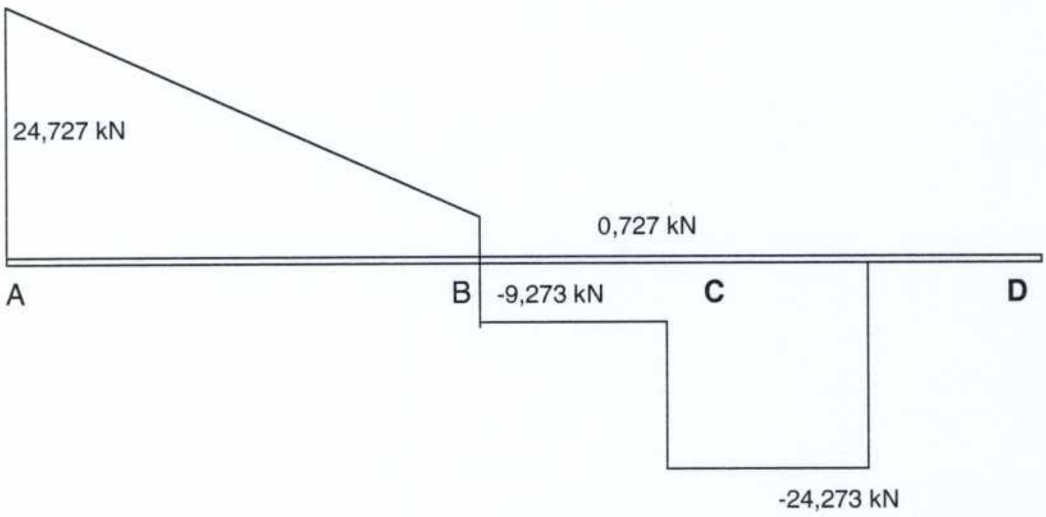
Take moments around D:
ΣCWM = ΣACWM
A x 11 = (24 x 8) + (10 x 5) + (15 x 2)
A = 24,727 kN (2)

4.3 BM at B = -(24 x 3) + (24,727 x 6) = 76,362 kN.m
BM at C = -(24 x 6) – (10 x 3) + (24,727 x 9) = 48,543 kN.m
BM at D = -(24 x 8) – (10 x 5) – (15 x 2) + (24,727 x 11) = -0,003 kN.m
BM at F = -(4 x 3 x 1,5) + **(24,727 x 3)** = 56,181 kN.m (4)

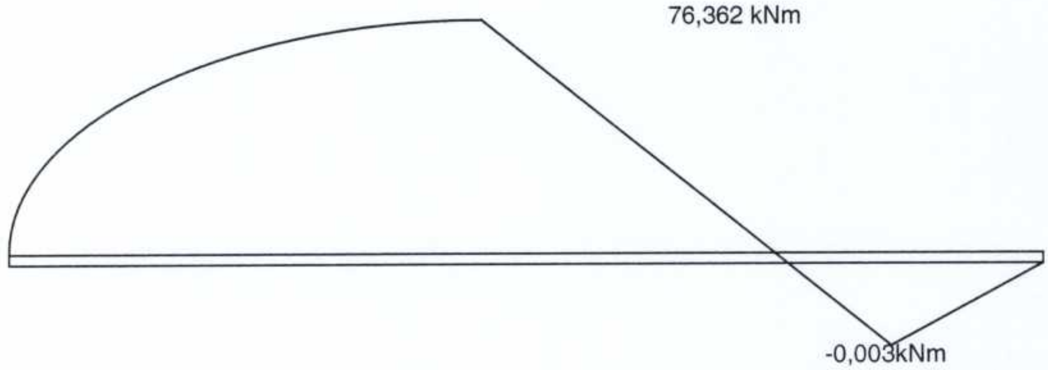
4.4 Maximum Bending moment at B = 76,362 kN.m (1)


4 kN/m
10 kN
15 kN
6m
3m
2m
2m
A
B
C
D

(1)


24,727 kN
0,727 kN
A
B
-9,273 kN
C
D
-24,273 kN

(2,5)


76,362 kNm
-0,003kNm

(2,5)

[15]

QUESTION 5

5.1 The pressure exerted on the surface of a liquid within a closed container acts on the liquid in all directions with the same magnitude. (1)

5.2
- The pressure exerted by a liquid depends on the density of the liquid.
- The pressure at a point in a liquid increases in proportion to the depth of the point
- The pressure at a point in a liquid is the same for points at the same horizontal level
- The pressure does not depend on the size or shape of the vessel containing the liquid (Any TWO) (2)

5.3 5.3.1

$F/D^2 = f/d^2$
$f/25^2 = 3000 \times 9{,}8/200^2$
$f = 459{,}375$ N

$MA = f/F_l$
Therefore $F_l = 459{,}759/14 \times 100/80$
$= 41{,}016$ N (4)

5.3.2

$nd^2h = D^2H$
$n = D^2H/d^2h \times 100/94$
$= (200^2 \times 500)/(25^2 \times 80) \times 100/94$
$= 425{,}532$ strokes (3)

5.4.1

$W = F \times s$
$s = W/F$
$= 4000/\ 12\ 000$
$= 0{,}333$ m
$= 333$ mm (2)

5.4.2

$P = F/A$
$= 12\ 000/\pi(0{,}15)^2/4$
$= 679\ 061{,}09$ Pa
$= 679{,}061$ kPa (2)

5.4.3

$V = \pi d^2/4 \times h$
$= \pi(0{,}15)^2/4 \times 0{,}333$
$= 5{,}885 \times 10^{-3}\ m^3$
$= 5{,}885$ litres (2)

[16]

QUESTION 6

6.1 Hookes's Law states that within the elastic limit of any material the ratio of the stress to the strain produced is constant. (2)

6.2 $= F/A$ and $\varepsilon = x/L$

$E = \sigma/\varepsilon$
$= F/A \; / \; x/L$
$= F/A \times L/x$
248×10^9
$= F/2,5 \times 10^{-6} \times 0,310/0,25 \times 10^{-3}$
$= 0,31F/0,625 \times 10^{-9}$
$F = 500$ N (4)

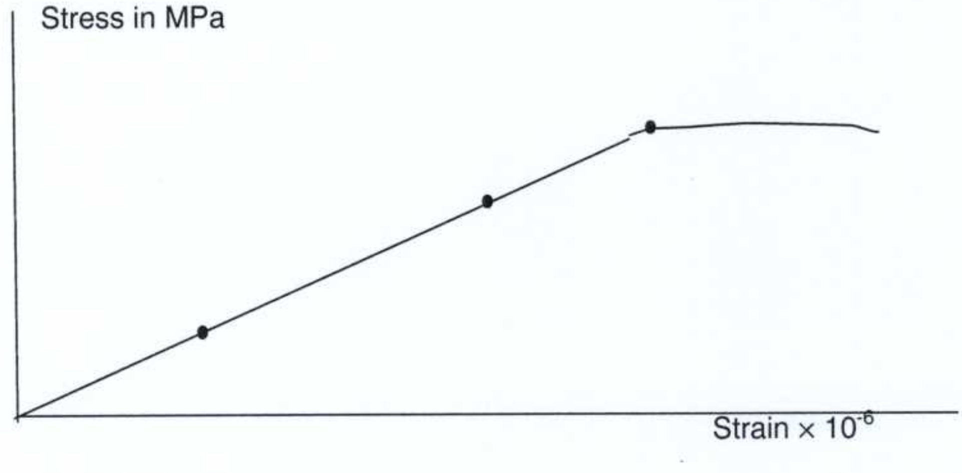
6.3 6.3.1 Area $= (20 \times 10^{-3})^2 \times \pi/4 = 314 \times 10^{-6}$ m^2

Stress in MPa

Load in kN	0	10	20	30	40	50
Stress in MPa	0	32	64	96	127	159

Strain

Elongation in mm	0	0,0121	0,0243	0,0361	0,0485	0,0618
Strainx 10^{-6}	0	151	303	451	606	772



(5)

6.3.2 $E = \Delta\sigma/\Delta\varepsilon$
$= (127 \times 10^6 - 32 \times 10^{6)}/(606 \times 10^{-6} - 151 \times 10^{-6})$
$= 96 \times 10^6/455 \times 10^{-6}$
$= 0,21 \times 10^{12}$ P $= 210 \times 10^9$ Pa
$= 210$ GPa (3)

[14]

QUESTION 7

7.1 The change in length per unit length of a material per degree change in temperature. (1)

7.2 D_0 (steel) = 55 mm en D_0 (hole in brass plate) = 55 – 0,0075 = 54,9925 mm

ΔD *(steel)* = $D_0 \times \alpha \times \Delta t = 55 \times 12 \times 10^{-6} \times \Delta t$

ΔD *(hole in brass plate)* = $D_0 \times \alpha \times \Delta t = 54{,}9925 \times 19 \times 10^{-6} \times \Delta t$

But ΔD(steel) + 55 = ΔD (hole in brass plate) + 54,9925

Therefore: $55 \times 12 \times 10^{-6} \times \Delta t + 55 = 54{,}9925 \times 19 \times 10^{-6} \times \Delta t + 54{,}9925$
$\Delta t = 19{,}488$ °C

Therefore the common final temperature is = 30 + 19,488 = 49,488 °C (5)

7.3 7.31 PV = mRT when filled
$380 \times 10^3 \times 0{,}075 = m \times 265 \times 323$
m = 0,333 kg (2)

7.3.2 PV = mRT after oxygen being used
$280 \times 10^3 \times 0{,}075 = m \times 265 \times 298$
m = 0,2659 kg left in cylinder

Therefore mass of oxygen used by patient = 0,333 - 0,2659 = 0,0671 kg = 67,1 gram (4)
[12]

TOTAL: 100