higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

AUGUST EXAMINATION

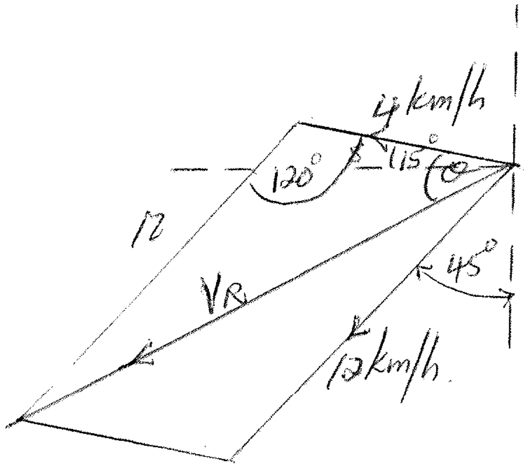
ENGINEERING SCIENCE N4

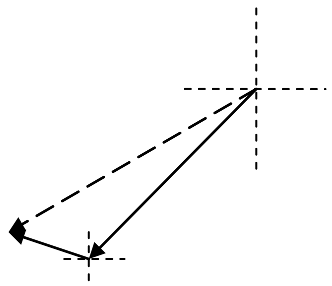
28 JULY 2014

This marking guideline consists of 10 pages.

QUESTION 1

1.1 1.1.1





(2)

1.1.2 $V_R = \sqrt{12^2 + 4^2 - 2(12)(4)\cos 120°}$ √

$= 14,422$ km/h √

$\frac{\sin \theta}{12} = \frac{\sin 120°}{14,422}$ or $\frac{\sin\theta}{4} = \frac{\sin 120°}{14,422}$

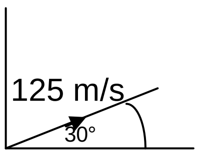
$\therefore \theta = 46,103°$ √ $\theta = 13,898°$

$46,103 - 15 = 31,103°$ $45 + 13,898 = 58,898°$

S 58,898° W

Direction: W 31,103° south √ (3)

1.2



HC = 125 cos30° = 108,253 m/s
VC = 125 sin30° = 62,5 m/s

1.2.1 $t_2 = \frac{2u\sin x}{g}$ or $v = u + gt$

$= \frac{2(125)\sin 30°}{9,8}$ √ $0 = 62,5 - 9,8t$

$t = 6,378 \times 2$

$t = 12,756$ s

$= 12,755$ s √ (2)

1.2.2 $Lmax = \frac{u^2}{g} = \frac{125^2}{9,8}$ or VC(45°) = 88,388 m/s HC(45°) = 88,388 m/s

$t = \frac{2(88,388)}{9,8} = 18,038$ s

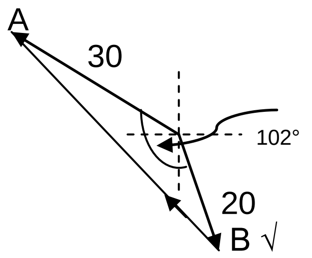
$= 1594,388$ m √ $s = (88,388)(18,038) = 1594,343$ m (1)

1.2.3 $s = ut + \frac{1}{2}gt^2$ or $s = ut + \frac{1}{2}gt^2$

$\therefore h = (125 \sin 30°)(5) + \frac{1}{2}(-9{,}8)(5)^2$ ✓ $h = (62{,}5)(5) - (0{,}5)(9{,}8)(5^2)$

= 190 m✓ h = 190 m (2)

1.3



$\therefore {}_AV_B = \sqrt{30^2 + 20^2 - 2(30)(20)\cos 102°}$✓

=39,364 km/h✓

$$\frac{\sin\theta}{30} = \frac{\sin 102°}{39{,}364}$$

$\therefore \theta$ = 48,199°✓

90 – 48,199 – 15 = 26,801°

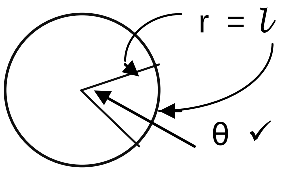
Direction: W26,801°N✓ (5)

[15]

QUESTION 2

2.1 One radian is the angle in a circle, subtended by an arc on the circumference equal in length to the radius of the circle.✓ (1)

2.2



(1)

2.3 2.3.1 Ø = 120° ✓ or $\frac{360°}{12} \times 4 = 120°$

= 2,094 rad✓ (2)

2.3.2 $S = 2\pi r\left(\frac{1}{3}\right)$ or s = θr

$= 2\pi(1{,}2)\left(\frac{1}{3}\right)$ ✓ s = (2,094)(1,2)

= 2,513 m ✓ s = 2,513 m (2)

2.3.3 $\omega = 2\pi n = \frac{\emptyset}{t}$

$= \frac{2{,}094}{20 \times 60}$ ✓

$= 1{,}745 \times 10^{-3}$ rad/s ✓ (2)

2.3.4 $v = wr$

$= 1{,}745 \times 10^{-3}(1{,}2)$ ✓

$= 2{,}094 \times 10^{-3}$ m/s ✓ (2)

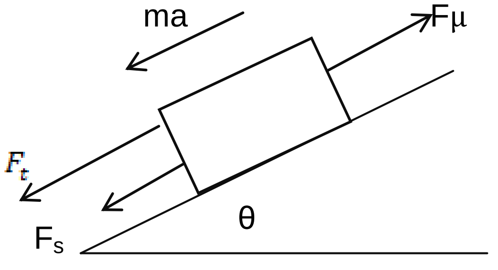
[10]

QUESTION 3

3.1 The rate of change in momentum is directly proportional to the unbalanced force and in the direction of the unbalanced force.✓ (1)

3.2 $Ft + Fs - F\mu = ma$ also $\tan\theta = \frac{1}{15}$

$Ft = 0$ $\theta = 3{,}814°$



3.2.1 $F = mg\sin\theta = Fs\ Sin\theta = \frac{1}{15}$ √

$= 588\ N$✓

or $F_P = mg\sin\theta$

$= (900)(9{,}8)(\sin 3{,}814°)$

$= 586{,}686$ N (2)

3.2.2 $Fs - Fu = ma$

$\therefore 588 - 200$ ✓ or $586{,}686 - 200$

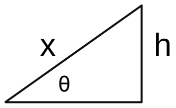
$\therefore ma = 388N$ ✓ $ma = 386{,}686$ N (2)

3.2.3 $a = \frac{fa}{m}$

$= \frac{388}{900}$ √ or $\frac{386{,}686}{900}$

$= 0{,}431$ m/s² √ $= 0{,}43$ m/s^2 (2)

3.2.4



$\sin 3{,}814° = \frac{h}{402{,}797}$

h = 26,793 m

$v^2 = u^2 + 2as$

$\therefore 25^2 = 16{,}667^2 + 2(0{,}431)x$✓

$\therefore x = 402{,}797m$ ✓ (2)

3.2.5 $Ep\ (lost) = mgh$

$= 900(9{,}8)402{,}797\ (\frac{1}{15})$ ✓ or (900)(9,8)(26,793)

$= 236\ 844{,}636J$✓ = 236 314,26 J

$= 236{,}845kJ$ (2)

[11]

QUESTION 4

4.1 The bending moment at a specific point of a beam is the algebraic sum of the clockwise and anti-clockwise moments of the forces acting on the beam, to the left or to the right of that point on the beam.✓✓ (2)

4.2.1 $let\ AF = x$

$\therefore x = \frac{21{,}455}{4} = 5{,}364m\ from\ A$ ✓

$BMmax = BMf$

$= 21{,}455(5{,}364) - 21{,}455\left(\frac{5{,}364}{2}\right)$ ✓

$= 57{,}542\ kNm$ ✓ (3)

4.2.2 $BMB: 21{,}455(6) - 24(3) = 56{,}73kNm$

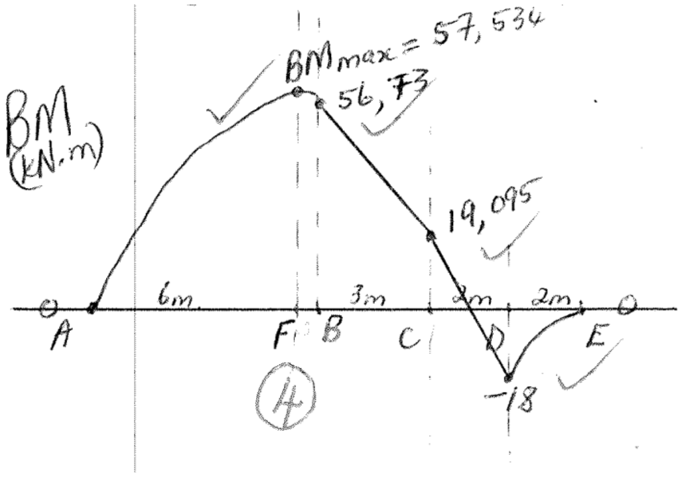
$BMD = 21{,}455(11) - 24(8) - 10(5) - 6(2) = -17{,}995 \approx -18kNm$

Or from right:

$BMd = -5(2) - 8(1)$

$= -18kNm$

$BMc = 21{,}455(9) - 24(6) - 10(3) = 19kNm$



(4)

4.3 V1(CONE) = $\frac{1}{3}\left(\frac{\pi D^2}{4}\right)h$ $x_1 = \frac{3}{4}(32) = 24\,mm$

= 19301,945 mm^3 ✓

V2(CYLINDER) = $\left(\frac{\pi D^2}{4}\right)h$ $x_2 = 32 + \frac{1}{2}(60) = 62\,mm$

= 108573,442 mm^3 ✓

V3(HEMISPHERE) = $\frac{4}{6}\pi r^3$

$x_3 = 32 + 60 + \frac{3}{8}(24) = 101\,mm$

= 28952,918 mm^3✓

$Vtotal = 156\,828{,}305\,mm^3$

$\therefore \bar{x} = \frac{V_1x_1 + V_2x_2 + V_3x_3}{V_{total}}$

$= \frac{19301{,}945(24) + 108573{,}442(62) + 28952{,}918(101)}{156\,826{,}305}$ ✓

$= 64{,}523mm\ from\ A$✓

(5)

[14]

QUESTION 5

5.1 The pressure exerted on the surface of a liquid in a closed container is spread throughout the liquid with the same intensity in all directions.✓✓ (2)

5.2.1 $W = F_{RAM} = mg = 2300(9{,}8)$
$= 22540\ N$✓

$\frac{Fpl}{d^2} = \frac{Fr}{D^2}$

$F_{PL} = \left(\frac{20}{100}\right)^2 \times 22540$ ✓

= 901,6 N ✓

$\frac{Fpl}{Epl}$ = MA

$\therefore Epl = \frac{901{,}6}{16}$

= 56,35 N ✓

$\eta = 85\%$

$\therefore$ effective $Epl = \frac{56{,}35}{1}$ x $\frac{100}{85}$ ✓

= 66,294 N ✓ (5)

5.2.2 $V = A \times L \times 5 \times 0{,}95$

$= \frac{\pi d^2}{4} \times L \times 5 \times 0{,}95$

$= \pi \frac{(0{,}02)^2}{4} \times 0{,}05 \times 5 \times 0{,}95$✓✓

$= 7{,}461 \times 10^{-5}\ m^3$ ✓ (3)

5.2.3 $Vpl = Vram$

$\therefore 7{,}461 \times 10^{-5} = \pi \frac{(0{,}1)^2}{4} \times h$ ✓

$\therefore h = 0{,}0095 m$

$= 9{,}5 mm$ ✓ (2)

5.3 5.3.1 V/sec = V/stroke × n

= a x sl x n

= 17,671 x 10^{-3} × 0,3 x $\frac{100}{60}$ ✓

= 8,836 x $10^{-3} m^3/s$ ✓ (2)

5.3.2 F/sec = mg

= ρVg

=1 000 (8,836 X 10^{-3})×9,8 ✓

= 86,593 N/s ✓ (2)

5.3.3 Power = F/sec × h stat

= 86,593 × 18 ✓

= 1558,674 W ✓

=1,559 kW (2)

5.4 The hydraulic accumulator is used to store liquid energy under pressure until needed.✓✓ (2)
[20]

QUESTION 6

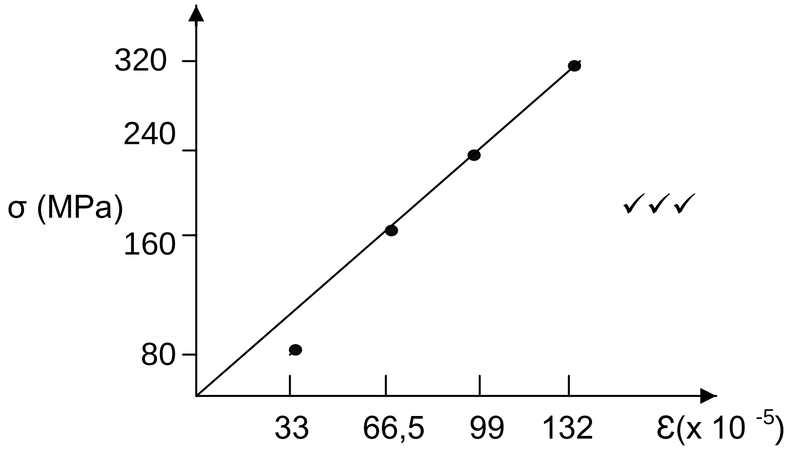
6.1 The principle that the stress applied to a solid is proportional to the strain produced within the elastic limit of the material. ✓✓ (2)

6.2.1

σ (MPa)	ε (× 10^{-5})
80	33
160	66,5
240	99
320	132

✓✓ (2)

6.2.2



✓✓✓ (3)

6.2.3

$$E = \frac{\Delta\sigma}{\Delta\varepsilon}$$

$= \frac{240 \times 10^{6}}{99 \times 10^{-5}}$ ✓

$= 2{,}42424 \times 10^{11}$

= 242,424 GPa ✓ (2)

6.3 $A_0 = 1,3\ cm^2$
$= 1,3 \times 10^{-4}\ m^2$

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

$E = \frac{FL_0}{A\Delta L}$ ✓

F = E x A x α x Δt ✓

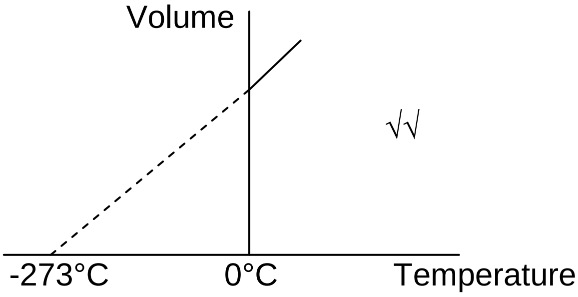
$= 1,28 \times 10^{11} \times 1,3 \times 10^{-4} \times 17 \times 10^{-6} \times 10$ ✓✓
= 2828,8 N ✓
= 2,829 kN (5)

[14]

QUESTION 7

7.1 7.1.1 Charles' law states that for a given mass at constant pressure the volume of a gas is directly proportional to the temperature. (3)

7.1.2



(2)

7.1.3 $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ ✓ (1)

7.2 $\Delta V = V_o . \gamma . \Delta t$

$10 \times 6 \times 0,005 = 10 \times 6 \times 1,795 \times 207 \times 10^{-6} \times \Delta t$ ✓

$\therefore\ \Delta t = \frac{0,005}{(1,795)(207 \times 10^{-6})}$ ✓✓
= 13,457

$\Delta t = t_f - t_i$

$t_f = 13,457 + 25$
= 38,457 °C ✓ (4)

7.3 7.3.1 $P_2V_2 = m_2RT_2$

$(200 \text{ X } 10^3)V_2 = 5 \times 287 \times 308$ ✓
$V_2 = 2{,}21 \text{ m}^3$ ✓ (2)

7.3.2 $P_1V_1 = m_1RT_1$

$500 \times 10^3 \times 1 = m_1 \times 287 \times 298$

$m_1 = 5{,}846 \text{ kg}$ ✓

$P_3V_3 = m_3RT_3$
$P_3 \times 3{,}21 = 10{,}846 \times 287 \times 293$ ✓✓
$P_3 = 284{,}128 \text{ kPa.}$ ✓ (4)
[16]

TOTAL: 100