

higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

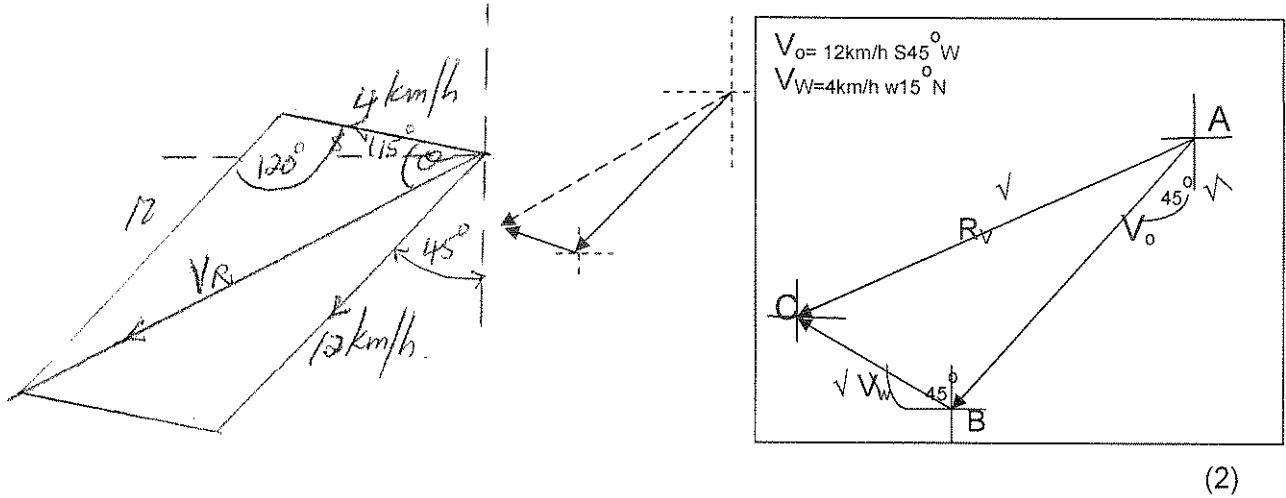
NATIONAL CERTIFICATE
AUGUST EXAMINATION
ENGINEERING SCIENCE N4
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This marking guideline consists of 10 pages.

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28/07/14

QUESTION 1

1.1 1.1.1



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

$$= 14,422 \text{ km/h} \checkmark$$

$$\frac{\sin \theta}{12} = \frac{\sin 120^\circ}{14,422}$$

$$\therefore \theta = 46,103^\circ \checkmark$$

$$46,103 - 15 = 31,103^\circ$$

Direction: W 31,103° south \checkmark

or
$$\frac{\sin \theta}{4} = \frac{\sin 120^\circ}{14,422}$$

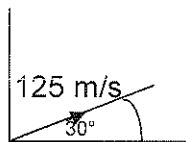
$$\theta = 13,898^\circ$$

$$45 + 13,898 = 58,898^\circ$$

S 58,898° W

(3)

1.2



$$HC = 125 \cos 30^\circ = 108,253 \text{ m/s}$$

$$VC = 125 \sin 30^\circ = 62,5 \text{ m/s}$$

1.2.1
$$t_2 = \frac{2u \sin \alpha}{g}$$

$$= \frac{2(125) \sin 30^\circ}{9,8} \checkmark$$

$$= 12,755 \text{ s} \checkmark$$

or
$$v = u + gt$$

$$0 = 62,5 - 9,8t \checkmark$$

$$t = 6,378 \times 2$$

$$t = 12,756 \text{ s} \checkmark$$

(2)

1.2.2
$$L_{max} = \frac{u^2}{g} = \frac{125^2}{9,8}$$

or
$$VC(45^\circ) = 88,388 \text{ m/s} \quad HC(45^\circ)$$

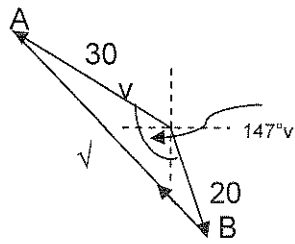
$$= 88,388 \text{ m/s}$$

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

$$= 1594,388 \text{ m} \checkmark \quad s = (88,388)(18,038) = 1594,343 \text{ m} \quad (1)$$

1.2.3 $s = ut + \frac{1}{2}at^2$ or $s = ut + \frac{1}{2}at^2$
 $\therefore h = (125 \sin 30^\circ)(5) + \frac{1}{2}(-9,8)(5)^2 \checkmark$ $h = (62,5)(5) - (0,5)(9,8)(5^2)$
 $= 190 \text{ m} \checkmark$ $h = 190 \text{ m}$ (2)

1.3



(3)

$\therefore v_{AB} = \sqrt{(30)^2 + (20)^2 - 2(30)(20)\cos 147} \checkmark$
 $= 48,025 \text{ km/h} \checkmark$

$\frac{\sin \theta}{30} = \frac{\sin 147}{48,025}$

$\therefore \theta = 19,89^\circ$
 $B = 15 + 19,89 = 34,890^\circ$

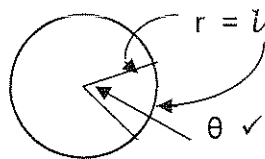
Direction: N34,890°W°✓ OR
 Direction: W55,11N°N✓

(2)
[15]

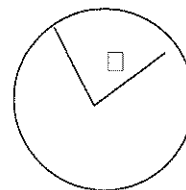
QUESTION 2

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)
 OR
 The S.I unit of angular displacement. ✓

2.2



OR



(1)

2.3 2.3.1 $\theta = 120^\circ \checkmark$ or $\frac{360^\circ}{12} \times 4 = 120^\circ$
 $= 2,094 \text{ rad} \checkmark$ (2)

2.3.2 $S = 2\pi r \left(\frac{1}{3}\right)$ or $s = \theta r$
 $= 2\pi(1,2) \left(\frac{1}{3}\right) \checkmark$ $s = (2,094)(1,2)$
 $= 2,513 \text{ m} \checkmark$ $s = 2,513 \text{ m}$ (2)

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

$$= \frac{2,094}{20 \times 60} \checkmark$$

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

2.3.4
$$v = \omega r$$

$$= 1,745 \times 10^{-3} (1,2) \checkmark$$

$$= 2,094 \times 10^{-3} \text{ m/s } \checkmark \quad (2)$$

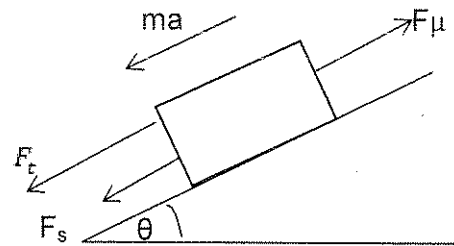
[10]

QUESTION 3

3.1
$$\frac{d}{dt} (mv) = F_{unbalanced}$$
 The rate of change in momentum is directly proportional to the unbalanced force and in the direction of the unbalanced force. (1)

3.2
$$F_t + F_s - F\mu = ma \quad \text{also } \tan\theta = \frac{1}{15}$$

$$F_t = 0 \quad \theta = 3,814^\circ$$



3.2.1
$$F - mg \sin\theta - F_s \sin\theta = \frac{1}{15} \checkmark$$

$$= 588 \text{ N} \checkmark$$

or
$$F_p = mg \sin\theta$$

$$= (900)(9,8)(\sin 3,814^\circ)$$

$$= 586,686 \text{ N} \quad (2)$$

3.2.2
$$F_s - F_u = ma$$

$$\therefore 588 - 200 \quad \checkmark \quad \text{or } 586,686 - 200$$

$$\therefore ma = 388 \text{ N} \quad \checkmark \quad ma = 386,686 \text{ N} \quad (2)$$

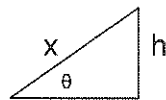
3.2.3

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

$$= \frac{388}{900} \quad \checkmark \quad \text{or} \quad \frac{386,686}{900}$$

$$= 0,431 \text{ m/s}^2 \quad \checkmark \quad = 0,43 \text{ m/s}^2 \quad (2)$$

3.2.4



$$\sin 3,814^\circ = \frac{h}{402,797}$$

$$h = 26,793 \text{ m}$$

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

$$\therefore 25^2 = 16,667^2 + 2(0,431)x \quad \checkmark$$

$$\therefore x = 402,797 \text{ m} \quad \checkmark \quad (2)$$

3.2.5

$$E_p (\text{lost}) = mgh$$

$$= 900(9,8)402,797 \left(\frac{1}{15}\right) \quad \checkmark \quad \text{or} \quad (900)(9,8)(26,793)$$

$$= 236\,844,636 \text{ J} \quad \checkmark \quad = 236\,314,26 \text{ J}$$

$$= 236,845 \text{ kJ} \quad (2)$$

[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. $\checkmark \checkmark$ (2)

The sum of the moments from a section.vv

4.2.1 let $AF = x$

$$\therefore x = \frac{21,455}{2} = 5,364 \text{ m from A} \quad \checkmark$$

$$BM_{\text{max}} = BM_f$$

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

$$= 57,542 \text{ kNm} \quad \checkmark \quad (3)$$

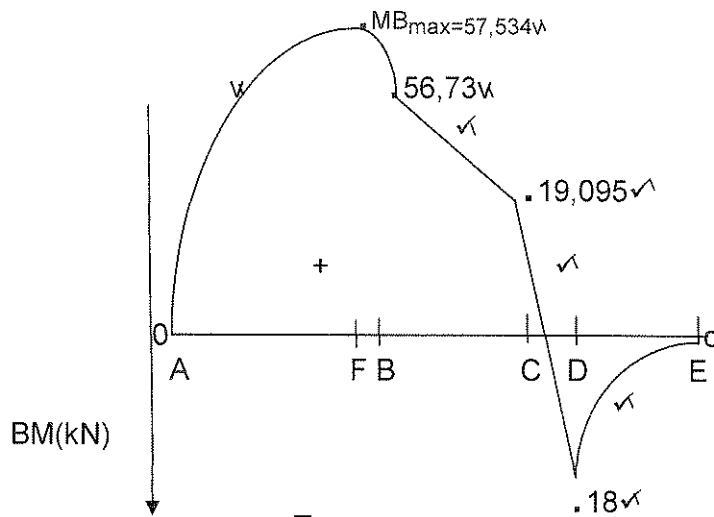
4.2.2 $BMB: 21,455(6) - 24(3) - 56,73kNm$
 $BMD = 21,455(11) - 24(8) - 10(5) - 6(2) = -17,995 \approx -18kNm$

Or from right:

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

$$= -18kNm$$

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



(4)

4.3 $V_1(\text{CONE}) = \frac{1}{3} \left(\frac{\pi D^2}{4} \right) h$ $x_1 = \frac{3}{4} (32) = 24 \text{ mm}$ ✓
 $= 19301,945 \text{ mm}^3$ ✓

$V_2(\text{CYLINDER}) = \left(\frac{\pi D^2}{4} \right) h$ $x_2 = 32 + \frac{1}{2} (60) = 62 \text{ mm}$ ✓
 $= 108573,442 \text{ mm}^3$ ✓

$V_3(\text{HEMISPHERE}) = \frac{4}{6} \pi r^3$
 $x_3 = 32 + 60 + \frac{3}{8} (24) = 101 \text{ mm}$
 $= 28952,918 \text{ mm}^3$ ✓

$$V_{\text{total}} = 156\,828,305 \text{ mm}^3$$

$$\therefore \bar{x} = \frac{V_1 x_1 + V_2 x_2 + V_3 x_3}{V_{\text{total}}}$$

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

$$= 64,524 \text{ mm}$$
 ✓

(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)

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

$$\frac{F_{\text{pl}}}{d^2} = \frac{F_r}{D^2}$$

$$F_{\text{PL}} = \left(\frac{20}{100}\right)^2 \times 22540 \checkmark \quad \text{note minus } \frac{1}{2} \text{ if no S.I units}$$

$$= 901,6 \text{ N} \checkmark$$

$$\frac{F_{\text{pl}}}{E_{\text{pl}}} = MA$$

$$\therefore E_{\text{pl}} = \frac{901,6}{16}$$

$$= 56,35 \text{ N} \checkmark$$

$$\eta = 85\%$$

$$\therefore \text{effective } E_{\text{pl}} = \frac{56,35}{1} \times \frac{100}{85} \checkmark$$

$$= 66,294 \text{ N} \checkmark \quad (5)$$

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

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

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

$$= 7,461 \times 10^{-5} \text{ m}^3 \checkmark \quad (3)$$

$$5.2.3 \quad V_{\text{pl}} = V_{\text{ram}}$$

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

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

$$= 9,5 \text{ mm} \checkmark \quad (2)$$

$$5.3 \quad 5.3.1 \quad V/\text{sec} = V/\text{stroke} \times n$$

$$= a \times s \times n$$

$$= 17,671 \times 10^{-3} \times 0,3 \times \frac{100}{60} \checkmark$$

$$= 8,836 \times 10^{-3} \text{ m}^3/\text{s} \checkmark \quad (2)$$

$$5.3.2 \quad F/\text{sec} = mg$$

$$= \rho Vg$$

$$= 1000 (8,836 \times 10^{-3}) \times 9,8 \checkmark$$

$$= 86,593 \text{ N/s} \checkmark \quad (2)$$

$$5.3.3 \quad \text{Power} = F/\text{sec} \times h \text{ stat}$$

$$= 86,593 \times 18 \checkmark$$

$$= 1558,674 \text{ W} \checkmark$$

$$= 1,559 \text{ kW} \quad (2)$$

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

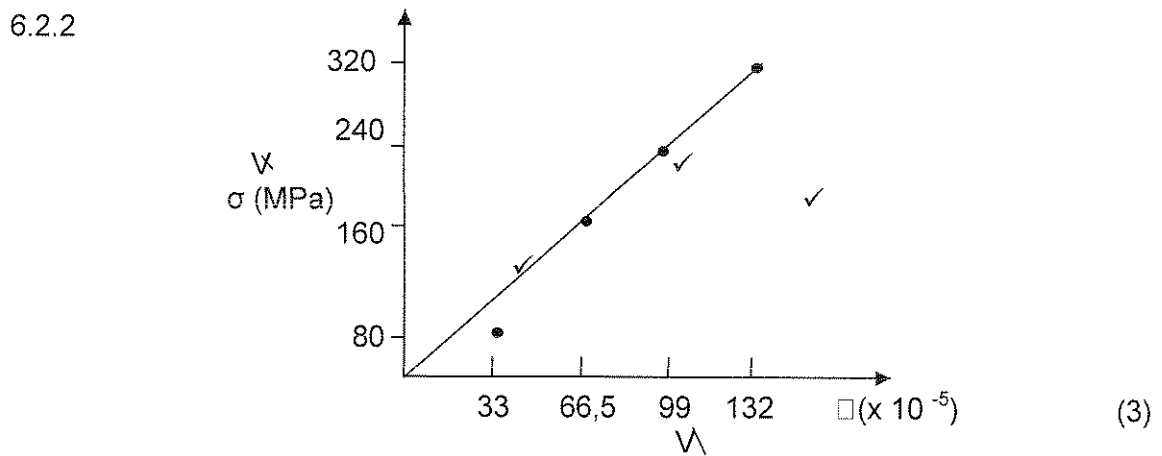
QUESTION 6

- 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 ($\times 10^{-5}$)
80	33
160	66,5
240	99
320	132

✓✓ (2)



6.2.3

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

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

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

$$= 242,424 \text{ GPa} \checkmark \quad [237,24\text{---}247,424] \text{GPa} \quad (2)$$

$$6.3 \quad \Delta_0 = 1,3 \text{ cm}^2 \\ = 1,3 \times 10^{-4} \text{ m}^2$$

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

$$E = \frac{FL_0}{A\Delta L} \checkmark$$

$$F = E \times A \times \alpha \times \Delta t \checkmark$$

$$= 1,28 \times 10^{11} \times 1,3 \times 10^{-4} \times 17 \times 10^{-6} \times 10 \checkmark \checkmark$$

$$= 2828,8 \text{ N} \checkmark$$

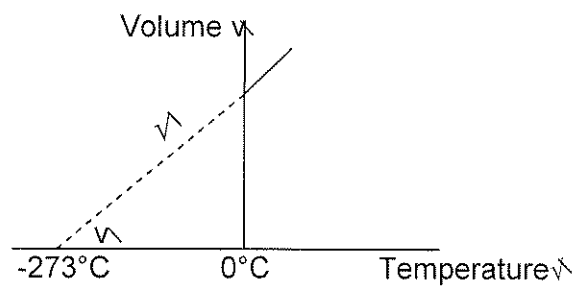
$$= 2,829 \text{ kN}$$

(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)

$$7.1.3 \quad \frac{V_1}{T_1} = \frac{V_2}{T_2} \checkmark$$

(1)

$$7.2 \quad \Delta V = V_0 \cdot \gamma \cdot \Delta t$$

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

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

$$\Delta t = t_f - t_i$$

$$t_f = 13,457 + 25 \\ = 38,457 \text{ }^\circ\text{C} \checkmark$$

(4)

7.3	7.3.1	$P_2V_2 = m_2RT_2$ $(200 \times 10^3)V_2 = 5 \times 287 \times 308 \checkmark$ $V_2 = 2,21 \text{ m}^3 \checkmark$	(2)
	7.3.2	$P_1V_1 = m_1RT_1$ $500 \times 10^3 \times 1 = m_1 \times 287 \times 298$ $m_1 = 5,846 \text{ kg} \checkmark$ $P_3V_3 = m_3RT_3$ $P_3 \times 3,21 = 10,846 \times 287 \times 293 \checkmark \checkmark$ $P_3 = 284,128 \text{ kPa.} \checkmark$	(4) [16]
		TOTAL:	100