higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE

## NOVEMBER EXAMINATION

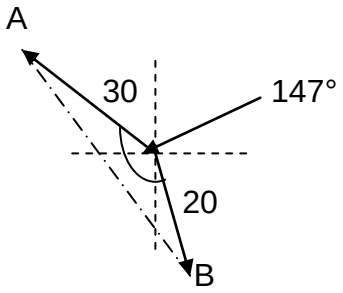
## ENGINEERING SCIENCE N4

## 18 NOVEMBER 2014

**This marking guideline consist of 9 pages.**

## QUESTION 1

1.1 $V_A$ = 30 km/h; $V_B$ = 20 km/h



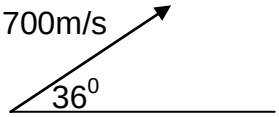

$_A\overline{V}_B = \sqrt{30^2 + 20^2 - 2(20)(30)\text{Cos } 147°}$ √
= 48,025 km/h √

$\frac{Sin\ \theta}{30} = \frac{Sin\ 147}{48{,}025}$ √ $_AV_B$ = 48,025 km/h

Sin $\theta$ = 0,3402 N 34,89° W
$\theta$ = 19,89° √ or W 55,11° N √

(5)

1.2




HC = 700cos36°= 566,312 m/s
VC = 700sin36° = 411,45 m/s

1.2.1 $h_{max} = \frac{u^2 sin^2 \alpha}{2g}$ or $v^2 = u^2 + 2gs$

$0^2 = (411{,}45)^2 - 2(9{,}8)s$

$= \frac{700^2\ sin^2 36°}{2\ (9{,}8)}$ √√ s = 8637,3 m

= 8637,288 m √
= 8,637 km (3)

1.2.2 $L = \frac{u^2 \sin 2\alpha}{g}$ or v = u + gt

$= \frac{700^2\ sin\ 72^0}{9{,}8}$ √√√ 0 = 411,45 – 9,8t
= 47 552,826m √ t = 41,985 s
= 47,553 km s = vt
s = (566,312)(2)(41,985)
s = 47553,219 m (4)

1.3 v = 0 m/s
s = 88m
α = -9,8 m/s$^2$

$v^2 = u^2 + 2as$
$0^2 = u^2 - 2(9,8)(88)$ √√
∴u = 41,531 m/s √ (3)
**[15]**

## QUESTION 2

2.1 The rate of change of the angular displacement. √√ (2)

2.2 $N_1$ = 1200 r/min ⇒ $N_1$ = 20 r/s $W_1 = 2\pi N_1$ = 125,664 rad/s
$N_2$ = 1500 r/min ⇒ $N_2$ = 30 r/s $W_2 = 2\pi N_2$ = 188,496 rad/s
t = 2 sec

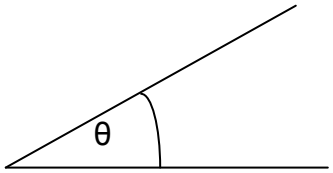
2.2.1 $\omega_2 = \omega_1 + \alpha t$
$2\pi(30) = 2\pi(20) + \alpha(2)$√√
$\alpha = 30\pi - 20\pi$
$\alpha = 10\pi$
α = 31,416 rad/s √ (3)

2.2.2 $\theta = \frac{(\omega_2+\omega_1)}{2} t$
$= (\frac{2\pi(30)+2\pi(20)}{2})2$√√√
$= 2\pi\ (50)$
$= 314,159$
$= 100\pi\ rad$
$\therefore\ \theta = 50\ revolutions$ √ (4)
**[9]**

## QUESTION 3

3.1 When an unbalanced force acts upon a body, it is accelerated in the direction of the force. The magnitude of acceleration is directly proportional to the applied force and is inversely proportional to the mass of body. √√
or
The rate of change in the momentum of an object is proportional to, and in the direction of the applied force. (2)

3.2




$\sin\ \theta = \frac{1}{25}$
$m = 1200kg$
$v = 54km/h = 15m/s$
t = 2 min = 120 s
$u = 0$ m/s

3.2.1 $v = u + at$
$15 = 0 + a(120)$ √
$\therefore a = 0{,}125\ m/s^2$ √ (2)

3.2.2 $Ek = ½mv^2$
$= ½(1200)(15)^2$ √
$= 135\ 000\ J$ √
$= 135kJ$ (2)

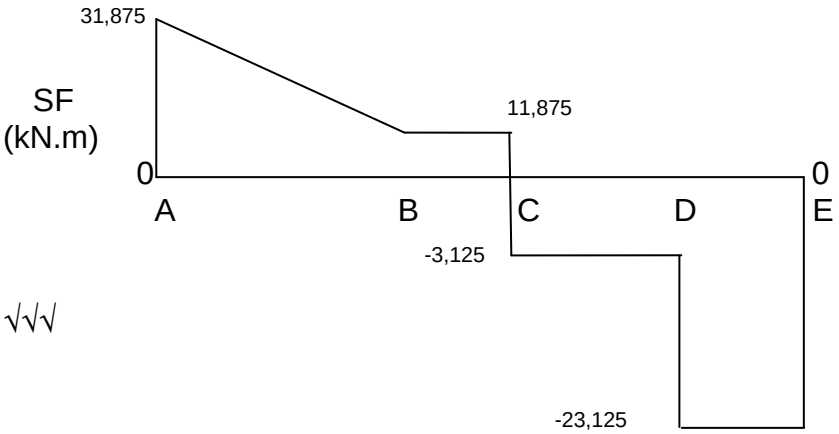
3.2.3 $s = ut + ½at^2$
$= 0 + ½(0{,}125)(120)^2$ √
$= 900m$ √
$h = 900\ sin\theta$
$= 900 \times \frac{1}{25}$ √
$= 36m$√
$Ep = mgh$
$= 1200(9{,}8)(36)$√
$= 423\ 360J$ √
$= 423{,}360kJ$ (6)
**[12]**

## QUESTION 4

4.14 4.1.1 Moments about A: CWM = ACWM
(20 x 1) + (15 x 2,5) + (20 x 3,5) = (E x 4) √
E = 31,875 kN √

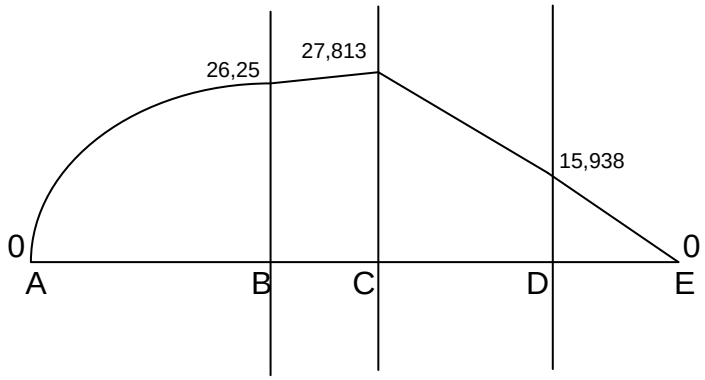
Moments about E: CWM =ACWM
(A x 4) = (20 x 0,5) + (15 x 1,5) + (20 x3 ) √
A = 23,125 kN √ (4)

4.1.2




√√√

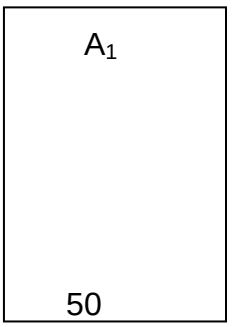
$BM_B$ = 23,125(2) – 20(2x½) = 26,25 kN.m
$BM_C$ = 23,125(2,5) – 20(1,5) = 27,813 kN.m
$BM_D$ = 23,125(3,5) – 20(2,5) – 15(1) = 15,938 kN.m




√√√

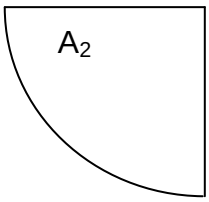
(6)

4.2




$A_1 = 100(50)$
$= 5000mm^2$

$x_1 = ½(50)$
$= 25mm$




$A_2 = ¼(\pi r^2)$
$= ¼(\pi x 20^2)$
$= 314,159mm^2$

$x_2 = 50 - 0,424(20)$
$= 41,52mm$

$$X_T = \frac{A_1 X_1 - A_2 X_2}{A_T}$$

$$= \frac{5000(25) - 314,159(41,52)}{5314,159}$$ √√√√

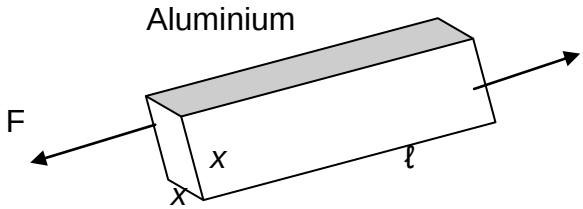
$= 21,068mm\ from\ YY$√ (5)

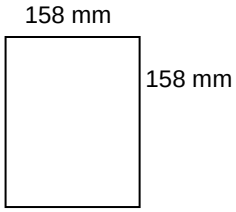
**[15]**

**QUESTION 5**

5.1 Tensile stress, compressive stress, shear stress.√√√ (3)

5.2




$F = 500kN$

σ = 20 MPa

$$\sigma = \frac{F}{A}$$

$$A = \frac{F}{\sigma}$$

$$A = \frac{500 \times 10^3}{20 \times 10^6}$$ √√

$A = x^2$

$\therefore x = 0,158m = 158mm$ √

(3)

5.3 $\sigma_1 = \frac{F_1}{A}$ $A = \frac{\pi d^2}{4}$ $\varepsilon = \frac{\Delta \ell}{\ell o}$

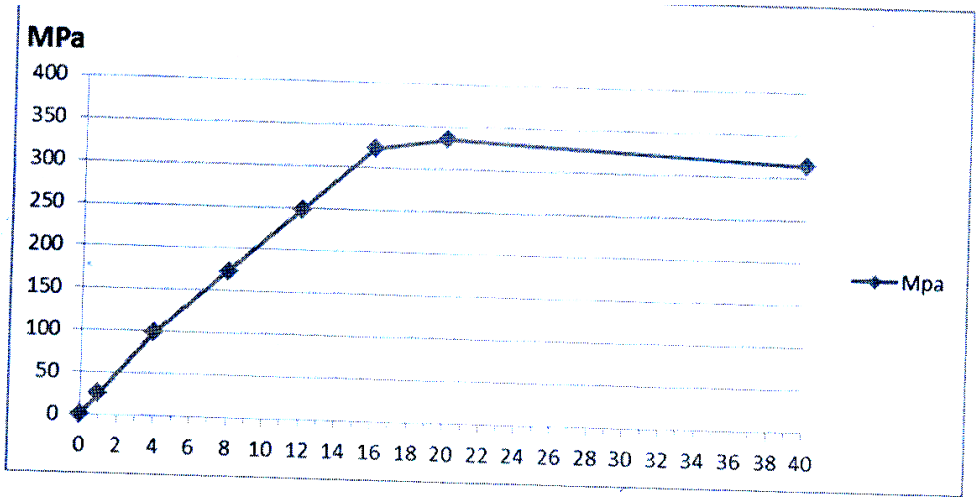
$= \frac{2500}{99,756}$ $= \frac{\pi(11,27)^2}{4}$ $= \frac{0,0056}{56}$

$= 25,061MPa$ $= 99,756mm^2$ $= 0,0001$

$= 1 \times 10^{-4}$

| | STRESS (MPa) | STRAIN (x $10^{-4}$) |
|---|---|---|
| 1 | 25,061 | 1 |
| 2 | 98,937 | 4,393 |
| 3 | 173,115 | 8,143 |
| 4 | 247,594 | 11,786 |
| 5 | 321,772 | 16 |
| 6 | 334,804 | 20,179 |
| 7 | 313,753 | 40,179 |

5.3.1




(5)

5.3.2 $E = \frac{(247,594 - 0)x10^6}{(11,786 - 0) \times 10^{-4}}$

$= 210,021$ GPa √ (1)

5.3.3 $\%\Delta A = \frac{\Delta A}{A_o} \times 100$

$= \frac{\frac{\pi d_o^2 - \pi d_f^2}{4}}{\frac{\pi d_o^2}{4}} \times 100$

$= \frac{d_o^2 - d_f^2}{d_o^2} \times 100$

$= \frac{(11,27)^2 - (6,51)^2}{(11,27)^2} \times 100$ √

= 66,633% √ (2)

**[14]**

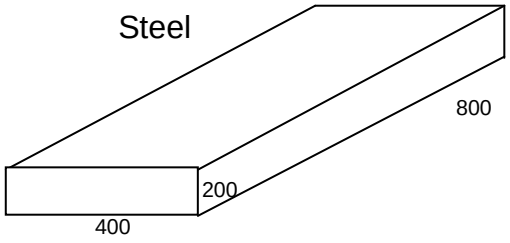
## QUESTION 6

6.1 The volume of a given mass of gas is inversely proportional to the pressure on it if the temperature remains constant.√√ (2)

6.2
- Celcius scale is used for general purposes. Freezing point of water is indicated as 0 °C and the boiling point as 100 °C. √
- Kelvin scale used for thermodynamic temperature calculations. Freezing point of water is indicated as 273 K and the boiling point as 373 K. √

Kelvin $= ℃ + 273$ (2)

6.3




$\Delta t = 350 - 20$
$= 330\ °C$
$\alpha = 13 \times 10^{-6}/°C$

6.3.1 $\Delta l = l_o.\alpha.\Delta t$
$= (800)(13 \times 10^{-6})(330)$ √
$= 3{,}432$ mm √ (2)

6.3.2 $\Delta A = A_o.\beta.\Delta t$
$= (800 \times 400)(2)(13 \times 10^{-6})(330)$ √
$= 2745{,}6\ mm^2$ √
$A_f = A_o + \Delta A$
$= (800 \times 400) + 2745{,}6$
$= 322745{,}6\ mm^2$ √ (3)

6.3.3 $\Delta V = V_o.\gamma.\Delta t$
$= (0{,}8 \times 0{,}4 \times 0{,}2)(3)(13 \times 10^{-6})(330)$ √√
$= 8{,}237 \times 10^{-4}\ m^3$ √ (3)

6.4 $\frac{T_1}{P_1V_1} = \frac{T_2}{P_2V_2}$

$\frac{303}{(600)(1{,}2)} = \frac{T_2}{(900)(0{,}85)}$ √√

$T_2 = 321{,}938$ K√ (3)
**[15]**

## QUESTION 7

7.1 The pressure which results when a force of 1 N acts perpendicularly and evenly on an area of 1 $m^2$. √√ (2)

7.2 The pressure exerted on the surface of a liquid in a closed system is transmitted with the same intensity through the liquid and in all directions.√√√ (3)

7.3 d = 100 mm
L = 80 mm
h = 20 m

7.3.1 V = Axsl

$= \frac{\pi d^2}{4} \times sl$

$= \frac{\pi (0,1)^2}{4} \times 0,08$√√

= 6,283 x $10^{-4}$ $m^3$ √ (3)

7.3.2 $m = \rho . V$

= 1 000 x 6,283 x $10^{-4}$ √

= 0,628 kg √ (2)

7.3.3 P = ρgh

= 1 000 x 9,8 x 20

= 196 kPa √

W = PV

= (196 x $10^3$)(6,283 x $10^{-4}$) √

= 123,147 J √ (3)

7.4 7.4.1 $V_{ACT}$ = A x sl x 0,95

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

$= \frac{\pi (0,08)^2}{4} \times 0,12 \times 0,95$ √√

= 5,73 x $10^{-4}$ $m^3$ √ (3)

7.4.2 $V_{ACT}$ = A x h

(5)(5,73 x $10^{-4}$) = $\frac{\pi d^2}{4} \times h$ √√√

h = 0,041 m (4)

**[20]**

**TOTAL: 100**