higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# MARKING GUIDELINE

## NATIONAL CERTIFICATE

## ENGINEERING SCIENCE N4

**30 July 2021**

**This marking guideline consists of 8 pages.**

**MJ**

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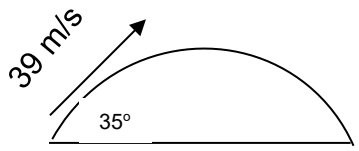
## QUESTION 1

1.1 $V_H$ +
178 km/h

-130 km/h
$V_T$

$_HV_T = V_H - V_T$
$= 178 – (-130)$✓
$= 178 + 130$✓
$= 308$ km/h✓ (3)

1.2 1.2.1




$H_{max} = \frac{u^2 Sin^2 \propto}{2g}$✓
$= \frac{39^2 Sin^2 35^0}{2\ (9,8)}$✓
$= 25,530$ m✓

ALTERNATIVE SOLUTION:

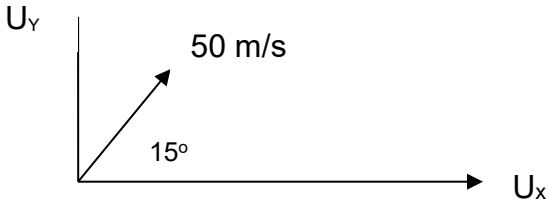
$v_f^2 = v_i^2 + 2gs$✓
$0^2 = (39sin35°)^2 + 2(-9,8)s$✓
$= 25,530$ m✓ (3)

1.2.2 $S_H = L = \frac{u^2 Sin\ 2\propto}{g}$✓
$= \frac{39^2 Sin\ 70^0}{9,8}$✓
$= 145,844$ m✓

ALTERNATIVE SOLUTION:

$v_f = v_i + at$
$0 = 39sin35° - 9,8t$
$t = 2,283s$✓
$s = v2t$
$s = (39cos35°)(2)(2,283)$ ✓
$s = 102,139$ m✓ (3)

1.3




U = 50 m/s; v = 0 m/s ; a = g = - 9,8 m/s$^2$
$U_x$ = 50cos15° = 48,296 m/s
$U_y$ = 50sin15° = 12,941 m/s

1.3.1 v = u + at
$t = \frac{v-u}{a}$

$= \frac{0 - 12{,}941}{-9{,}8}$ ✓

= 1, 321 s✓ (2)

1.3.2 $s = ut + \frac{1}{2}at^2$
$= (12{,}941 \times 1{,}321) + \frac{1}{2}(-9{,}8)(1{,}321)^2$ ✓
= 8,544 m✓ (2)

1.3.3 s = ut
$= U_x \times (2t)$
$= 48{,}296 \times (2 \times 1{,}321)$ ✓
= 127,598 m✓ (2)
**[15]**

## QUESTION 2

2.1 Angular displacement is the motion from one position to another on a circular course, measured in radians.✓✓ (2)

2.2 $P = \frac{2\pi nT}{60}$

$T = \frac{P}{2 \times \pi n}$ ✓

$= \frac{4500}{2 \times \pi \times 120}$ ✓

= 5, 968 r/s ✓ (3)

2.3 2.3.1 T = F × r
= 500 × 2,2✓
= 100 N.m✓ Not N/m?

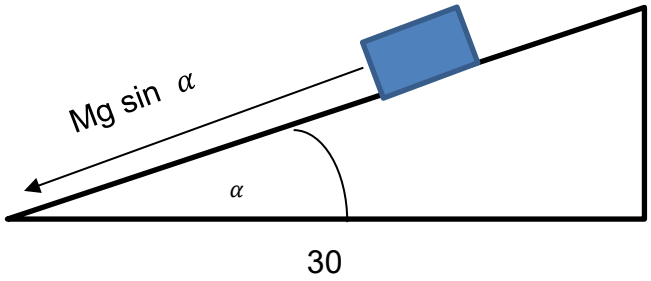
2.3.2 W = T × θ
= (100 × 60 × 2π) /360 ✓
= 104,721 J✓

(2 × 2) (4)
**[9]**

## QUESTION 3

3.1 The law of the conservation of energy states that energy can be neither created nor destroyed but only transformed from one kind to another.✓✓ (2)

3.2




3.2.1 $\alpha = tan^{-1}\frac{1}{30}$

$= 1,909^{o}$ ✓

h = 30 sin $\alpha$
= 30 sin1, 909 °
= 0, 999 m✓

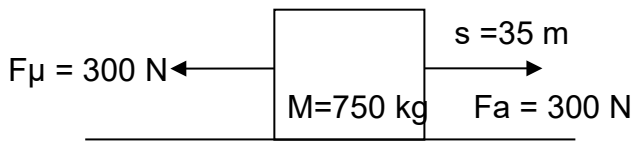
Loss in $P_E$ = mgh
= 10 × 9,8 × 0, 999✓
= 97, 902 J✓ (4)

3.2.2 Gain in $K_E$ = Loss in $P_E$
½× (10) × $v^2$ = 97, 902 J✓✓

$v = \sqrt{\frac{97,902}{5}}$ ✓

∴ v = 4, 425 m/s✓ (4)

3.2 u = 54 km/h = 15 m/s




$a = \frac{v^2 - u^2}{2s}$

$= \frac{0^2 - 15^2}{2x35}$✓

$= -3,214 m/s^2$✓ (2)

**[12]**

## QUESTION 4

4.1 4.1.1 A cantilever is a beam which is supported at one end only.✓✓

4.1.2 The algebraic sum of the moments of external forces on one side of a section about a section is called the bending moment at the section.✓✓

(2 × 2) (4)

4.2 $w = m \times g$
$= 1000 \times 9,8$
$= 9\,800$ N✓

Weight per length $= \frac{9800}{10}$

$= 980$ N/m
$= 0,98$ Kn/m✓

$R_A$ : take moments about D
$\Sigma \curvearrowright$ moments $= \Sigma \curvearrowleft$ moments
$R_A \times 8 + (30 \times 2) = (20 \times 6) + (14 \times 3) + (9,8 \times 3)$ ✓

$R_A = \frac{191,4 - 60}{8}$✓

$R_A = 16,43$ kN✓

$R_D$ : take moments about A
$\Sigma \curvearrowleft$ moments $= \Sigma \curvearrowright$ moments
$R_D \times 8 = (20 \times 2) + (14 \times 5) + (9,8 \times 5) + (30 \times 10)$ ✓

$R_D = \frac{459}{8}$

$R_A = 57,38$ kN✓

Test : $\Sigma \downarrow$ forces $= \Sigma \uparrow$ forces
$(20 + 14 + 9,8 + 30)$ kN $= (16, 43 + 57,38)$ kN✓
73,8 kN = 73,8 kN ✓ (9)

**[13]**

## QUESTION 5

5.1 5.1.1 The density ($\rho$) of a body is the mass per unit volume.✓✓

5.1.2 Pressure (P) is the force per unit area.✓✓

(2 × 2) (4)

5.2 Pascal's principle states that when the pressure on any part of a confined fluid is changed, the pressure on every other part of the fluid is also changed by the same amount.✓✓

**OR**

The pressure exerted on the surface of a liquid within a closed container acts on the liquid in all directions with the same magnitude. (2)

5.3 5.3.1 Volume per stroke × number of strokes = volume required by ram

$V_p \times 50 = \frac{\pi \times D^2}{4} \times 0,08$ ✓

$= \frac{\pi \times (0,01)^2}{4} \times \frac{0,08}{50}$

$V_p = 0,00001257\ m^3$ ✓

$V_p$ required with a 5% slip = $\frac{0,00001257}{0,95}$ ✓

$= 0,00001323\ m^3$ ✓ (4)

5.3.2 $\frac{\pi d^2}{4} \times 0,04 = 0,00001323$ ✓

$d = \sqrt{\frac{4 \times 0,00001323}{0,04 \times \pi}}$ ✓

$d = 0,0205$ m

$d = 20,52$ mm ✓ (3)

5.3.3 $\frac{W}{F} = \frac{D^2}{d^2}$

$1,2\ Mg = 1,2 \times 10^6\ g$

$= 1,2 \times 10^3\ kg$

$W = m \times g$

$= 1200 \times 9,8$ ✓

$= 11760\ N$ ✓

$F = \frac{W \times d^2}{D^2}$

$= \frac{11760 \times 0,0205^2}{0,1^2}$ ✓

$= 494,214\ N$ ✓

$Effort = \frac{F}{MA}$

$= \frac{F}{30}$

$= \frac{494,214}{30}$ ✓

$= 16,474\ N$ ✓ (6)

5.4 N = 240 r/min
d = 90 mm
$S_l$ = 590 mm
C = 3

$V_a$ (Actual volume in l/s), $Slip\% = 1.8\%$ η=100-slip%

$$V_s = \frac{\pi.d^2 sl.n.C.}{4}.\frac{N}{60}$$

$$= \frac{\pi.(0{,}09\ m)^2.0{,}59\ m.1.(3)}{4}.\frac{240\ r/\min}{60}$$

$$= 0{,}045041\ m^3 \quad \checkmark$$

$$V_a = V_s.\frac{\eta}{100}$$

$$= 0{,}045041\ m^3/s.\frac{98.2}{100}\checkmark$$

$$= 0{,}044230275 m^3/s(1000 l/m^3)$$

$$= 44{,}230\ l/s \quad \checkmark$$

(3)
**[22]**

## QUESTION 6

6.1
- Compressive stress
- Shear stress
- Tensile stress (3)

6.2 Within the elastic limit,✓ the stress is directly proportional✓ to the strain.✓ (3)

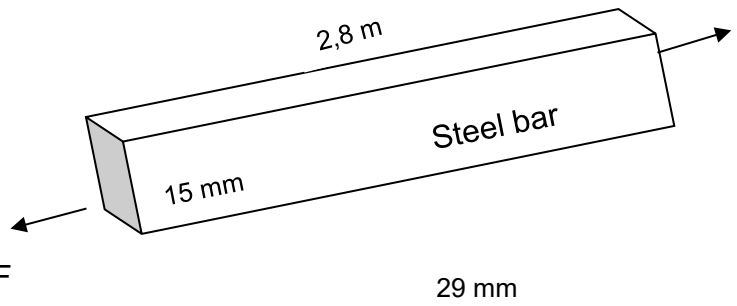
6.3 6.3.1

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

$$= \frac{27 \text{ x } 10^3}{(0{,}029 \text{ x } 0{,}015)}\checkmark\checkmark$$

= 62 068965,52 Pa

= 62,069 MPa✓




(3)

6.3.2 $E = \frac{\sigma}{\varepsilon}$

$\therefore\ 208\ x10^9 = \frac{62{,}069\ x\ 10^6}{\varepsilon}\checkmark$

$\therefore\ \varepsilon = 2{,}984\ x\ 10^{-4}\checkmark$ (2)

6.3.3 $\varepsilon = \frac{\Delta\ell}{\ell_0}$ ✓

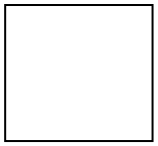
$\therefore\ 2{,}984\ x\ 10^{-4} = \frac{\Delta\ell}{2800}$ ✓

$\therefore\ \Delta\ell = 0{,}836$ mm✓ (3)
**[14]**

## QUESTION 7

7.1 Linear expansion coefficient is the change✓ in length per unit length per 1 °C change in temperature.✓ (2)

7.2 $\Delta A = A_0 .2 \propto \Delta t$
= $(37 \text{ x } 37)(2)(17 \text{ x } 10^{-6})(67)$✓
= 3,119 cm²✓




→ (2)

7.3 $\rho_1 = 1{,}07 \times 10^4 \text{kg/m}^3$
$\rho_1 = 0^0\text{C}$ $m_1 = 1{,}07 \times 10^4$ kg
= 273 K $V_1 = 1$ m³ ✓

$\gamma = 200 \times 10^{-6}/^0\text{C}$

$\rho_2 = ?$ $V_2 = ?$
$T_2 = 70^0\text{C} = 273$
$\frac{70}{343\text{K}}$

$\Delta V = V_1 \gamma \Delta t$
= 1 × 200 × $10^{-6}$ × 70✓

= 0,014 m³✓

$\therefore V_2 = 1{,}014\ m^3$
$\rho_2 = \frac{m}{v_2}$
= $\frac{1{,}07 \text{ x } 10^4\text{kg}}{1{,}014\text{m}^3}$✓

= 1,055 × $10^4$ kg/m³✓ (5)

7.4 7.4.1 $P_1V_1 = m_1RT_1$✓
$\therefore 410\ x\ 10^3 \times 0{,}184$
$= m_1(273)(334)$✓
$\therefore m_1 = 0{,}827$ kg✓ (3)

7.4.2 $P_2V_2 = m_2RT_2$
$\therefore 300 \times 10^3 \times 0{,}184 = m_2\ (273)(305)$✓
$\therefore m_2 = 0{,}663$ kg✓

$\therefore \Delta m = 0{,}827 - 0{,}663$
= 0,164 kg leaked out✓ (3)
**[15]**

**TOTAL: 100**

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