higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ENGINEERING PHYSICS N6

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This marking guideline consists of 7 pages.

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QUESTION 1

1.1
1.1.1 False
1.1.2 True
1.1.3 True
1.1.4 True
1.1.5 True
1.1.6 False
1.1.7 True
1.1.8 False
1.1.9 True
1.1.10 False

(10 × 1) (10)

1.2

$$\gamma = \frac{C_p}{Cv}$$
$$\gamma = \frac{850}{620}$$
$$\gamma = 1{,}371\surd$$

$$R = C_p - C_v$$
$$R = 850 - 620$$
$$R = 230\ J/kg°C\surd$$

$$P_1 x V_1 = m.R.T_1$$
$$V_1 = \frac{m.R.T_1}{P_1}$$
$$V_1 = \frac{1{,}5x230x302}{126250}$$
$$V_1 = 0{,}825\ m^3\surd$$

$$(P_1 x V_1)1^{\gamma} = (P_2 x V_2)1^{\gamma}$$

$$126250x0{,}825x1^{1{,}371} = 958000x V_2 x1^{1{,}371}$$
$$V_2 x1^{1{,}371} = \frac{126250x0{,}825x1^{1{,}371}}{958000}$$

$$V_2 = \sqrt{0{,}101}$$
$$V_2 = 0{,}187\ m^3\surd$$

$$Work\ done = \frac{(P_1 x V_1) - (P_2 x V_2)}{1{,}371 - 1}$$

$$Work\ done = \frac{(126250x0{,}825)-(958000x0{,}187)}{1{,}371-1}\surd$$
$$Work\ done = -\ 142579{,}043\ J \text{ or } -\ 142{,}579\ kJ\surd$$ (6)

1.3 1.3.1 $f_o = \frac{f_s(V_a + V_o)}{(V_a + V_s)}$

$f_o = \frac{1\,250(340+0)}{(340-0)}\surd$

$f_o = 1\,250\ m/s\surd$ (2)

1.3.2 $f_o = \frac{f_s(V_a + V_o)}{(V_a + V_s)}$

$f_o = \frac{1\,250(340+0)}{(340+16{,}667)}\surd\surd$

$f_o = 1\,191{,}588\ m/s\surd$ (3)

1.4 1.4.1 $V = f\ x\ \lambda_o$

$V\ f\ x\ (2l)$

$334 = 268\ x\ 2l\surd$

$l = \frac{334}{2\ x\ 268}$

$l = 0{,}623\ m\surd$

1.4.2 $V = f\ x\ \lambda_o$

$V\ f\ x\ (4l)$

$334 = 268\ x\ 4l$

$l = \frac{334}{4\ x\ 268}$

$l = 0{,}311\ m\surd$

(2 × 2) (4)
[25]

QUESTION 2

2.1 2.1.1 False
2.1.2 False
2.1.3 True
2.1.4 True
2.1.5 True

(5 × 1) (5)

2.2 Heat lost by steam at 100 °C + Heat lost by water at 100 °C = Heat gained✓

(1 kg × X)✓ + 4 200 J/kg.K × 25 K × 1✓ = 4 200 J/kg.K × 30 × 19✓

1 kg × X = 238 650 – 125 610✓

X = 228 900 J/kg **OR** 0,2289 MJ/k✓ (6)

2.3

$$58\ liters = 0{,}058\ m^3 \ \surd$$
$$R = C_p - C_v$$
$$R = 1{,}006 - 0{,}717$$
$$R = 0{,}289 \frac{kJ}{kg}.K \surd$$

$$At\ constant\ pressure$$
$$T_1 = 200 + 273 = 473\ K$$
$$T_2 = 45 + 273 = 723\ K$$
$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$
$$\frac{V_1}{T_1}\ x\ T_2 = V_2$$
$$\frac{0{,}058}{473}\ x\ 723 = V_2 \surd$$
$$V_2 = 0{,}089\ m^3 \surd$$

$$Change\ in\ entropy = C_p \text{ x ln } \frac{V_2}{V_1}$$
$$Change\ in\ entropy = 1{,}006\ x\ ln \text{ x } \frac{0{,}089}{0{,}058} \surd$$
$$Change\ in\ entropy = 0{,}431\ kJ/kg.K \surd$$ (6)

2.4 Heat gained by the water (Q) = m x shc × Δt

Q = 280 × 4200 × (96 – 25)√√

Q = 83,496 MJ√

Heat lost by the coal = m × HV

$Q_{lost} = Q_{gained}$

m x HV = 8349600 × η√√

$$m = \frac{83{,}496 \times 100 \surd}{35 \times 92 \surd}$$

m = 2,593 kg√ (8)

[25]

QUESTION 3

3.1 The electric field intensity at a point is the force experienced✓ by a unit positive charge placed at that point.✓ (2)

3.2 3.2.1

$$E = \frac{Q}{4\pi\varepsilon_o r^2}$$
$$= \frac{1x10^{-7}\ x9x10^9}{(0{,}1)^2}$$
$$= 900x10^2 = 90000 N/C$$

3.2.2
$$V = \frac{Q}{4\pi\varepsilon_o a}$$
$$= \frac{1x10^{-7}\,x9x10^{9}}{0{,}1}$$
$$= 9000V$$

(2 × 3) (6)

3.3
$$If\ the\ 15\ \mu C\ charge\ fixed.$$
$$Potential\ difference = \frac{Q}{4\pi\varepsilon_0}\left(\frac{1}{a} - \frac{1}{b}\right)$$
$$Potential\ difference = 15\ x\ 10^{-6}\ x\ 9\ x\ 10^{9}\left(\frac{1}{0{,}04} - \frac{1}{0{,}08}\right)\ ✓$$
$$Potential\ difference = 1{,}6875\ MV\ ✓$$
$$WD\ to\ move\ 10\ \mu C\ to\ 4\ cm$$
$$WD = 10\ x\ 10^{-6}\ x\ 1{,}6875\ x\ 10^{6}$$
$$WD = 16{,}875\ J\ ✓$$

(3)

3.4 3.4.1
V = E × d
V = 1150 × 1 × 10^{-3}
V = 115 Volts

3.4.2
F = E × Q
F 1,15 × 10^{4} × 2 × 10^{-9}
F = 2,3 × 10^{-5} N

3.4.3
W = V × Q
W = 115 × 1 × 10^{-9}
W = 1,15 × 10^{7}

(3 × 2) (6)

3.5 3.5.1
$$\vartheta = \frac{\varepsilon_o\ x\ V}{r}$$
$$\vartheta = \frac{8{,}85\ x\ 10^{-12}\ x\ 30\,000}{1\ x\ 10^{-2}}\ ✓$$
$$\vartheta = 2{,}655\ x\ 10^{-6}\ Coulum/m2✓$$

3.5.2
$$E = \frac{\vartheta}{\varepsilon_o}$$
$$E = \frac{30\,000}{10^{-12}}✓$$
$$E = 3\ x\ 10^{6}\ V/m✓$$

(2 × 2) (4)

3.6 3.6.1 Coulomb's law
3.6.2 Gauss's Law
3.6.3 Dielectric constant
3.6.4 Capacitance

(4 × 1) (4)

[25]

QUESTION 4

4.1 $C = \frac{kEoA}{d}$

$C = \frac{1,2 \times 10^6 \times 8.9 \times 10^{-12} \times 25}{2,72}$ ✓

$= 9,11 \times 10^{-7}$ F

Energy = ½ CV²

= ½ × 9,11 × 10^{-7} × (1,2 × 10^6)² ✓

= 4 555 Joule ✓ (4)

4.2 4.2.1 $I = \frac{Q}{T} = \frac{63 \times 10^{-19}}{1,6 \times 10^{-14}}$ ✓ ✓

$I = 39,375 \times 10^{-5}$ A ✓ (3)

4.2.2 $V = \frac{W}{Q} = \frac{8,4 \times 10^{-16}}{1,6 \times 10^{-14}}$ ✓

V = 5 250 V ✓ (2)

4.3 4.3.1 Since the frequency of the light is $c = f \times \lambda$

therefore $f = c/\lambda = \frac{3 \times 10^8 \text{ m/s}}{5 \times 10^{-7} \text{ m}}$ ✓

$f = 6 \times 10^{14}$ Hz ✓ (2)

4.3.2 The energy of each proton is

E = h × f

= 6,630 × 10^{-34} J.s × 6 × 10^{14} Hz

E = 3,98 × 10^{-19} J ✓

But 1 eV = 1,60 × 10^{-19} J

Therefore $E = \frac{3,98 \times 10^{-19} \text{ J}}{1.6 \times 10^{-19} \text{ J}}$ ✓

E = 2,49 eV ✓ (3)

4.4 4.4.1 Number of disintegrations per second

$$No = \frac{1\,012 \times 0{,}693}{30 \times 24 \times 60 \times 60}$$

$No = 2{,}7 \times 10^5$ (3)

4.4.2 Time for $N = 10^4$ to remain

$N = 10^4$

$10^4 = 10^{12}\, e^{-\lambda t}$

Taking logs to the base of 10

$- 8 = - \lambda.t \log e$

$$t = \frac{8\lambda \times 1}{\log e}$$

t = 64 days (2)

4.4.3 Number of disintegrations per hour $= \frac{0.693 \times 10^4}{30 \times 24}$

= 9,6 (2)

4.5 4.5.1 Electron (- charge)
4.5.2 Neutron (no charge)
4.5.3 Nucleus (no charge)
4.5.4 Proton (+ charge)

NOTE: 4.5.2 and 4.5.4 may be alternated

(4 × 1) (4)
[25]

TOTAL: 100

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