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 8 pages.

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QUESTION 1: SOUND

1.1
- The amplitude of the wave is its greatest deviation.
- The wavelength is the distance taken for the completion of one wave and is measured from one peak of one wave to the peak of the next.
- The frequency of a wave is the number of vibrations made by the wave in one second.
- The speed of a wave = frequency × wavelength.
- A standing wave is formed when a wave does not move forwards through a medium but is reflected just as much as it transmitted. (5)

1.2
1.2.1 False
1.2.2 False
1.2.3 False
1.2.4 True
1.2.5 True

(5 × 1) (5)

1.3 1.3.1 Speed of sound $V_0 = 330$ m/s Vs = 80 km/h = 22,222 m/s

$$f_o = \frac{F\,(V + V_0)}{(V - V_s)}$$

$$= \frac{1\,200(330 + 0)}{(330 - 22{,}222)}\checkmark$$

$$= \frac{1\,200(330)}{307{,}778}\checkmark$$

$$= 1\,286{,}642 \text{ Hz}\checkmark$$ (3)

1.3.2 $$f_o = \frac{1\,200(330 + 0)}{(v + vs)}$$

$$= \frac{1\,200(330 + 0)}{(330 + 22{,}222)}\checkmark$$

$$= \frac{396\,000}{(352{,}222)}$$

$$= 1\,124{,}291 \text{ Hz}\checkmark$$ (2)

1.3.3 $$f_o = \frac{(v + vo)}{(v + vs)}$$

$$f_o = \frac{1\,200(330 + 5)}{330 + 22{,}222}\checkmark$$

$$= \frac{402\,000}{352{,}222}$$

$$= 1\,141{,}326 \text{ Hz}\checkmark$$ (2)

1.4 1.4.1 $V_R = Vg \times \frac{L}{\ell}$

$= \frac{334 \times 2 \times 0,8}{2 \times 0,06}$ ✓

$= 4\ 453,333$ m/s ✓

1.4.2 $V_R = f \times \lambda_R$

$f = \frac{vR}{\lambda r}$

$= \frac{4\ 453,333}{0,8 \times 0,2}$ ✓

$= 2\ 783,333$ Hz ✓

(2 × 2) (4)

1.5 $t_1 + t_2 = 5$ s
$t_2 = (5\text{ s} - t_1)$

Down: $S_1 = ½ \times 9,8 \times t_1^2$
$S_1 = 4,9t_1^2$ ✓

Up: $S_2 = V \times t_2$
$S_2 = 330 \times (5 - t_1)$ ✓

Thus:

$S_2 = S_1$
$330 \times (5 - t_1) = 4,9\ t_2$
$1\ 650 - 330t_1 = 4,9t_2$
$4,9t_1^2 + 330t_1 + 1\ 650 = 0$
$t_1 = 4,675$ s ✓

$S_2 = V \times t_2$
$S_2 = 330 \times (5 - 4,675)$
$S_2 = 107,25$ m ✓ (4)

[25]

QUESTION 2: THERMODYNAMICS

2.1 2.1.1 closed system
2.1.2 constant
2.1.3 heat
2.1.4 work done
2.1.5 colder body
2.1.6 freezing point

(6 × ½) (3)

2.2 2.2.1 $\eta = 32\%$
$= 0,32$
$T_1 = 205\ °C + 273 = 478\ K$
$T_2 = 54\ °C + 273 = 327\ K$

$$\eta = \frac{0,32 \times (T_1 - T_2)}{T_1} \times 100\checkmark$$

$$= \frac{0,32 \times (478 - 327)}{478} \times 100\checkmark$$

$= 10,11\%\checkmark$

2.2.2 $$\text{Power} = \frac{Po}{\eta} \times 100$$

$$= \frac{6,5 \times 1\ 000\checkmark}{10,11} \times 100\checkmark$$

$= 64,293\ kW\checkmark$

(2 × 3) (6)

2.3 Heat needed to bring the ice to 0 °C:

$Q = M \times C \times \Delta T$
$= 0,05 \times 2,1 \times 10^3 \times (0 - (-15\ °C))\checkmark$
$= 1,575\ J\checkmark$

Heat to melt the ice:

$Q_2 = Lf \times m\ (ice)$
$= 350 \times 0,05$
$= 17,5\ kJ\checkmark$

Heat needed to warm the melted ice 0 °C to find temperature:

$Q_3 = M\ (_{water}) \times C \times \Delta T$
$= 0,38 \times 4,187 \times \Delta T\checkmark$
$= 1,591\ kJ/K \times t_F\checkmark$

Heat lost by the tea:

$Q = m \times c \times \Delta T$
$Q_4 = 0,38 \times 4,187 \times (78 - t_r)\checkmark$
$= 124,103 - 1,591\ t_f\checkmark$

Heat gained = Heat lost
$Q_1 + Q_2 + Q_3 = Q_4$
$1,575 + 17,5 + 1,591 \times t_f = 124,103 - 1,591 \times 10^3\checkmark$
$1,591 \times t_f + 1,591 \times t_f = 124,103 - 1,575 - 17,5\checkmark$
$3,1821\ t_f = 105,028$
$t_f = 33\ °C\checkmark$ (10)

2.4 $T_1 = 38\ °C = 38 + 273 = 311\ K$

$P_2 = 1\ 500\ kPa$

$R = 865 - 625$

$= 240\ J/kg.°C$✓

$\alpha = \frac{Cp}{Cv} = \frac{865}{625}$

$= 1,384$✓

$P_1 = 135\ kPa$

$$T_2 = T_1 \frac{(P_2)^{\alpha - 1}}{(P_1)^{\alpha}}$$

$$= 311 \times \frac{1\ 500^{1,384 - 1}}{135^{1,384}}$$✓

$$= 311 \times 11,111^{1,384 - 0722}$$

$= 1\ 531,26\ K$✓

$$Wd = \frac{MR\ (T_2 - T_1)}{D - 1}$$

$$= \frac{1,5 \times 240 \times (1\ 531,26 - 311)}{0,4}$$✓

Work done = 1 098,234 kJ✓ (6)

[25]

QUESTION 3: ELECTROSTATICS

3.1
3.1.1 magnitude
3.1.2 attraction
3.1.3 two point
3.1.4 product
3.1.5 square
3.1.6 straight line

(6 × ½) (3)

3.2 Electric field strength is a quantitative expression of the intensity of an electric✓ field at a particular location.✓ The standard unit is volt per meter.✓ (3)

3.3
3.3.1 True
3.3.2 True
3.3.3 False

(3 × 1) (3)

3.4 3.4.1

$$F = k \times \frac{Q_1 \times Q_2}{r_2}$$

$$F = \frac{9 \times 10^9}{0{,}135^2} \times 12{,}5 \times 10^{-6} \times 12{,}5 \times 10^{-6} \checkmark$$

$$F = 77{,}16 \text{ N} \checkmark$$

3.4.2

$$F = k \times \frac{Q_1 \times Q_2}{r_2}$$

$$F = k \times \frac{2Q_1 \times Q_2}{r_2}$$

$$F = 2 \times f$$

$$F = 2 \times 77{,}16 \text{ N} \checkmark$$

$$F = 154{,}32 \text{ N} \checkmark$$

3.4.3

$$F = k \times \frac{Q_1 \times Q_2}{r_2}$$

$$F = k \times \frac{Q_1 \times Q_2}{2r_2}$$

$$F = 0{,}25 \times 77{,}16 \checkmark$$

$$F = 19{,}29 \text{ N} \checkmark$$

(3 × 2) (6)

3.5 3.5.1

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$= \frac{1}{3{,}5} + \frac{1}{7}$$

$$= \frac{2+1}{7} \checkmark$$

$$\therefore C = \frac{7}{3}$$

$$= 2{,}333 \text{ } \rho F \checkmark$$

3.5.2 $Q = CV$

$Q = 2{,}333 \times 10^{-12} \times 800 \checkmark$

$Q = 1{,}866 \times 10^{-9} \text{ C} \checkmark$

3.5.3

$$V_1 = \frac{Q}{C_1} \qquad V_2 = \frac{Q}{C_2}$$

$$V_1 = \frac{1{,}866 \times 10^{-9} \text{ C}}{3{,}5 \times 10^{-12} \text{ C}} \qquad V_2 = \frac{1{,}866 \times 10^{-9} \text{ C}}{7 \times 10^{-12} \text{ C}}$$

$V_1 = 533 \text{ V} \checkmark$ $V_2 = 266 \text{ V} \checkmark$

3.5.4 $E = \frac{1}{2}QV^2$

$E = 0,5 \times 2,333 \times 10^{-12} \times (800)^2$✓

$E = 7,46 \times 10^{-7}$ J✓

(4 × 2) (8)

3.6 Gauss' law which states that the net number of magnetic lines leaving✓ an enclosed area is equal to $\frac{1}{\varepsilon 0}$ multiplied by the net positive charge inside space.✓ (2)

[25]

QUESTION 4: ATOMIC PHYSICS

4.1
- Charge: Negatively charged particle
- Magnitude of charge of electron: $1,6022 \times 10^{-19}$ C
- Mass of electron: $9,11 \times 10^{-31}$ kg
- Symbol of electron: e
- Location in the atom: Electrons revolve around the nucleus of the atom in different circular orbits. (Any 4 × 1) (4)

4.2 Thermionic emission is the thermally induced flow of charge carriers from a surface or over a potential-energy barrier.✓ This occurs because the thermal energy given to the carrier overcomes the work function of the material.✓ (2)

4.3 Spectrophotometer (1)

4.4 $W = \frac{1}{2} CV^2$
$W = \frac{1}{2} \times 1,5 \times 10^{-6} \times (3,2 \times 10^3)^2$✓
$W = 7,68$ J✓ (2)

4.5 4.5.1 $P = W/t = \frac{12 \times 15}{1}$ C/s✓
$P = 180$ W✓

4.5.2 $W = P \times t$
$W = 180 \text{ W} \times 60 \times 60$✓
$W = 6,48 \times 10^5$ J or 648 kJ✓

(2 × 2) (4)

4.6 $E_k = \frac{1}{2} \times m \times V^2$
$E_k = \frac{1}{2} \times 9,1 \times 10^{-31} \times (10^7)^2$
$E_k = 4,55 \times 10^{-17}$ J✓

But $1 \text{ eV} = 1,6 \times 10^{-19}$

$E_k = \frac{4,55 \times 10^{-17}}{1,6 \times 10^{-19}}$ J
$E_k = 284$ eV✓ (2)

4.7 4.7.1 $f = c/h$

$= \frac{3 \times 10^{8}}{5 \times 10^{-7}}$

$= 6 \times 10^{+14}$ Hz✓

The energy of each photon:

$E = h \times f$

$= 6{,}63 \times 10^{-34} \times 6 \times 10^{14}$

$= 3{,}98 \times 10^{-19}$ J✓ (2)

4.7.2 But $1 = eV = 1{,}6 \times 10^{-19}$

Therefore:

$E = \frac{3{,}98 \times 10^{-19}\ J}{1{,}6 \times 10^{-19}}$✓

$E = 2{,}49$ eV

$E = 2 - 2{,}49$

$E = 0{,}49$ eV✓ (2)

4.8 $E = \frac{k(Q_1 \times Q_2)}{r^2}$

$= \frac{9 \times 10^{9}\ (1{,}6 \times 10^{-19})^2}{(5{,}3 \times 10^{-11})^2}$✓✓

$= 8{,}2 \times 10^{-8}$ N✓ (3)

4.9 26 protons
30 neutrons
26 electron (3)
[25]

TOTAL: 100

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