higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ENGINEERING PHYSICS N6

29 MARCH 2018

This marking guideline consists of 7 pages.

Copyright reserved

QUESTION 1

1.1 1.1.1 True
1.1.2 False
1.1.3 False
1.1.4 False
1.1.5 True

(5 × 1) (5)

1.2 1.2.1 Loudness
1.2.2 Amplitude
1.2.3 Pure tone
1.2.4 Transverse

(4 × 1) (4)

1.3 1.3.1

$$v = \sqrt{\frac{750}{\frac{0{,}925\ X\ 10^{-3}}{0{,}525}}}\checkmark$$

$$v = \frac{27{,}386}{0{,}0419751}\checkmark$$

v = 652,438 m/s✓ (3)

1.3.2

$$F_{fund} = \frac{652{,}438}{2 \times 0{,}525}\checkmark$$

F_{fund} = 621,370 Hz✓

First tone = 2 × v
= 2 × 621,369
= 1242,739 Hz✓

Second tone = 3 × v
= 3 × 621,369
= 1864,109 ✓ (4)

Copyright reserved

1.4 1.4.1

$$f = \frac{V}{L}$$

$$L = \frac{V}{f}$$

$$L = \frac{1329}{3450}\checkmark$$

$$L = 0{,}385\checkmark$$

$$\text{Distance} = \frac{0{,}385}{2}$$

$$L = 0{,}1925 \text{ m}\checkmark$$ (3)

1.4.2 $$\frac{V_{air}}{V_{hydrogen}} = \frac{L_{air}}{L_{hydrogen}}$$

$$V_{air} = \frac{L_{air}}{L_{hydrogen}} \times V_{hydrogen}$$

$$V_{air} = \frac{4{,}65 \times 10^{-2} \times 1329}{0{,}1925}\checkmark$$

$$V_{air} = 321{,}031 \text{ m/s}\checkmark$$ (2)

1.5 The force of attraction or repulsion acting✓ along a straight line between two electric charges is directly proportional to the product✓ of the charges and inversely to the square of the distance between them. (2)

1.6 The lowest sound emitted by a source is the fundamental tone.✓ When a frequency twice that of the fundamental is emitted, the first over tone is produced.✓ (2)

[25]

QUESTION 2

2.1 2.1.1 E
2.1.2 A
2.1.3 B
2.1.4 D
2.1.5 C

(5 × 1) (5)

2.2 The heat needed to raise the temperature of the water to the boiling point of 100 °C is.

$Q_1 = m_1 \times shc \times \Delta t$
$= 4,5\ kg \times 4186\ J/kg\ °C \times (100\ °C - 0\ °C)$✓
$= 1,884 \times 10^6\ J$✓

Hence $Q_2 = (2,5 - 1,884) \times 10^6\ J$
$= 0,616 \times 10^6\ J$✓ of the heat is available to convert water at 120 °C to steam at the same temperature

Since $Q_2 = M_{steam} \times Lv$, the steam produced is

$$M_{steam} = \frac{Q_2}{Lv} = \frac{0,616 \times 10^6\ J}{2,26 \times 10^6\ J}$$✓

$M_{steam} = 0,273\ kg$✓ (5)

2.3 2.3.1 The mass of the gas

$R = Cp - Cv = 1,041 - 0,743$
$= 0,298\ kJ/kg.K$✓

therefore:

$P_1V_1 = mRT_1 \quad m = \frac{P_1V_1}{RT_1}$

$m = \frac{150 \times 10^3 \times 0,18}{0,298 \times (273 + 25)}$✓

$m = 304\ kg$✓ (3)

2.3.2 The volume of the gas at P_2

$(P_1V_1)^n = (P_2V_2)^n$

$V_2 = V_1 \left(\frac{P_1}{P_2}\right)$

$V_2 = 0,18 \times \left(\frac{150}{1500}\right)^{\frac{1}{1,4}}$ ✓

$= 0,18 \times 0,193$

$= 0,0348\ m^3$✓ (2)

2.3.3 The change in entropy

$S_2 - S_1 = Cp \times \ln \frac{V_2}{V_1} + Cv \times \ln \frac{P_2}{P_1}$

$S_2 - S_1 = 1,041 \ln \frac{0,0221885}{0,18150} + 0,743 \ln \frac{1500}{}$ ✓

$S_2 - S_1 = -2,179 + 1,7108$

$S_2 - S_1 = -0,4684$ kJ/kg.K✓

But there is 0,0348 kg of gas

Change in entropy = -0,46847 × 0,0348
= -0,00163 kJ/K therefore is a decrease✓ (3)

2.3.4 The work done on the gas

$W = \frac{P_1V_1 - P_2V_2}{n - 1}$

$W = \frac{150 \times 0,18 - 1500 \times 0,0348}{1,4 - 1}$ ✓✓

W = - 63 kJ✓ (3)

2.4 2.4.1 Kinetic energies of these particles which are in rapid motion constitute the internal energy of the body of matter.✓ The temperature of the body is a measure of the average kinetic energy of its particle.✓ (2)

2.4.2 Heat may be thought of as energy in transit. When heat is added to a body, its internal energy increases and its temperature rises.✓ (1)

2.4.3 A body, of matter, consists of atoms, or molecules, which are in rapid motion.✓ (1)

[25]

QUESTION 3

3.1 3.1.1 Distance squared
3.1.2 Force
3.1.3 Potential (V)
3.1.4 Difference
3.1.5 Ration

(5 × 1) (5)

3.2 $E = \frac{Q_1}{4\pi\varepsilon_0 x^2} = \frac{Q_2}{4\pi\varepsilon_0 x^2}$

Thus $\frac{8}{x^2} = \frac{12}{(35-x)^2}$✓

$8(35 - x)^2 = 12x^2$✓

$8(1225 - 70x + x^2) = 12x^2$✓

$9\,800 - 560x + 8x^2 - 12x^2 = 0$

$-4x^2 - 560x + 9\,800 = 0$✓

$x = \frac{-560 \pm \sqrt{(-560)^2 - 4 \times -4 \times +9\,800}}{2 \times 4}$✓

$X \frac{-560 \pm \sqrt{470400}}{8}$✓

$X = \frac{-560 \pm 685{,}857}{4}$✓

X = 15,732 cm or 157,32 mm✓ (8)

3.3 $\varepsilon_1 = \frac{k \times Q}{r^2} = \frac{90 \times 10^9 \times 30 \times 10^{-6}}{2^2}$✓

$= 675 \times 10^3 N/C$✓

$\varepsilon_2 = \frac{k \times Q}{r^2} = \frac{90 \times 10^9 \times (-25 \times 10^{-6})}{2^2}$✓

$= -562{,}5 \times 10^3 N/C$✓

$\varepsilon_r = \varepsilon_1 \times \cos 60^0 + \varepsilon_2 \times \cos 60^0$
$= 675 \times 10^3 \times 0{,}5 - 562{,}5 \times 10^3 \times 0{,}5$✓
$= 337{,}5 \times 10^3 - 281{,}25 \times 10^3$
$= 56{,}25 \times 10^3$ N/C✓ (6)

3.4 $C = \frac{k \times \varepsilon_o \times A}{d}$

$C = \frac{3,6 \times 8,85 \times 10^{-12} \times 1,2}{6 \times 10^{-5}}$ ✓✓

$C = 6,372 \times 10^{-7}$ F✓ (3)

3.5 $E = ½CV^2$

$E = ½ (7,1 \times 10^{-7} \text{ F}) \times (0,125 \text{ V})^2$ ✓✓

$E = 5,547 \times 10^{-9}$ J✓ (3)
[25]

QUESTION 4: ATOMIC PHYSICS

4.1 If a heavy nucleus is split in to smaller ones,✓ the greater binding energy of the latter means that energy will be liberated.✓ This process is called nuclear fission.

In nuclear fusion, two light nuclei combine to form a heavier one who is building energy per nucleon is greater.✓✓ (2 × 2) (4)

4.2 In order that the total numbers of protons and neutrons be the same before and after the fission reaction, two neutrons must be liberated. Hence there action is:

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{140}_{54}Xe + ^{94}_{38}Sr + ^{1}_{0}n + ^{1}_{0}n + \Delta E$$ ✓✓✓ (3)

4.3 If an isotope has a half-life of say, 5 hours and we start with 100g of it after 5 hours 50 g✓ will be left un-decayed. After 10 hours 25 g✓ will be undecayed. After 15 hours only 12,5 will be left decayed.✓ (3)

4.4 $E = h \times f$

$= 6{,}626 \times 10^{-34} \times 3 \times 10^{9}$✓✓

$E = 1{,}9878 \times 10^{-24}$ J✓ (3)

4.5 4.5.1 Emits an electron Z (atomic number) increases by 1✓
A (mass number), is unchanged✓

4.5.2 Undergoes electron capture Z (atomic number) decreases by 1✓
A (mass number), is unchanged.✓

4.5.3 Emits an alpha particle Z decreases by 2,✓ and A decreases by 4✓

(3 × 1) (6)

4.6 Kinetic Energy $K_E = ½ \times m \times V^2$

$K_E = ½ \times 9{,}1 \times 10^{-31} \times (10^7)^2$✓✓

$K_E = 4{,}55 \times 10^{-17}$ J ✓ (3)

4.7 The reading on the ammeter increases.✓ More photons with sufficient energy reach the cathode per second,✓ thus more photo-electrons are emitted per second.✓ (3)

[25]

TOTAL: 100

Copyright reserved