higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ENGINEERING PHYSICS N6

28 JULY 2021

This marking guideline consists of 6 pages.

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QUESTION 1: SOUND

1.1 1.1.1 False
1.1.2 True
1.1.3 False
1.1.4 True
1.1.5 True
1.1.6 True

(6 × 1) (6)

1.2
- Recorder
- Trumpet
- Organ
- Motor car exhaust pipe (4 x 1) (4)

1.3 **Transverse waves:**
Displacement of the medium is perpendicular to the direction of propagation of the wave.✓
To understand this, it is good to think of a rope being held still by person B while being moved up and down by person A. The direction of propagation is from person A to B, so you will see the waves move along this way.
But the displacement will be up and down.✓
Can travel in solids, but not in liquids and gas.✓

Longitudinal waves:
Displacement of the medium is parallel to the direction of propagation of the wave.✓
Sound waves and compression waves in a spring.✓
A good example for this is a slinky being pushed along the table, the propagation will be along the table and so will be the displacement of all the 'rings'.
Can travel through all states of matter.✓ (6)

1.4 V = 333 m/s and $v = \frac{72 \times 1\,000}{3\,600} = 20$ m/s✓

Ratio or Change in pitch = $\frac{330 + 20}{330 - 20}$✓
= 1,129:1✓ (4)

1.5 1.5.1 $V = \frac{\sqrt{F}}{\sqrt{\mu}}$ ✓

$V = \frac{\sqrt{90\ N}}{\sqrt{\frac{0,45 \times 10^{-3}}{53 \times 10^{-2}}}}$ ✓

$V = 325,576$ m/s ✓ (3)

1.5.2 $F_{fund} = \frac{V}{\eta_{Fund}} = \frac{325,576\ m/s}{2 \times 0,53\ m}$✓
= 307,15 Hz✓ (2)
[25]

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QUESTION 2: THERMODYNAMICS

2.1 2.1.1 True
2.1.2 False
2.1.3 True
2.1.4 True

(4 × 1) (4)

2.2 2.2.1

$$W = mRT_1 \ln\left[\frac{V_2}{V_1}\right] \quad \checkmark$$

$$W = 1 \text{ x } 0{,}297 \text{ x } 408 \ln\left[\frac{0{,}285}{0{,}0567}\right] \quad \checkmark$$

$$W = 195{,}665 \text{ kJ} \quad \checkmark$$

2.2.2 $\Delta U = m \times C_v \times (T_2 - T_1)$
$\Delta U = 1 \times 0{,}754 \times 0$✓ But T2 – T1 is isothermally = 0✓
$\Delta U = 0$ ✓

(2 × 3) (6)

2.3 The heat needed to raise the temperature of the water from 80 °C to the boiling point of 100 °C is:

$Q_1 = m_1 \times cx\Delta t$
$= 2 \text{ kg} \times 4186 \text{ J/kg °C} \times 20 \text{ °C}$✓
$= 0{,}17 \text{ MJ}$✓

Hence $Q_2 = (2{,}0 - 0{,}17) \times 10^6 \text{ J}$
$= 1{,}83 \text{ MJ}$ ✓ of the heat is available to convert water at 100 °C to steam at the same temperature

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

$$M_{steam} = \frac{Q_2}{Lv} = \frac{1{,}83 \times 10^6 \text{ J}}{2{,}26 \times 10^6 \text{ J}}$$

$M_{steam} = 0{,}81 \text{ kg}$ ✓ (4)

2.4 Actual Efficiency = 0,35 × ideal efficiency

$$= \frac{0.35 \times T_1 - T_2}{T_1}$$

$$= \frac{0,35 \times (212 + 273) - (48 + 273)}{(212 + 273)} \checkmark$$

$$= 0,118 \text{ or } 11,8\% \checkmark$$

$$\text{Power Input} = \frac{\text{Power output} \times 100}{\text{Efficiency}}$$

$$= \frac{6,25 \times 1\,000 \times 100}{11,8} \checkmark$$

$$= 52,966 \text{ kW} \checkmark$$ (4)

2.5 2.5.1 Pressure will change. Product of pressure is constant.
2.5.2 Volume will change. Product of volume is constant.
2.5.3 Isothermal process – the temperature remains constant
Adiabatic process – the temperature decreases
2.5.4 Heat must be subtracted with compression.
In an adiabatic process no heat flow takes place across the boundaries of the system.
2.5.5 In an adiabatic process the work done decreases.
(5 × 1) (5)

2.6
- Heat of vaporisation (Lv) is the amount of heat that must be added to a unit quantity of a substance at its boiling point to change it from liquid to gas.
- The same amount of heat must be removed from the unit quantity of the substance when it is a gas at its boiling point to change it to liquid. (2)

[25]

QUESTION 3: ELECTROSTATICS

3.1 The relation between the electrostatic charge density at a point on a conducting surface and✓ the curvature of the surface (at that point) is presented.✓ It is an observational fact that on a conducting surface, electric charge density is greater at those points where local surface curvature is also higher.✓ (3)

3.2

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

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

$$d = \frac{5 \times 8,85 \times 10^{-12} \times 0,04 \times 0,03 \times (9-1)}{300 \times 10^{-12}} \checkmark \checkmark$$

$$d = 1,416 \times 10^{-3} \text{ m or } 1,416 \text{ mm} \checkmark$$ (3)

3.3 3.3.1 $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2}$

$\frac{1}{C_T} = \frac{1}{3} + \frac{1}{6}$ ✓

$C_T = 2\ \mu F$ ✓

3.3.2 $C_T = C_1 + C_2$

$C_T = 3 + 6$ ✓

$CT = 9\ \mu F$ ✓

3.3.3 $Q = C \times V$

$Q = (2 \times 10^{-12}\ F) \times (1\ 200)$ ✓

$Q = 2,4 \times 10^{-9}\ C$ ✓

(3 × 2) (6)

3.4 $F = k\frac{Q_1 \times Q_2}{r^2}$ ✓

$F = \frac{9 \times 10^{9} \times 20 \times 10^{-8} \times -5 \times 10^{-8}}{(0,12)^2}$ ✓

$F = 6,25 \times 10^{-3}\ N$ ✓ (3)

3.5 3.5.1 $q = \frac{m \times g \times s}{V}$

$q = \frac{4,5 \times 10^{-15} \times 9,81 \times 0,025}{3\ 000}$

$= 3,675 \times 10^{-19}\ C$

3.5.2 Amount of electrons = $\frac{3,675 \times 10^{-19}}{1,9 \times 10^{-19}}$ ✓

= 1,9 use 2 electrons ✓

3.5.3 $W = V \times Q = 3\ 000 \times 8,5 \times 10^{-16}$ ✓

$W = 2,55 \times 10^{-12} J$ ✓

(3 × 2) (6)

3.6 $Q = \frac{m \times g}{E}$

$Q = \frac{2,5 \times 10^{-12} \times 9,81}{8 \times 10^{4}}$ ✓

$= 3,0625 \times 10^{-9}\ C$ ✓

Amount of electrons = $\frac{3,0625 \times 10^{-9}}{1,6 \times 10^{-9}}$ ✓

= 1,914 use 2 electrons ✓ (4)

[25]

QUESTION 4: ATOMIC PHYSICS

4.1 $F = \frac{Q_1 \times Q^2}{S^2}$

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

$F = 4,35 \times 10^{-9}$ N ✓ (3)

4.2
- If a heavy nucleus is split into 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 with a greater building nucleon. (4 x 1) (4)

4.3 $E = W = V \times Q$
$= 34\,000 \times 1,6 \times 10^{-19}$ ✓
$= 5,44 \times 10^{-15}$ J✓

$f = \frac{E}{h} = \frac{5,44 \times 10^{-15}}{6,6 \times 10^{-34}}$ ✓
$f = 8,242 \times 10^{18}$ Hz✓ (4)

4.4 TWO✓ neutrons must be liberated for the total number of protons and neutrons to be the same before and after the fission reaction.✓
Hence the reaction is:

$$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{140}_{54}Xe + ^{94}_{38}Sr + ^{1}_{0}n + ^{1}_{0}n + \Delta E \ .\checkmark$$

(3)

4.5
- 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 x 1) (3)

4.6 26 protons
30 neutrons
23 electrons (3)

4.7
4.7.1 True
4.7.2 False
4.7.3 True
4.7.4 True
4.7.5 False

(5 × 1) (5)
[25]

TOTAL: 100

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