higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

MARKING GUIDELINE

NATIONAL CERTIFICATE

ENGINEERING PHYSICS N6

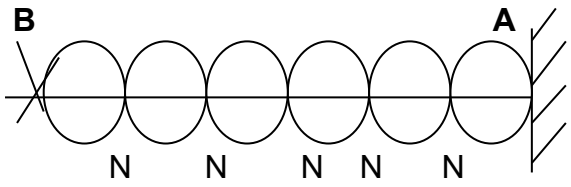
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This marking guideline consists of 7 pages.

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QUESTION 1: SOUND

1.1 A standing wave is formed when a wave does not move forwards through a medium but is reflected just as much as it is transmitted,✓ so that the total movement of the wave is nil. The places where the reflected and transmitted waves meet (N) are called the nodes (no interference) and the places where the bulge is greatest (M) are called the antinodes (maximum interference).✓



(2 marks for correct sketch) (4)

1.2 1.2.1 If a process is carried out such that there is no heat transferred into or out of the system, then the process is said to be adiabatic.✓

If a system is sufficiently thermally insulated, then heat transfer can be considered as negligible and the process or processes within the system can be considered being adiabatic.✓

1.2.2 Alternatively, if a process is carried out with sufficient rapidity then there will be little time for heat transfer.✓ Thus, if a process is rapid enough it can be considered being effectively adiabatic✓

(2 × 2) (4)

1.3 Wave length of the wiggles is $\lambda = 0{,}25 \times 10^{-4}$ m, so they pass the needle at the rate of

$$f = \frac{v}{\lambda} = \frac{3{,}5 \text{ m/s}}{0{,}25 \times 10^{-4}} \checkmark \checkmark$$

$$= 14\,000 \text{ Hz} \checkmark \quad (3)$$

1.4 1.4.1 $V = \sqrt{\frac{T}{\mu}}$ where $\mu = \frac{m}{} = \frac{5{,}8 \times 10^{-4} \text{ kg}}{0{,}731 \text{ m}}$

$$= 7{,}934 \times 10^{-3} \text{ kg/m} \checkmark$$

$$= \sqrt{\frac{94{,}5}{7{,}934 \times 10^{-3}}}$$

$$= 109{,}34 \text{ m/s} \checkmark \quad (2)$$

1.4.2 $\text{Ratio} = \frac{\sqrt{4T}}{\sqrt{T}} = \sqrt{\frac{4T}{T}}$ ✓ ✓

Ratio = 2:1✓ (3)

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1.5 1.5.1 $\frac{Vg_1}{Vr} = \frac{l}{L}$

$\frac{340}{Vr} = \frac{0,1}{L}$

therefore $\frac{1}{Vr} = \frac{0,1}{340L}$ … 1✓

$\frac{Vg_2}{Vr} = \frac{l_2}{L}$

$\frac{Vg_2}{Vr} = \frac{0,385}{L}$ … 2✓

Put 1 = 2

$\frac{0,385}{Vg_2L} = \frac{0,1}{340L}$

$Vg_2 = \frac{340 \times 0,385}{0,1}$✓

= 1 309 m/s✓ (4)

1.5.2 f is the frequency of the longitudinal wave and is the same in the gas as the rod.

$f = \frac{Vg_1}{2 \times l}$

$= \frac{340}{2 \times 0,1}$✓

= 1 700 Hz✓ (3)

1.6 The doppler effect refers to the change in wave frequency during the relative motion between a wave source and its observer.✓ For instance, when a sound object moves towards you, the frequency of the sound waves increases, leading to a higher pitch.✓ (2)

[25]

QUESTION 2: THERMODYNAMICS

2.1 The first law of thermodynamics states that in a closed system the total amount of energy is constant.✓ (Closed system – no energy may enter or leave the system). This is also an adiabatic process Q = U + W.✓ (2)

2.2 After compression, the temperature in an isothermal process remains constant.✓ After compression, the temperature in an adiabatic process rises and does not give off to environment, thus the pressure is higher.✓ (2)

2.3 2.3.1 P_1 = 700 kPa V_1 = 2,5 litres T_1 = 1 100 ºC or 1 373 K
P_2 = 270 kPa

$$P_1 \times V_1^n = P_2 \times V_2^n$$
$$V_2 = \left(\frac{735}{250}\right)^{0,769} \times 2,8 \times 10^{-3} \quad ✓$$
$$V_2 = 0,00642\ m^3\ ✓$$ (3)

2.3.2 $$\frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2}$$

$$T_2 = \frac{250 \times 0,00642 \times 1473}{735 \times 2,8 \times 10^{-3}}✓$$
$$T_2 = 1148,768\ K \text{ or } 875,768\ ºC✓$$ (3)

2.3.3 $$\text{Work done} = \frac{P_1 \times V_1 - P_2 \times V_2}{\alpha - 1}$$
$$\text{Work done} = \frac{735 \times 2,8 - 250 \times 6,42}{1,3 - 1}✓$$
Work done = 1,510 J✓ (2)

2.3.4 $P_1 \times V_1 = m \times R \times T$
$$m = \frac{735 \times 2,8}{289 \times 1\,473}$$
$m = 4,834 \times 10^{-3}$ kg✓

$(U_2 - U_1) = m \times Cv \times (T_2 - T_1)$
$= 4,834 \times 10^{-3} \times 710 \times (1148,768 - 1473)$✓
= - 230,205 kJ✓ (3)

2.4

$$T_1 = 27°C + 273°C$$
$$= 300°C$$
$$y = \frac{C_p}{C_v}$$
$$= \frac{861}{615} \quad ✓$$
$$= 1,4$$

$$T_2 = T_1\left(\frac{P_2}{P_1}\right)^{\frac{y-1}{y}}$$
$$= 300\left(\frac{960}{120}\right)^{\frac{1,4-1}{1,4}}$$
$$= 300(8)^{0,2857}$$
$$= 300x1,81144$$
$$= 543,418K \quad ✓$$

$$R = C_p - C_v$$
$$861 - 615$$
$$= 246J/kg°C$$

$$W = \frac{mR(T_1 - T_2)}{y-1}$$
$$= \frac{1x246[300 - 543,43}{1,4-1} \quad ✓$$
$$= \frac{✓ \ 59884,8128}{0,3}$$
$$= -149,71kJ \quad ✓$$

(5)

2.5 (1 kg × L) + (4 187 × 1 × 30) = (4 187 × 19 × 30)✓
L = 2 386 590 – 125 610✓
L = 2 260 kJ/kg✓ (3)

2.6 Conservation of heat is never 100% and even if it happens, the heat develop will be so intense that the metal used will melt if it is not cooled down.✓
Friction causes mechanical energy loss in heat energy, and the process thus proceeds more in one direction. An ideal gas does not exist, thus the clashes of the molecules are not completely elastic.✓ (2)
[25]

QUESTION 3

3.1 Electric potential (also called electric field potential, potential drop or electrostatic potential) is the amount of work needed✓ to move a unit positive charge from a reference point✓ to a specific point inside the field without producing an acceleration.✓ (3)

3.2 A line of force represents the path that a positively charged particle✓ would follow in an electric field✓ if such a particle can travel in only one direction at any point.✓ (3)

3.3 Yes, by a coulomb.✓ A coulomb is the quantity of electrical charge which moves through a conductor in one second✓ when a constant current of one ampere flows through the conductor.✓ (3)

3.4 3.4.1 $\frac{+2,5 \ q \ +(-9)}{2}$✓ $= \frac{9}{2}$✓ (2)

3.4.2 $F_1 = \frac{K2Q^2 \times -Q^2}{X^2}$ and $F_2 = \frac{K\,Q^2 - Q2}{\frac{2\quad 2}{X^2}}$

$F_1 = F_2$ ✓

$\frac{-2,5q\,K\,Q^2}{X^2}$ ✓ = $\frac{KQ^2}{4x^2}$ ✓

- 10:1 ✓ (4)

3.5 $W = Vq = ½\,mv^2$
$V \times v^2\ g\ \sqrt{v} = v$ ✓

400 volt is 1,5 times✓ greater than 380 volt and because $V\sqrt{v}$,v is 3 times greater✓ (3)

3.6 It means that the charge can only have a certain value✓ (in this case, multiples of $1,6 \times 10^{-19}$ C).✓ (2)

3.7 3.7.1 Since the ball is positively charged,✓ it has fewer electrons than are needed to balance the positive charges of its nuclear protons.✓ (2)

3.7.2 Number of electrons = $\frac{9}{e} = \frac{8,8^{-12}\ C}{1,6 \times 10^{-19} C}$

$= 5,5 \times 10^6$ electrons✓ (1)

3.8 $C = \frac{Q}{V} = \frac{6 \times 10^{-4} C}{380\ V}$ ✓

$= 1,579 \times 10^{-6}$ F
= 1,579 µF✓ (2)
[25]

QUESTION 4

4.1 4.1.1 True
4.1.2 False
4.1.3 False
4.1.4 True
4.1.5 True
(5 × 1) (5)

4.2 4.2.1 protons
4.2.2 neutrons
4.2.3 Alpha
4.2.4 nucleus
4.2.5 Beta
4.2.6 gamma
(6 × 1) (6)

4.3 Is the property of a capacitor to store an electric charge.✓ When its plates are at different potentials it is referred to as its capacitance.✓ (2)

4.4 4.4.1 Z, which is the atomic number, will increase by 1✓ and the mass number remains unchanged.✓

4.4.2 Z, which is the atomic number, will decrease by 1✓ and the mass number remains unchanged.✓

4.4.3 Z, which is atomic number, will increase by 2✓ and the mass number decreases by 4.✓

(3 × 2) (6)

4.5 4.5.1 α.
4.5.2 P
4.5.3 N
4.5.4 γ.
4.5.5 2n.
4.5.6 $_{+1}e$

(6 × 1) (6)
[25]

TOTAL: 100

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