TANZANIA HEAD OF ISLAMIC SCHOOLS COUNCIL
FORM SIX INTER ISLAMIC MOCK EXAMINATIONS

131/2 PHYSICS 2

PROPOSED MARKING GUIDE

1. (a) (i) $P \rightarrow$ Gauge pressure of liquid - - - - 00½ mark

$\rho \rightarrow$ Density of the fluid (liquid) - - 00½ mark

$V \rightarrow$ flow velocity of fluid (liquid) - - 00½ mark

(ii) Conditions.

- → Fluid must be Incompressible
- → Fluid must be non-viscous
- → The flow must be Irrotational
- → The flow must be steady

any two. - - 01½ marks

(iii) When speed of fluid Increases the Internal pressure of fluid DECREASES so that; - - 01 marks

$$P + \frac{1}{2}\rho v^2 = \text{constant}.$$ - - - 01 marks

(b) Given; Height of Mercury $h_m = 0.5\,m$

Required; Velocity head of water.

1st find height of water (h_w).

From

$$P_{Hg} = P_{H_2O}$$ - - - 00½

$$\rho_m \cancel{g} h_m = \rho_w \cancel{g} h_w.$$ - - - 00½

$$h_w = \frac{\rho_m h_m}{\rho_w} = \frac{13600 \times 0.5}{1000} = 6.8\,m.$$ - 00½

Then from

$$V_w^2 = 2g h_w = 2 \times 9.8 \times 6.8$$ - - 00½

$$V_w = \sqrt{2 \times 9.8 \times 6.8} = 11.5\,m/s.$$

∴ The velocity head of water is 11.5m/s. - - 00) c (i) Due to accumulation of snow on the wing of aeroplane, the structure of the wings no longer remains as of that of aerofoil. As a results the net upward force (lift) is decreased — 03 marks

(ii) From the continuity equation.

$$-A\frac{dh}{dt} = av \quad \text{but } v = \sqrt{2gh} \quad \text{— 00 1/2 mark}$$

$$-A\frac{dh}{dt} = a\sqrt{2gh}$$

$$-\frac{dh}{h^{1/2}} = \frac{a\sqrt{2g}}{A}dt \quad \text{— 00 1/2 mark}$$

Integrate both sides.

$$-\int_{H_1}^{H_2} h^{-1/2}dh = \frac{a\sqrt{2g}}{A}\int_0^t dt \quad \text{— 00 1/2 mark}$$

$$-2\left[h^{1/2}\right]_{H_1}^{H_2} = \frac{a\sqrt{2g}}{A}t \quad \text{— 00 1/2 mark}$$

$$2\left[\sqrt{H_1} - \sqrt{H_2}\right] = \frac{a}{A}\sqrt{2g}\,t$$

$$t = \frac{A}{a}\sqrt{\frac{2}{g}}\left(\sqrt{H_1} - \sqrt{H_2}\right) \quad \text{— 00 1 mark}$$

(d)(i) According to Bernoulli's principle this energy is acquired from the expense of a lowered pressure at the constriction. — 02 marks.

(ii) According to poiseuille's formula

$$Q = \frac{\pi P R^4}{8\eta L}$$

The rate through Individual capilaries are

$$Q_1 = \frac{\pi P (3R)^4}{8\eta L}, \quad Q_2 = \frac{\pi P (4R)^4}{8\eta L} \text{ and}$$ — 01 mark

$$Q_3 = \frac{\pi P (5R)^4}{8\eta L}$$

Since the capilaries are in series.

$$\frac{\pi P_1 (3R)^4}{8\eta L} = \frac{\pi P_2 (4R)^4}{8\eta L} = \frac{\pi P_3 (5R)^4}{8\eta L}$$ — 01 mark

$$81 P_1 = 256 P_2 = 625 P_3$$

meaning

$$P_1 = \frac{625}{81} P_3$$ — 0½ mark

It is given that $P_3 = 8.1$ mm of liquid

$$P_1 = \frac{625}{81} \times 8.1 \text{ mm of liquid}$$ — 0½ mark

$$P_1 = 62.5 \text{ mm of liquid}$$ — 0½ mark

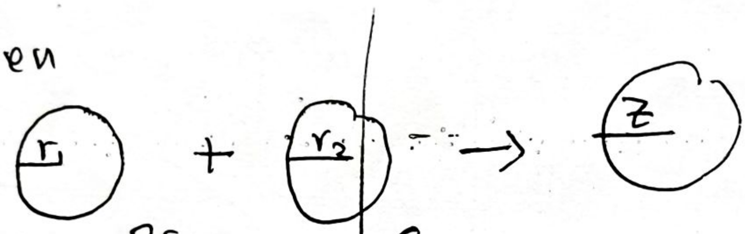
∴ The pressure across the first pipe

$$P_1 = 62.5 \text{ mm of liquid.}$$ — 0½ mark

2(a)(i) This is because the surface tension of hot soup is less than cold one, consequently hot soup spread more than cold soup, for this reason hot soup is tastier than cold soup. — 02 marks.

(ii) It is because hot needle lower surface tension of water between the matchsticks and the pull of the water molecules on the outside matchsticks becomes greater than the pull on the inside. As a results the matchsticks fly apart. — (02 marks)

(b) Given



$r_1 = 3cm$ $r_2 = 6cm$

Since these bubble coalesce in vacuum the total energy is conserved — 01/2 mark

$8\pi\gamma r_1^2 + 8\pi r_2^2\gamma = 8\pi z^2\gamma$ — 01/2 mark

$\cancel{8\pi\gamma}(r_1^2 + r_2^2) = \cancel{8\pi\gamma}(z^2)$

$z^2 = r_1^2 + r_2^2$ — 01 mark

$z^2 = 3cm^2 + 6cm^2$

$z^2 = 9 + 36 = 45$

$z = \sqrt{45}\ cm = 6.7cm$

∴ The radius of common Interface

$Z = 6.7cm$. — 01 mark

(c) (i) The ductility of a material is the extent of plastic deformation, clearly it is greater for a material "A". — 02 marks

(ii) The maximum height of a mountain on earth can be estimated from elastic behaviours of earth. If "h" is the maximum height of a mountain then; — 00 1/2 mark

Pressure exerted by mountain on earth = elastic limit of earth material. — 00 1/2 mark

$$\rho g h = 3\times10^{8}$$

$$h = \frac{3\times10^{8}}{3\times10^{3}\times9.8} = 10^{4}\,\text{m}$$

$\therefore$ The maximum height (h) $= 10^{4}$ m — 01 mark

(d) (i) Average speed

$$V_{av} = \frac{5+12+12+12+8+14+14+17+20}{9} = \underline{12.7\,\text{m/s}}$$ — 001 mark

(ii) Root mean square speed

$$V_{rms}^{2} = \frac{V_1^{2}+V_2^{2}+\ldots V_9^{2}}{9}$$

$$V_{rms}^{2} = \frac{5^2+12^2+12^2+12^2+8^2+14^2+14^2+17^2+20^2}{9}$$ — 00 1/2 mark

$$V_{rms}^{2} = 178$$

$$V_{rms} = \sqrt{178} = \underline{13.3\,\text{m/s}}$$ — 00 1/2 mark

(iii) Most probable speed is;

$\underline{12\,\text{m/s}}$ — 01 mark

3(a)(i) at a given temperature, the velocity of sound in air (gas) is Independent on pressure. Therefore the velocity of sound in a tube is 330 m/s even if pressure is Increased to 100 mm Hg. ——— 02 marks.

(ii) The water surface reflects sound back into air and only a little fraction of sound ($\simeq 0.1\%$) is refracted through water, that is why a diver cannot hear the sound. ——— 02 marks.

(b) The frequency of fundamental vibration is given as;

$$f = \frac{1}{2L}\sqrt{\frac{T}{m}}$$ ——— 001 mark

when temperature of the wire is Changed by ($\Delta\theta = 20°C$) Tension is developed in the wire

$$T = YA\alpha\Delta\theta$$ ——— 001 mark

$$f = \frac{1}{2L}\sqrt{\frac{YA\alpha\Delta\theta}{m}}$$ ——— 00½ mark

As $Y = 2\times10^{11} N/m^2$, $A = 10^{-6} m^2$, $\alpha = 1.21\times10^{-5}/°C$, $\Delta\theta = 20$
$L = 1 m$ and $m = (0.1/1)$ kg m-1 ——— 00½ mark

$$f = \frac{1}{2\times1}\sqrt{\frac{2\times10^{11}\times10^{-6}\times1.21\times10^{-5}\times20}{0.1}} = 11\ v/sec$$ ——— 01 mark

∴ The frequency = 11 vibrations/seconds. ——— 01 mark

(C) (i) The relationship between transmitted intensity and angle is given by Malus law ie

$$I = I_o \cos^2\theta$$

where

$I \rightarrow$ Transmitted Intensity.

$\theta \rightarrow$ Angle between transmision axis of polaroid and analyser. — 02 marks

(ii) From Malus law;

$$I = I_o \cos^2\theta$$ — 01 mark.

But $I = I_o - \frac{50}{100} I_o = \left(\frac{50}{100} I_o\right)$

Then

$$\frac{50 \cancel{I_o}}{100} = \cancel{I_o} \cos^2\theta$$

$$\cos^2\theta = \frac{1}{2}$$

$$\cos\theta = \sqrt{0.5} = 0.707$$ — 01 mark

$$\cos\theta = 0.707$$

$$\theta = \cos^{-1}(0.707) = 45^\circ.$$

$\therefore$ The angle $(\theta) = 45^\circ$. — 01 mark

(iii) Plane of vibration is the plane that contain vibrations of the waves while Plane of polarization is the plane that contain the direction of propagation of the waves. These two are parpendicular to each other. 02 marks

4(a)(i) when a vehicle is in motion, its tyre rubs against the ground (road) and get charged due to friction. further due to friction of air, the body of the vehicle also get charged. If the accumulation of charges become excessive, sparking may occur and the Inflammable material may catch fire. Since the chain ropes are touching the ground, the charg leake to the earth hence the danger of fire is avoided. — 02 marks.

02

(ii) Force between charge is given as;

$$F = \frac{Kq_1q_2}{r^2} \text{ for same K and r} \quad \text{— 01 mark}$$

$$F = K'q_1q_2 \text{ Hence}$$

$$\frac{F'}{F} = \frac{q'_1 q'_2}{q_1 q_2} \quad \text{— 01 mark}$$

$$\frac{F'}{F} = \frac{(2+-4)(+6+-4)}{(2)\times(6)}$$

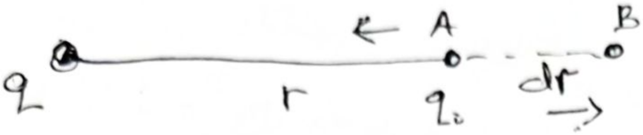
04

$$F' = \frac{(-2)(+2)}{12} F = \frac{-4}{12} F \quad \text{— 01 mark}$$

$$F' = \frac{-4}{12} \times 12 = -4N$$

∴ New force will be $F = -4N$ (attraction) — 01 mark

(b) (i) Consider the charge q_0 is to be moved against electrostatic force from B to A i.e



Work done against electric field of "q" is

$$dW = -F\,dr.$$ — 01/2 mark

But as

$$E = \frac{F}{q_0} \Rightarrow F = Eq_0.$$

02

$$dW = -Eq_0\,dr$$

$$\frac{dW}{q_0} = -E\,dr \quad \text{From } \frac{dW}{q_0} = dV$$ — 01/2 mark

$$dV = -E\,dr$$

$$E = -\frac{dV}{dr}$$ — 01 mark

(ii) Given $r_{AB} = 0.2\,m$, $r_{BC} = 0.15\,m$ and $r_{CA} = 0.1\,m$

$q_A = 10\times10^{-6}C$, $q_B = -75\times10^{-6}C$ and

$q_C = 25\times10^{-6}C$

Total energy of the system is given as.

$$W = W_{AB} + W_{BC} + W_{CA}$$ — 01 marks

04

$$W = \frac{Kq_Aq_B}{r_{AB}} + \frac{Kq_Bq_C}{r_{BC}} + \frac{Kq_Cq_A}{r_{CA}}$$ — 01 mark

$$W = 9\times10^{9}\left[\frac{10\times10^{-6}\times-75\times10^{-6}}{0.1} + \frac{-75\times10^{-6}\times25\times10^{-6}}{0.2} + \frac{25\times10^{-6}\times10\times10^{-6}}{0.1}\right]$$ — 01 mar

$$W = 9\times10^{9}(-1.6875\times10^{-8} + 2.5\times10^{-9}) = -129.375\,J.$$

$\therefore$ Work done of the system $\underline{-129.375\,J}$. — 01 mark

(C) Total emf $(E_0) = 12V$

Capacitance $(C_\circ) = 5\mu F$

Resistance $(R) = 2\times10^{6}\,\Omega$

Time for discharge $= 5$ sec.

Required: Charge (Q) after 5 sec

From

$Q = Q_0 e^{-t/RC}$ ——— 00 1/2 mark

where

$Q_0 = E_0 C = 12\times5\times10^{-6}$ —— 00 1/2 mark

$Q_0 = 60\times10^{-6}C$

$RC = 2\times10^{6}\times5\times10^{-6}$

$RC = 10$ sec ——— 00 1/2 mar

Then

$Q = 60\times10^{-6}\,e^{-5/10}$ ——— 00 1/2 mark

$Q = 60\times10^{-6}\times0.60653 0659$

$Q = 36\times10^{-6}C$

$Q = 36\,\mu C$

∴ The charge $Q = 36\,\mu C$ —— 01 mark

03

5 (a) (i) Because they are scalar quantities and the magnitude of the velocity does not change when the particle enter magnetic field perpendicular. — — — — — .. 02 marks.

(ii) The induced emf in the coil is given as

$\mathcal{E} = IR$ and $R = \frac{\rho L}{A} = \frac{\rho \pi D}{\pi r^2}$ where D — — 01 marks

and r are diameter and radius of the coil and radius of the copper wire respectively.

Hence;

$$\mathcal{E} = \frac{I \rho D}{r^2} = \frac{7.3 \times 1.68 \times 10^{-8} \times 15 \times 10^{-2}}{(0.18 \times 10^{-2})^2}$$ — — — 01 marks

$$\mathcal{E} = 5.7 \times 10^{-3} \text{ Volts}$$ — — — —

But it is clear that;

$$\mathcal{E} = -A_{loop} \cdot \frac{dB}{dt}.$$ — — — 00½ mark

$$\frac{dB}{dt} = \frac{-\mathcal{E}}{A_{loop}} = \frac{-(-5.7 \times 10^{-3})}{\pi \left(\frac{0.15}{2}\right)^2} = 0.32 \, Ts^{-1}$$ — — 00½ marks

∴ The rate of change of magnetic field intensity;

$$\frac{dB}{dt} = 0.32 \, Ts^{-1}$$ — — — 01 mark

(b) (i) From the formula

$$S_v = \frac{BAN}{KR}$$ 01 mark

Voltage sensitivity (S_v) increases with increase in
- → Magnetic flux density (B)
- → Area of the conductor (A) 01 mark
- → Number of turns (N)

And decreases with increase in;
- → Torsional constant (K) 01 mark
- → Resistance of the coil (R)

(ii) The Magnetic field Intensity, H is given by

$$B = \mu_0(H + M)$$ 0½ mark

Meaning.

$$H = \frac{B}{\mu_0} - M$$ 0½ mark

Given $B = 5.3T$, $\mu_0 = 4\pi \times 10^{-7} mA^{-1}$ and $M = 9 \times 10^5 Am^{-1}$

Then;

$$H = \frac{5.3}{4\pi \times 10^{-7}} - 9 \times 10^5 = 3.32 \times 10^6 Am^{-1}$$ 0½ mark

∴ The magnetic field (intensity)

$$\underline{\underline{H = 3.32 \times 10^6 Am^{-1}}}$$ 0½ mark

(C)(i) For Material Q, slope is positive and has small Magnetic succeptibility (I/H) hence its a paramagnetic material, "P" has large positive slope (I/H) hence its a FERROMAGNETIC material. — 02 marks

P — ferro
Q - Para

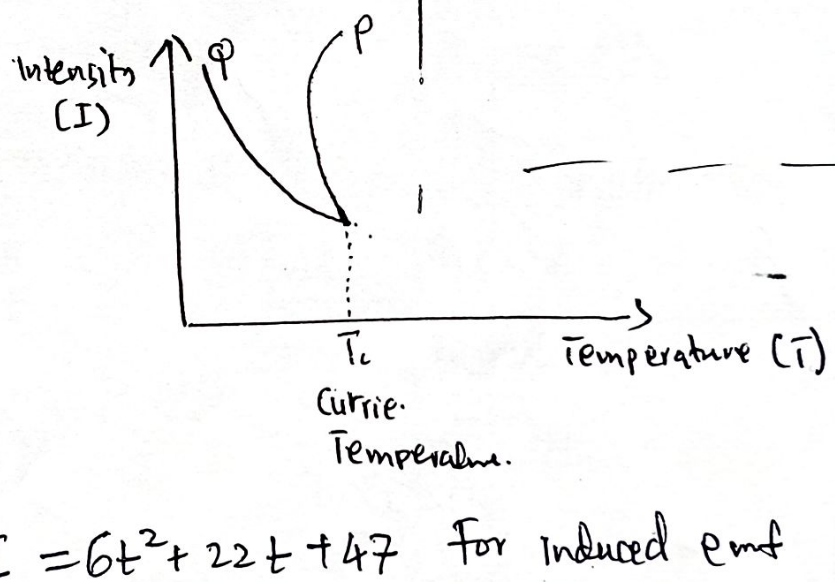
(ii) From $M = \frac{C B_o}{T}$ but $I = \frac{M}{\text{Volume}} \Rightarrow M = IV_o$ — 01 marks

$$I V_o = \frac{C B_o}{T}$$

$$I = \left(\frac{C B_o}{V_o}\right) \cdot \frac{1}{T} \Rightarrow I \propto \frac{1}{T}$$ — 01 marks

As Intensity (I) is inverse proportional to temperature

For material "P" and "Q"



— 02 marks

(d) Given; $I = 6t^2 + 22t + 47$ for Induced emf

$$e = L\frac{dI}{dt} = \left[\frac{d}{dt}\left(6t^2 + 22t + 47\right)\right] \times L$$ — 01 marks

$$\epsilon = [12t + 22] \times L$$

$$\epsilon = 3.4(12t + 22) = 40.8t + 74.8$$ — 01 marks

∴ The expression — 01 marks

$$\epsilon = 40.8t + 74.8$$

6(a)(i) The energy of electron in n^{th} orbit of hydrogen atom is given as;

$$E_n = -\frac{13.6\ eV}{n^2}$$ ---------- 01 max

The Integer "n" can assume any positive number from (1) to Infinity (∞) and hence Infinity number of lines can be drawn to form hydrogen spectrum. ---------- 01 mark

(ii) Random means difficult to predict which atom will decay first in a given sample and ---------- 01 mark

Spontanious maeans radioactivity process is independent on ~~natural fa~~ physical factors as temperature and pressure it occurs naturally. ---------- 01 mark.

(b) (i) Given; $V = 60kV = 60\times10^{3}\ V$

$I = 30mA = 30\times10^{-3}A$.

$\frac{dm}{dt} = 0.06\ kgs^{-1}$ and $P_H = \frac{99}{100}P$. Then;

(i) Rate of supply of electrical energy.

$P = IV = 30\times10^{-3}\times 60\times10^{3} = 1.8\times10^{3}\ J/s.$ ---------- 01 mark.

$\therefore$ The power $(P) = 1.8\times10^{3}\ J/s$ ---------- 01 mark

(ii) The increase in temperature $(\Delta\theta)$ from

$P_H = \frac{99}{100}\times 1800 = 1782\ J/s.$ ---------- 01 mark

But

$P_H = (m/t)\cdot C\Delta\theta$ ---------- 01 mark

$\Delta\theta = 1782/_{0.06}\times 4.2\times10^{3} = 7.1^{\circ}c.$

$\therefore$ The Increase in temperature $(\Delta\theta) = 7.1^{\circ}c$ ---------- 01 mark

(c) (i) Ionization energy (E_i) energy required to remove electron completely from its gaseous atom to infinity. ie — 01 mark

$$E_i = E_\infty - E_g.$$

$$E_i = 0 - -\frac{2.16 \times 10^{-18}}{1^2}$$ — 01 mark

$$\underline{\underline{E_i = 2.16 \times 10^{-18} \text{ Joules.}}}$$

(ii) From $n=2$ to $n=3$.

$$\Delta E = \left(\frac{-2.16 \times 10^{-8}}{3^2} - -\frac{2.16 \times 10^{-18}}{2^2}\right)$$

$$\Delta E = 2.16 \times 10^{-18} \times 0.138888 = 3 \times 10^{-19} J$$ — 01 mark

But since

$$\Delta E = \frac{hc}{\lambda}$$

$$\lambda = \left(\frac{\Delta E}{hc}\right)^{-1} = \frac{hc}{\Delta E} = \frac{6.6 \times 10^{-34} \times 3 \times 10^{8}}{3 \times 10^{-19}}$$ — 01 mark

$$\lambda = 6.6 \times 10^{-7} m/s.$$

∴ The wavelength of the line emitted

$$\underline{\underline{\lambda = 6.6 \times 10^{-7} m.}}$$ — 01 mark

6(d) Original activity $A_0 = 12000\ d/m$

Activity of $1\ cm^3 = 0.5\ d/m$

time $(t) = 30$ hrs

half life time $(t_{1/2}) = 15$ hrs.

1st Find Activity after 30 hours from

$\frac{dA}{dt} = -N\lambda$ But $N = N_0 e^{-\lambda t}$ — 01 mark

$\left(\frac{dN}{dt}\right)_{30} = -N_0 \lambda e^{-\lambda t}$ — 01 mark

$A = A_0 e^{-\lambda t}$

$A = \left[12000\, e^{-\frac{\ln 2}{15} \cdot 30}\right]$ as $\lambda = \frac{\ln 2}{t_{1/2}}$

$A = 12000\, e^{-2\ln 2}$ — 01 mark

$A = 12000\, e^{\ln(4^{-1})}$

$A = 12000 \times \frac{1}{4} = 3000\ d/m$ — 01 mark

Since

$1\ cm^3$ of blood has $A' = 0.5\ d/m$

then

V ? will be in $3000\ d/m$

$V = \frac{3000\ d/m \times 1\ cm^3}{0.5\ d/m}$ — 01 mark

$V = 6000\ cm^3$.

Total Volume of blood $(V) = 6000\ cm^3$. — 01 mar