PHYSICS 2 PROPOSED MARKING SCHEME

1. (a)(i) The law strictly applies to fluids of infinite extent

The law applies only under streamline conditions

The sphere must be smooth and rigid **any two points 1@=2 marks**

(ii) solid friction is independent on surface area in contact while viscosity is directly proportional to the area of layers of fluids in contacts
Friction is independent to the relative velocity between two bodies while viscosity is directly proportional to the relative velocity between layers of fluids **04marks**

(b) (i) parachute is used because the open parachute has large surface area. Hence experiencies large drag force while descending hence terminal velocity becomes low as a result the person does not hurt **02 marks**

(ii) from

$$V_T = \frac{2r^2(\rho-\partial)}{9\eta}g$$ **01 mark**

But $\partial = 0$(no buoyancy due to air)

Then

$$V_T = \frac{2\rho g r^2}{9\eta}$$ **01 mark**

$$= \frac{2x9.8\,x\,(2x10^{-5})^2\,x1.2x\,10^3}{9\,x\,1.8\,x\,10^{-5}}$$

$$= 5.8 \text{ x } 10^{-2}\frac{m}{s}$$ **01 mark**

Then from stokes law, Viscous force is given by

$$F = 6\pi\eta r V_T$$ **01 mark**

$$= 6\pi \text{ x } 1.8\text{x}10^{-5}\text{x } 2 \text{ x } 10^{-5} \text{ x } 5.8 \text{ x}10^{-2}$$

$$= 3.9 \text{ x } 10^{-10}\text{N}$$ **01 mark**

(c) (i) from continuity equation AV=constants
when water enters a narrow pipe the area of cross section decreases hence velocity of water flows increases **02 marks**

(ii) from Bernoulli's principle for horizontal flow

$$P_1 + \frac{1}{2}\rho V_1^2 = P_2 + \frac{1}{2}\rho V_2^2$$ **02 marks**

$$P_1 - P_2 = \frac{1}{2}\rho(V_2^2 - V_1^2)$$

Then kinetic energy per kg is given by

$\frac{1}{2}(V_2^{\ 2} - V_1^{\ 2}) = (P_1 - P_2)/\rho$ **01 mark**

$= \frac{5}{800} = 6.25 \text{ X } 10^{-3}$ J/kg **02 marks**

2. (a)(i) Diver under water is unable to hear the sound produced in air because the water surface reflects the sound back into the air and only a little fraction of incident intensity of about 0.1% is transmitted through water. **02 Marks**

(ii) Car horn's frequency f = 500Hz.

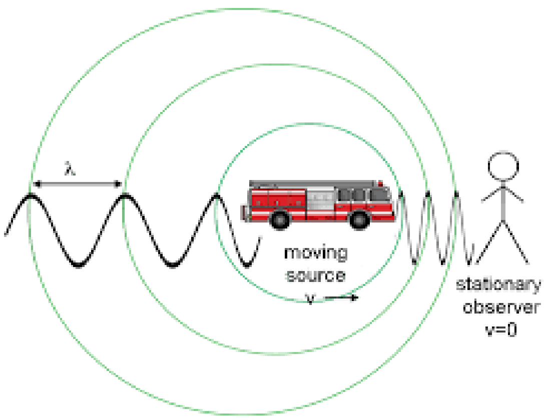
Speed of the car u_s = 20m/s (It approaches and passes a stationary observer)

Speed of stationary observer u_o = 0

To find change in pitch of note heard by the observer Δf = ?

Given; Speed of sound in air v_a = 340m/s.

Consider diagrams below.



During approaching when the car move towards the stationary observer apparent frequency increases, $f' = \left[\frac{v_a}{v_a - u_o}\right] f$ **00½ Marks**

$$f' = \left[\frac{340m/s}{340ms^{-1} - 20m/s}\right] X500Hz$$ **00½ Marks**

$$f' = 531.25Hz$$ **00½ Marks**

After the car passes the stationary observer and moves away, the apparent frequency decreases, $f'' = \left[\frac{v_a}{v_a + u_o}\right] f$ **00½ Marks**

$$f'' = \left[\frac{340m/s}{340ms^{-1} + 20m/s}\right] X500Hz$$ **00½ Marks**

$f'' = 472.22Hz$ **00½ Marks**

Now, change in pitch $\Delta f = f' - f''$ **00½ Marks**

Δf = 531.25Hz – 472.22Hz

Δf = 59.03Hz. **00½ Marks**

∴Change in pitch of the note head by the stationary observer is 59.03Hz.**01 Mark**

(b) (i) Note that, the mass M is inversely proportional to the square of the number of loops N i.e.

$$M \propto \frac{1}{N^2}$$
$$MN^2 = Constant$$
$$M_1 N_1^2 = M_2 N_2^2$$
$$M_2 = \frac{M_1 N_1^2}{N_2^2}$$
$$M_2 = \frac{8 \, x \, 3^2}{6^2}$$
$$M_2 = 2g$$

02 marks

(ii) From the relation given below,

$$f = \frac{1}{2L}\sqrt{\frac{T}{\rho A}}$$
$$f = \frac{1}{2 \, x \, 0.76}\sqrt{\frac{40}{8800 \, x \, 3.14 \, x \, 0.0005^2}}$$
$$f = 50.06Hz$$

05 marks

(c) (i)In double slit experiment in order to see fringes on the screen,

-*Slit separation must be small* so that the fringes formed are of greater thickness and

width. **01Mark**

-*The distance between the slits and the screen must be large* so that more interference

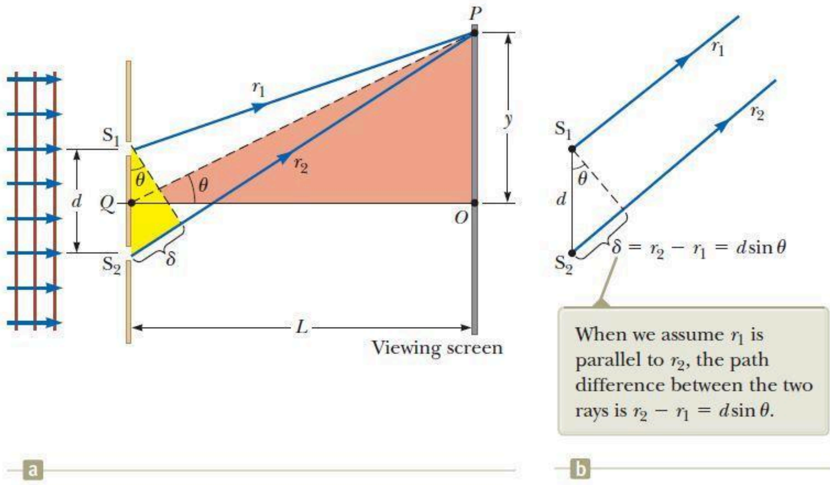
will be produced and observed. **01 Mark**

(ii) Distance between slits d = 0.125mm

Wavelength of light $\lambda = 4.5x10^{-7}$m

Distance between the screen and the slits L = 1.0m

To find separation of the 2nd bright fringes on both sides of the central maximum Y = ?



During constructive interference;

Path difference, $\square = n\lambda$

Consider the small triangle; $sin\theta = \frac{n\lambda}{d}$ …………….. (i) **00½ Marks**

For the larger triangle, $tan\theta = \frac{y_n}{L}$ …………….(ii) **00½ Marks**

For very small angles measured in radians, $sin\theta \approx tan\theta$

Hence,equation (i) = (ii).

$y_n = \frac{n\lambda L}{d}$ **00½ Marks**

$y_2 = \frac{2X4.5X10^{-7}m\,X\,1.0m}{0.125X10^{-3}m}$ **00½ Marks**

$y_2 = 7.2X10^{-3}m$ **00½ Marks**

But $Y = 2y_2$ **00½ Marks**

$Y = 2x7.2x10^{-3}m$

$Y = 14.4x10^{-3}m$ **00½ Marks**

∴Linear width of the 2nd central maximum is $14.4x10^{-3}$m. **00½ Marks**

3. (a) $P = \frac{1}{3}\rho \overline{c}^2$

$P = \frac{1}{3}\frac{m}{V}\overline{c}^2$ **01 mark**

$PV = \frac{1}{3}Nm\overline{c}^2$

$PV = \left(\frac{1}{2}m\overline{c^2}\right) \times \frac{2}{3}N$ **01 mark**

But $\frac{1}{2}m\overline{c^2} = \frac{3}{2}k_B T$ **01 mark**

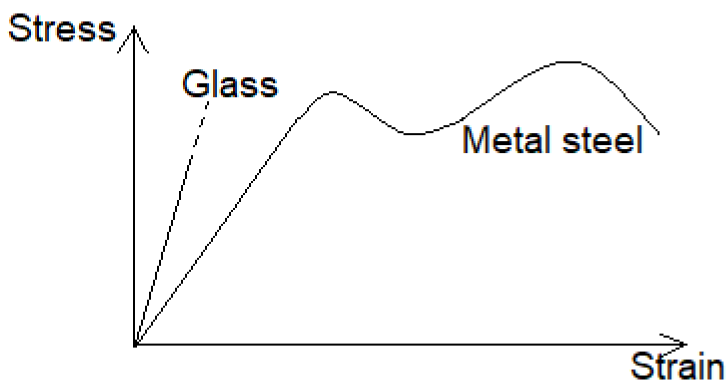
$\Rightarrow PV = \left(\frac{3}{2}k_B T\right) \times \frac{2}{3}N$

$PV = Nk_B T = constant$ **01 mark**

(b) (i)

(c) Steel	***Glass***
Undergoes both elastic and plastic deformation	Undergoes only elastic deformation
Ductile and tough	Brittle
Stiff	Stiff

Stress – strain curve for steel and glass



04 marks

(ii) Young's modulus of elasticity and modulus of rigidity do not exist for liquids and gases because liquids and gases cannot be deformed along one dimension only and also cannot undergo shear strain. **02 Marks**

(c) Length of each wire $L_{steel} = L_{Brass} = L = 2.00$m

Diameter of steel wire $d_{steel} = 0.60$mm

Length of the rigid bar AB is $l = 0.2$m

Mass of the load at the center of the rigid bar m = 10.0kg

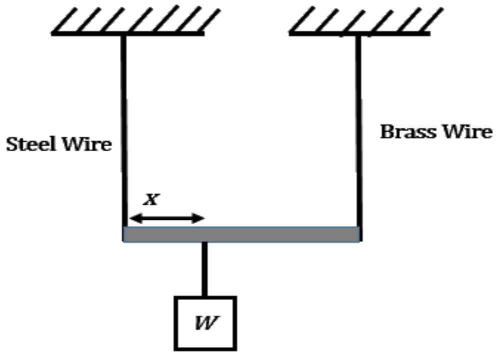
(i) To find tension in each wire $T_s = T_B = T$ (since load is at center).

(ii) To calculate the extension of the steel wire e_s and the diameter of the brass wire d_B

(iii) To find new position (x) of the mass for the rigid bar to remain horizontally when the brass wire is replaced by another brass wire of diameter 1.00mm

Given; Young's modulus of brass $Y_B = 1.0 \times 10^{11}$ Pa.

Young's modulus of steel $Y_s = 2.0 \times 10^{11}$ Pa.



(i) Totension T in each wire.

Sum of upward forces = Sum of downward forces.

$T + T = W$ **00½ Marks**

$2T = m\boldsymbol{g}$

$2xT = 10kg \times 9.8m/s^2$ **00½ Marks**

$$T = \frac{98N}{2}$$

$T = 49N$ **00½ Marks**

∴<u>Tension in each wire is 49N.</u> **00½ Marks**

(ii) To find extension of steel wire e_s.

Recall from $Y = \frac{F.l}{A.e}$

$$e_s = \frac{F_s L_s}{A_s Y_s}$$

But c.s A of steel, $A_s = \frac{\pi d_s^2}{4}$

Hence, $e_s = \frac{4F_s L_s}{\pi d_s^2 Y_s}$ **00½ Marks**

$$e_s = \frac{4X49N\ X\ 2}{\pi X(0.6X10^{-3}m)^2\ X\ 2.0X10^{11}Pa}$$ **00½ Marks**

$e_s = 1.733X10^{-3}m$ **(00½ Marks)**

$\therefore$extension of the steel wire is 1.733×10^{-3}m. **00½ Marks**

To find diameter of brass wire d_B.

From $$e_B = \frac{4F_BL_B}{\pi d_b^2 Y_B}$$

$$d_B = \sqrt{\frac{4F_BL_B}{\pi e_b Y_B}}$$ **00½ Marks**

$$d_B = \sqrt{\frac{4X49N\ X\ 2m}{\pi X1.733X10^{-3}m\ X\ 1.0X10^{11}Pa}}$$ **00½ Marks**

$$d_B = 8.57X10^{-4}m$$ **00½ Marks**

$\therefore$Diameter of the brass wire is 8.57×10^{-4}m **00½ Marks**

(iii) To find the new position x of the mass for the bar to remain horizontal after replacing the brass wire with another brass wire of diameter 1.00mm

By considering diagram above, Apply the principle of moments.

Sum of anti-clock wise moments = Sum of clock wise moments.

$F_s x = F_b (0.2m - x)$ ……………………………… (i) **00½ Marks**

Also for the rigid bar to remain horizontal,

$e_s = e_b$ **00½ Marks**

Where, $e_s = \frac{4F_sL_s}{\pi d_s^2 Y_s}$ and $e_B = \frac{4F_BL_B}{\pi d_b^2 Y_B}$ **00½ Marks**

$$\frac{4F_sL_s}{\pi d_s^2 Y_s} = \frac{4F_BL_B}{\pi d_b^2 Y_B}$$ **00½ Marks**

$$\frac{F_s}{d_s^2 Y_s} = \frac{F_B}{d_b^2 Y_B}$$

$$\frac{F_s}{(0.6mm)^2 X\ 2.0X10^{11}Pa} = \frac{F_b}{(1.00mm)^2 X\ 1.0X10^{11}Pa}$$ **00½ Marks**

$$\frac{F_s}{F_b} = 0.72$$ ………………………… (ii)

$F_s = 0.72F_b$

Now from equation (i), $0.72F_b \cdot x = F_b (0.2m - x)$ **00½ Marks**

$0.72x = 0.2m - x$

$0.72x + x = 0.2m$

$1.72x = 0.2m$

$$x = \frac{0.2m}{1.72}$$ **00½ Marks**

$x = 0.116m$

$\therefore$The mass should be placed at a distance of 0.116m from end A of steel wire or 0.084m from end B of brass wire in order the wire to remain horizontal after replacing the brass wire with another brass wire of diameter 1.00mm. **00½ Marks**

4. (a) (i) Two similarly charged pith balls suspended from a point repelling each other will come closer when a mica sheet with relative permittivity 6 is introduced between them.

Recall; $F = \frac{Q_1 Q_2}{4\pi\varepsilon_o \varepsilon_r r^2}$

Therefore, since relative permittivity $\boldsymbol{\varepsilon_r}$ mica is 6, Which means it is six times more than that of air, the force of repulsion will decrease. **02 Marks**

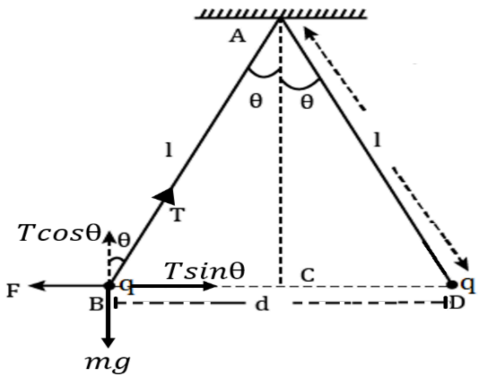
(ii) Angle between the two strings $2\theta = 30^o$

Density of the liquid $\rho' = 800 kg/m^3$

Dielectric constant of the liquid $\boldsymbol{\varepsilon_r} = ?$

Density of the material of the sphere $\rho = 1600 kg/m^3$

Let charge on each sphere be Q



At equilibrium;

Vertical component forces; $T.\cos 15^o = m\boldsymbol{g}$ ……………(i)

Horizontal component forces; $T.\sin 15^o = F$

Where, $F = \frac{Q^2}{4\pi\varepsilon_o r^2}$

$T.\sin 15^o = \frac{Q^2}{4\pi\varepsilon_o r^2}$ ………………………………..…….(ii) **00½ Marks**

By dividing equation (ii) by (i),

$\frac{T\sin 15^o}{T\cos 15^o} = \frac{Q^2/4\pi\varepsilon_o r^2}{mg}$

But $\frac{\sin\theta}{\cos} = \tan\theta$

$tan15^o = \frac{Q^2}{4\pi\varepsilon_o mgr^2}$ ……………………………………(iii) **00½ Marks**

Now when the spheres are immersed in the liquid, the effective weight of each sphere

and the repulsive force F decreases, and hence also tension T in the strings decreases.

Weight of sphere in liquid, $W' = mg\left(1 - \frac{\rho'}{\rho}\right)$

$W' = mg\left(1 - \frac{800kg/m^3}{1600kg/m^3}\right)$ **00½ Marks**

$W' = mg(1 - \frac{1}{2})$

$W' = \frac{mg}{2}$ **00½ Marks**

New force in liquid; $F' = \frac{Q^2}{4\pi\varepsilon_o\varepsilon_r r^2}$

New tension in strings $T'\cos15^o = \frac{1}{2}mg$ ……………………(iv) **00½ Marks**

$T'\sin15^o = \frac{Q^2}{4\pi\varepsilon_o\varepsilon_r r^2}$ ………………(v) **00½ Marks**

Similarly, by dividing equation (v) by (iv).

$tan15^o = \frac{2Q^2}{4\pi\varepsilon_o\varepsilon_r mgr^2}$……………(vi) **00½ Marks**

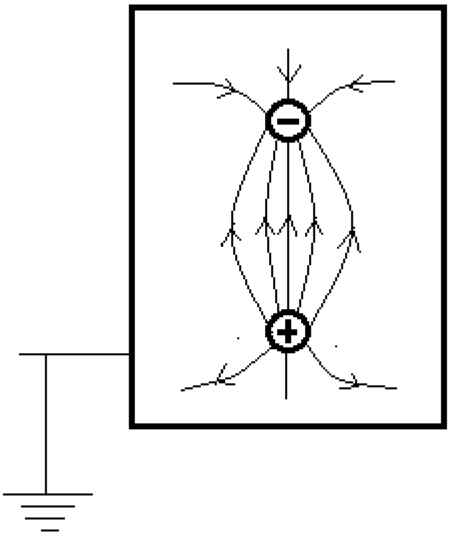
Now equation (iv) = (iii).

$\frac{2Q^2}{4\pi\varepsilon_o\varepsilon_r mgr^2} = \frac{Q^2}{4\pi\varepsilon_o mgr^2}$ **00½ Marks**

$\boldsymbol{\varepsilon}_r = 2$

∴Dielectric constant of the liquid is 2 **01 Mark**

(b) (i) By using electrostatic shielding.



02 marks

This is the protection of objects from intensive electric field by enclosing in a hollow conductor (faraday cage). Since charge inside a hollow conductor is zero, it is possible to prevent charges in one plate from setting up an electric field beyond the intermediate neighbourhood by surrounding the charges with a faraday cage and connecting the cage to earth.

02 marks

(ii) Charge on electron Q = 1.6×10^{-19}C

Electric field strength E =?

Electric potential V =?

Distance r = 10^{-10}m.

Solution;

To find electric field strength E.

Recall from $E = \frac{F}{Q_o}$ **00½ Marks**

Where; $F = \frac{QQ_o}{4\pi\varepsilon_o r^2}$

$$E = \frac{QQ_o/4\pi\varepsilon_o r^2}{Q_o}$$

$$E = \frac{Q}{4\pi\varepsilon_o r^2}$$

But again $\frac{1}{4\pi\varepsilon_o} = k = 9X10^9 Nm^2C^{-1}$

Hence, $E = k.\frac{Q}{r^2}$ **00½ Marks**

$$E = 9X10^9 Nm^2C^{-1} X \frac{1.6X10^{-19}C}{(10^{-10}m)^2}$$

E = 1.44×10^{11}V/m **00½ Marks**

To find electric potential V.

Recall from $E = \frac{V}{r}$ **00½ Marks**

V= E.r

$V = 1.44x10^{11}V/m \times 10^{-10}m$ **00½ Marks**

$V = 14.4$ V **00½ Marks**

∴The electric field strength and electric potential are $1.44x10^{11}$V/m and 14.4V respectively.

01 Marks

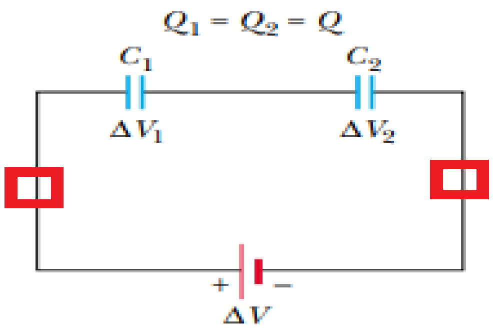
(c) (i) Any conducting object connected to earth is said to be grounded because the earth is electron sink or source of electrons and is arbitrarily said to be at zero potential and hence any conducting body connected to the earth is also at zero potential or ground potential, that is why that body is said to be grounded. **02 Marks**

(ii) Capacitance $C_1 = 15\mu F$

Capacitance $C_2 = 20\mu F$

Potential $V = 600V$

To find charge Q on each capacitor.



From $Q = CV$

$V = \frac{Q}{C}$

$V_1 = \frac{Q}{C_1}$ **00½**

Marks

$V_2 = \frac{Q}{C_2}$

Total potential $V = V_1 + V_2$ **00½ Marks**

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

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2}$$ **00½ Marks**

$$\frac{1}{C} = \frac{1}{15\mu F} + \frac{1}{20\mu F}$$

$C = 8.571\mu F$ **00½ Marks**

Now, $Q = 8.571x10^{-6}F \times 600V$

$Q = 5.143x10^{-3}C$ **00½ Marks**

$\therefore$Charge stored on each capacitor is 5.143×10^{-3}C **00½ Marks**

5. (a)(i) To name the three independent quantities used to specify earth's magnetic field.

-Magnetic declination

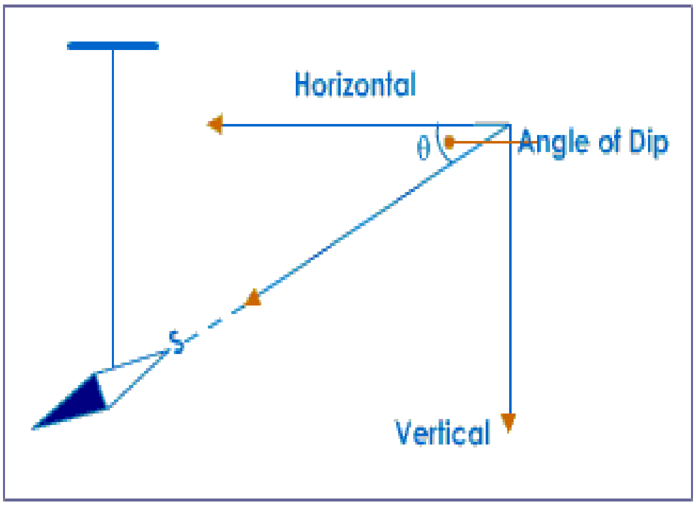
-Angle of dip.

-Horizontal component of the earth's magnetic field. **03 Marks**

(ii) Let horizontal component of earth at place $\beta_H = \beta$

vertical component of earth at a place $\beta_V = \beta$

Angle of dip at this place $\theta = ?$



Vertical component; $\beta_v = \beta_R.\text{Sin}\theta$ ……………………(i) **00½ Marks**

Horizontal component$\beta_H = \beta_R.\text{Cos}\theta$ …………………...(ii)

Since at this place; $\beta_v = \beta_H$ OR equation (i) = (ii).

$\beta_R.\text{Sin}\theta = \beta_R.\text{Cos}\theta$ **00½ Marks**

$\text{Sin}\theta = \text{Cos}\theta$

Divide each side by Cos θ

$$\frac{Sin\theta}{Cos\theta} = 1$$

Where $\frac{sin\theta}{cos} = tan\theta$

$$tan\theta = 1$$

$\theta = \tan^{-1}(1)$. **00½ Marks**

$\theta = 45^o$

$\therefore$*The angle of dip at this place is 45º*. **00½ Marks**

(b) (i) To mention three ways by which magnetic field can be produced.

-By using a magnet.

-By passing current through a conductor.

-By varying electric field. **03 Marks**

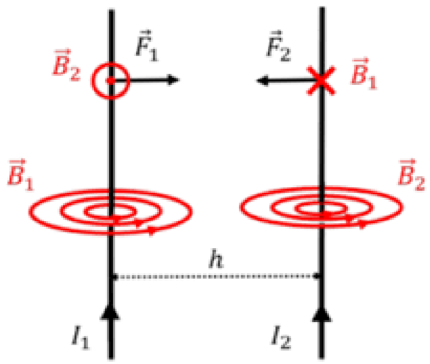
(ii) Separation distance between two wires r = 0.10m

Current in 1^{st} wire $I_1 = 5.0A$

Current in 2^{nd} wire $I_2 = 3.0A$

Magnetic field strength ß = ? at the center of the two wires.

Permeability of free space, $\mu_o = 4\pi\times 10^{-7}\ Hm^{-1}$.



Recall from $\beta = \frac{\mu_o I}{2\pi r}$

$$\beta_1 = \frac{\mu_o I_1}{2\pi r_1}$$ **00½ Marks**

Where; $r_1 = \frac{r}{2}$

$$r_1 = \frac{0.10m}{2}$$ **00½ Marks**

$r_1 = 0.05m$

$$\beta_1 = \frac{4\pi X 10^{-7} Hm^{-1}\ X\ 5A}{2\pi X\ 0.05m}$$ **00½ Marks**

$ß_1 = 2.0x10^{-5}T$

$$\beta_2 = \frac{\mu_o I_2}{2\pi r_2}$$

But $r_2 = r_1 = 0.05m$

$$\beta_2 = \frac{4\pi X 10^{-7} Hm^{-1}\ X\ 3A}{2\pi X\ 0.05m}$$ **00½ Marks**

$ß_2 = 1.2 \times 10^{-5}T$

Since the two fields acts in opposite directions,

Resultant magnetic field at the center; $ß_R = ß_1 - ß_2$ **01 Marks**

$ß_R = (2.0 - 1.2) x10^{-5}T$

$ß_R = 0.8 \times 10^{-5}T$. **00½ Marks**

$\therefore$Magnetic field at the center of the two wires is $0.8x10^{-5}$T. **00½ Marks**

(c) Velocity v = 0.2m/s.

Magnetic field ß = 10^{-2}T

Let distance AB be x = 0.1m

Let distance BC be y = 0.2m

Resistance R = 5Ω

To find current flowing in the metal frame when;

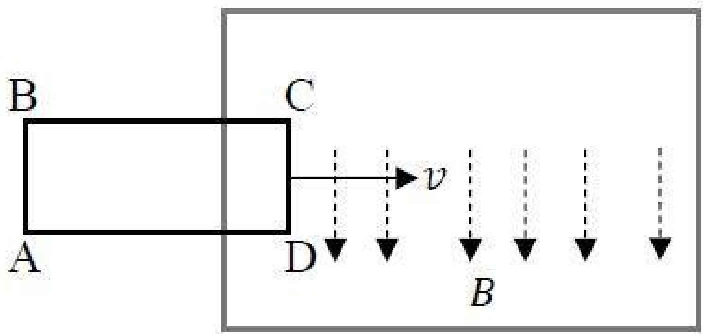
(i) CD just enters the field I_1 = ?

(ii) Whole frame is moving through the field I_2 = ?

(iii)CD just moves out of the field on the other side I_3= ? and sketch the graph showing current variation.

Solution.

Cons. fig. below.



(i) Current I_1

Recall from, $Emf = N\frac{d\emptyset}{dt}$

But $\emptyset = \beta A$ **00½ Marks**

Where A= x.y

$$\emptyset = \beta.x.y$$

$$Emf = N\frac{d(\beta.x.y)}{dt}$$

$$Emf = N.\beta.y\frac{dx}{dt}$$

But again $\frac{dx}{dt} = v$ and for single conductor N =1

$Emf = \beta.y.v$ **00½ Marks**

Emf = 10^{-2}T x 0.1m x 0.2m/s

Emf = $2.0x10^{-4}$V

Now from V = I.R,

$$I_1 = \frac{V}{R}$$

$$I_1 = \frac{2.0X10^{-4}V}{5\Omega}$$ **00½ Marks**

$I_1 = 4.0x10^{-5}$A

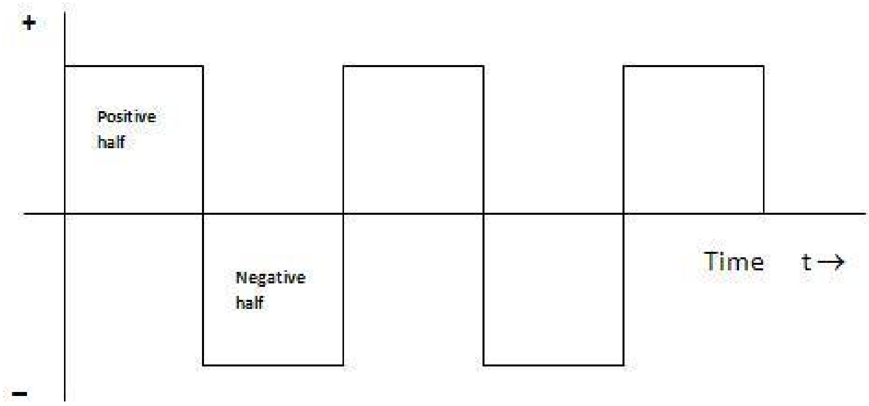
∴Current flowing when CD just enters the field is $4.0x10^{-5}$A. **00½ Marks**

(ii) No current is flowing in the metal frame when the whole frame is moving through the field because the magnetic flux is constant and hence since there is no varying magnetic flux, (no magnetic flux change) there will be no induced electromotive force (E.m.f) produced. i.e $I_2 = 0$

02 Marks

(iii)When CD just moves out of the field on the other side, The current flowing in the metal frame will be same in magnitude as calculated in 5(c).i. above but it is flowing in the opposite direction. Hence $I_3 = - I_1 = - 4.0x10^{-5}$A. **02 Marks**

sketch a graph of current against time. **02 Marks**



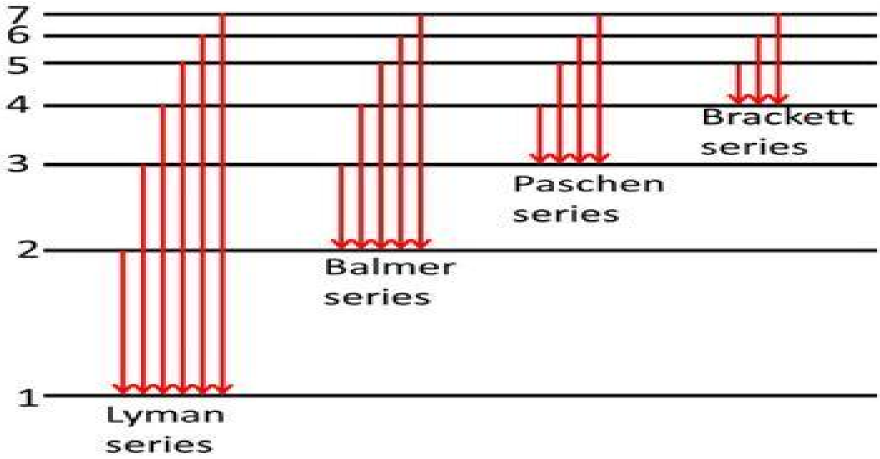
6. (a) (i) Three parameters of Bohr's model of the atom **03 Marks**

- Radii of stationary orbits.
- Velocity of electron in stationary orbits.
- Frequency of electron in stationary orbits.

(ii) Wavelength of 1st member in Balmer λ_B= $6.563x10^{-7}$m

To find wavelength of 1st member of Lyman series λ_L= ?(In the same spectrum).

Consider the fig. below.



Recall from $\frac{1}{\lambda} = R_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ **00½**

Marks

For Balmer series, $n_1 = 2$ and $n_2 = 3$ **00½ Marks**

$$\frac{1}{\lambda_B} = R_H\left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

$$\frac{1}{\lambda_B} = \frac{5R_H}{36} \text{..........................(i).}$$ **00½ Marks**

For Lyman series $n_1 = 1$ and $n_2 = 2$. **00½ Marks**

$$\frac{1}{\lambda_L} = R_H\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$$

$$\frac{1}{\lambda_L} = \frac{3R_H}{4} \text{..........................(ii).}$$ **00½ Marks**

By dividing equation (ii) by (i).

$$\frac{\lambda_L}{\lambda_B} = \frac{5R_H}{36} \times \frac{4}{3R_H}$$

$$\lambda_L = \frac{20}{108} \times \lambda_B$$ **00½ Marks**

$$\lambda_L = \frac{20}{108} X\, 6.563\, X\, 10^{-7} m$$

$\lambda_L = 1.215 \times 10^{-7}$m **00½ Marks**

∴Wavelength of 1st member in Balmer series is 1.215×10^{-7}m **00½ Marks**

(b) Wavelength of wavelength λ_1 = 500nm

Stopping potential of Potassium V_s = 0.226V

New wavelength λ_2 = 380nm

New stopping potential of Potassium V' = 1.00V

(i) To calculate the value of the Plank's constant h =?

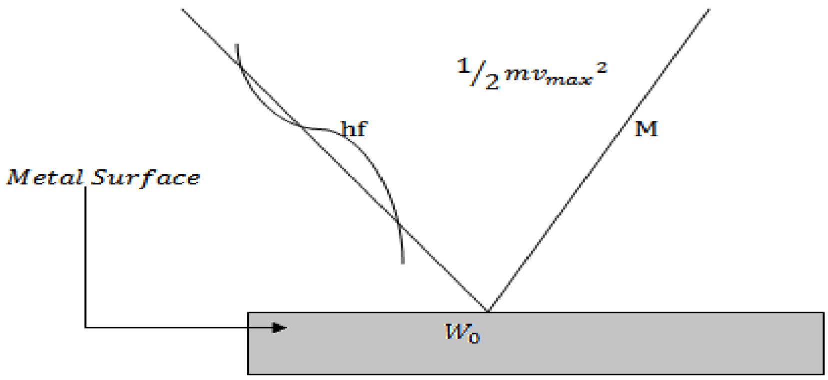
(ii) To calculate the work function of Potassium Wo=? (Value in eV)

Velocity of light in vacuum $c = 3.0 \times 10^8$m/s.

Electronic charge $e = 1.6 \times 10^{-19}C$

Solution.

Consider fig. shown below.



(i) To find Plack'sconstant h = ?

Recall from, Total incident energy = Work function + maximum kinetic energy.

$E = W_o + K.E_{max.}$

Where $E = hf$ and on stopping the electron, $K.E_{max} = eV_s$

$hf = W_o + eV_s$ **00½ Marks**

$eV_s = hf - W_o$

Where $c = \frac{c}{\lambda}$

$$eV_s = h\frac{c}{\lambda} - W_o$$

For the 1st case; $eV_s = h\frac{c}{\lambda_1} - W_o$ **00½ Marks**

$$e\,X\,0.226V = h\,X\,\frac{3.0X10^8 m/s}{500X10^{-9} m} - W_o$$

$0.226\ eV = 6.0x10^{14}h - W_o$ ……. (i) **00½ Marks**

For the 2nd case; $eV' = h\frac{c}{\lambda_2} - W_o$ **00½ Marks**

$$e\,X\,1.00V = h\,X\,\frac{3.0X10^8 m/s}{380X10^{-9} m} - W_o$$

$1.00eV = 7.895x10^{14}h - W_o$ ………………. (ii) **00½ Marks**

By taking equation (ii) minus equation (i). OR equation (i) – (ii).

$1.00eV - 0.226eV = (7.895 - 6.0) \times 10^{14}.h$ **00½ Marks**

$0.774eV = 1.895 \times 10^{14}.h$

$$h = \frac{0.774eV}{1.895X10^{14}/s}$$

$$h = \frac{0.774X1.6X10^{-19}C\,X1V}{1.895X10^{14}/s}$$ **00½ Marks**

$h = 6.535 \times 10^{-34}$Js

∴ Experimental value of Planck's constant is 6.535×10^{-34}Js **00½ Marks**

(ii) To find work function of Potassium W_o

Recall from equation (ii) ; $1.00eV = 7.895x10^{14}h - W_o$ ……….(ii).

$W_o = 7.895x10^{14}h - 1.00eV$ **00½ Marks**

$W_o = 7.895x10^{14} \times 6.535x10^{-34}Js - 1.00x1.6x10^{-19}C \times 1V$

$W_o = 3.559 \times 10^{-19}J$ **00½ Marks**

Now from; $1eV = 1.6x10^{-19}J$

$W_o = 3.559x10^{-19}J$

$$W_o = \frac{3.559X10^{-19}J}{1.6X10^{-19C}}$$ **00½ Marks**

$W_o = 2.225eV$

∴Work function of Potassium is 2.225eV **00½ Marks**

(c) (i) Although radioactive disintegration is random process yet it is possible to calculate reasonably accurately the number of atoms in a radioactive source of known activity and half-life because radioactivity is a process which has a mean life – time as one of its parameters. It progresses in such a way that each nucleus cooperate with the others so it decays at random, yet produces a particular life-time that depends on the nucleus and the process. **02 Marks**

(ii) Initial number of atoms $N_o = 10^{20}$ atoms.

Half-life $T_{1/2} = 12$hrs.

To find initial activity A_0 =?

Final number of atoms N =?

Time t = 1hr

Solution.

To find initial activity A_o

Recall, Activity of radioactive substance is directly proportional to the number of atoms of the radioactive substance present instantly at that time.

$$A \alpha N$$

$$A = kN$$

For initial activity, $A_o = k.N_o$ …………….(i) **00½ Marks**

Also from the rate decay lay,

The rate of disintegration is directly proportional to the number of atoms present.

Mathematically; $-\frac{dN}{dt} \propto N$ (-ve sign shows decrease of atoms due to decay).

$$-\frac{dN}{dt} = k.N$$ **00½ Marks**

Here k = decay constant.

$$\frac{dN}{N} =- k.dt$$

$$\int_{N_o}^{N} \left(\frac{dN}{N}\right) =- k.\int_{o}^{t} dt$$

$$ln(N)_{N_o}^{N} =- k.t$$

$$ln\left(\frac{N}{N_o}\right) =- kt \text{ ....(ii)}$$ **00½ Marks**

For initial amount to decay by ½ ; N = ½ N_o and $t = T_{1/2}$

$$ln\left(\frac{N_o/2}{N_o}\right) =- kT_{1/2}$$

$$ln\left(\frac{1}{2}\right) =- kT_{1/2}$$

Decay constant; $k = \frac{ln2}{T_{1/2}}$ **00½ Marks**

$$k = \frac{ln\,2}{12X60X60s}$$

$k = 1.6 \times 10^{-5}/s$ **00½ Marks**

Now from equation (i), we can find initial activity A_o

$$A_o = k.N_o$$

$A_o = 1.6x10^{-5}s^{-1} \times 10^{20}$ atoms.

$A_o = 1.6 \times 10^{15}$ atoms / s. **00½ Marks**

To find the final number of atoms N remaining after 1hr.

Recall from above $ln\left(\frac{N}{N_o}\right) =- kt$

$$log_e\left(\frac{N}{N_o}\right) =- kt$$

$$\frac{N}{N_o} = e^{-kt}$$ **00½ Marks**

$$N = N_o e^{-kt}$$

$$N = 10^{20} X e^{-(1.6X10^{-5}s^{-1}X1X60X60s)} atoms$$

$N = 9.44 \times 10^{19}$ atoms. **00½ Marks**

∴Initial activity and final atoms remaining after 1hr are $1.6x10^{15}/s$ and $9.44x10^{19}$atoms respectively. **01 Marks**