PHYSICS P510/1

MARKING GUIDE

1 (a)(i) - A body Continues in its State of rest or Uniform motion in a straight line Unless an external force acts on the body. ✓ (3)

- The rate of change of momentum of a body is directly proportional to the force applied on the body at it takes place in the direction of the force. ✓

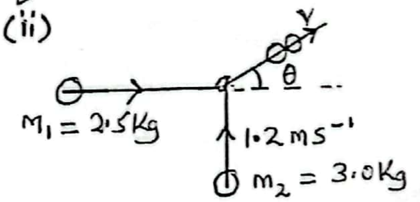
- To every action there is an equal and opposite reaction. ✓

(ii) From the 2nd Law we have; $F \propto \frac{m(V-u)}{t}$ ✓

But, $\frac{V-U}{t} = a$ ✓ $\therefore F = kma$ i.e for $k=1$, $F=ma$ ✓ (2)

(b)(i) It states;- If there is no external force acting on a System of colliding bodies the total momentum before collision equals to the total momentum after Collision. ✓ (1)

(ii)



Let their final Common Velocity be V making an angle θ with the Initial direction of m_1

$\therefore m_1u_1 = (m_1+m_2)V\cos\theta$ ✓

$\Rightarrow 2.5 \times 2 = (2.5+3.0)V\cos\theta$ $\therefore 5 = 5.5\cos\theta$ ✓ —(1)

And, $m_2u_2 = (m_1+m_2)V\sin\theta$ ✓ $\Rightarrow 3.0 \times 1.2 = (2.5+3.0)V\sin\theta$

$\therefore 3.6 = 5.5V\sin\theta$ ✓ —(2) $\Rightarrow (2) \div (1) = \tan\theta = 0.72$

$\therefore \theta = \tan^{-1}0.72 = \underline{35.75^\circ}$ ✓ (5)

& $V = 5/5.5\cos 35.75 = \underline{\underline{1.12ms^{-1}}}$ ✓

(c)(i) - Intensity of gravity is the force acting on 1Kg mass in the earth's field. ✓ (1)

- It is the work done to move 1Kg mass from Infinity to a given point in the gravitational field. ✓ (1)

(ii) Total gravitational force is the sum of the force of gravity (weight) and Centripetal force and it is Constant, ✓ Therefore at the equator where the Centripetal force is big ✓, then the force of gravity (weight) is low and therefore acceleration due to gravity, g is low. (3)

(iii) P.E at $r = \int_{\infty}^{r} F dr = \int_{\infty}^{r} \frac{G m_e M}{r^2} dr = \frac{G m_e M}{-1}\left[r^{-1}\right]_{\infty}^{r}$

$= \frac{G m_e M}{-r}$ (4)

And $K.E = \frac{1}{2}mv^2$, But $\frac{mv^2}{r} = \frac{G m_e M}{r^2} \Rightarrow K.E = \frac{G m_e M}{2r}$

$\therefore |P.E| = 2|K.E|$

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2 (a)(i) It is the frict… force acting between fluid layers per a unit area for a velocity gradient of $1\,s^{-1}$ (1)

(ii) Temperature increase leads to increase in the speed of molecules, where by molecules collide more frequently with their neighbouring molecules thus transfering momentum and therefore increasing viscosity. (3)

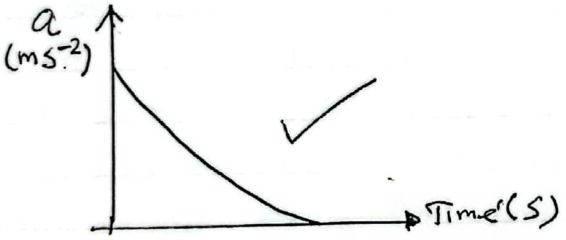
(b)(i)

$U + F = W$ $\therefore \frac{4}{3}\pi r^3\sigma g + 6\pi r\eta v = \frac{4}{3}\pi r^3\rho g$

$\therefore \frac{2}{3}r^2(\rho-\sigma) = 3\eta v$

$\Rightarrow v = \dfrac{2r^2(\rho-\sigma)g}{9\eta}$ (4)

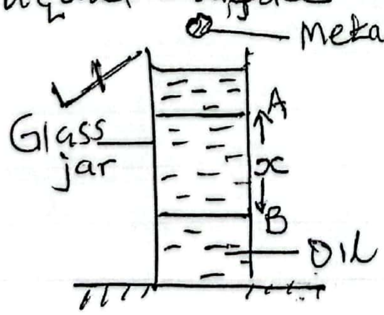
(ii)



(1)

(c)(i) It states:- The viscous force 'F' experienced by a spherical body falling (moving) in a fluid is directly proportional to the radius (size) of the body 'r', its velocity v and the coefficient of viscosity of the fluid η ($F = 6\pi\eta r v$). (1)

(ii) Oil of density σ is poured in a tall transparent jar. And two marks are made at two convinient levels A and B a distance x apart far below the liquid surface. (1)



(1)

A metallic steel ball of radius 'r' and density ρ is let to fall centrally through the oil and then time taken to fall through distance x is measured say 't'. The above procedure is repeated and the average value of t is determined. (4)

$$\therefore \eta = \frac{2r^2(\rho-\sigma)g}{9v}$$

(Coefficient of viscosity)

(d)(i) It states;- For a non-viscous, incompressible fluid under going steady flow, the sum of pressure, kinetic energy per a unit volume and potential energy per a unit volume is always constant at any point along a stream line. (1)

(ii) When the trailer is passing the air between the trailer and the person ~~is~~ made to move at a high speed thus reducing pressure. Then the air the other side moves at a low speed and therefore increasing pressure. The pressure difference drags the person towards the trailer. (3)

$\underline{\underline{20}}$

(3) (a) Elastic limit is the maximum point below which the load exerted on a stretched material is directly proportional to the extension produced. ($F \propto e$) (1)

Proportional limit is the maximum point below which the stress on a stretched material is directly proportional to the strain in the material. (Stress $\propto$ strain). (1)

(b)(i) $E = \frac{FL}{eA}$ $\Rightarrow \frac{F}{e} = \frac{E}{L}A$, Since E and L are fixed

$\therefore$ F/e (Slope) $\propto A$ $\Rightarrow$ Y has a smaller cross-sectional area. (2)

(ii) You determine the slope, $S = \Delta F/\Delta e$ of the graph. Measure the diameter d of the wire from which the area A is determined. The measure the length L.

$\therefore$ $\underset{\text{(Young's Modulus)}}{E} = \frac{L}{A}S.$ (4)

(c)(i) $E = \frac{FL}{Ae}$, But $D = \frac{M}{V}$ $\Rightarrow V = \frac{M}{D} = AL$

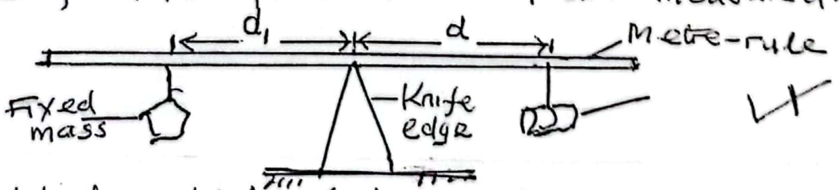
$\therefore$ $A = \frac{M}{DL}$ (3)

$E = \frac{80 \times DL^2}{Me} = \frac{80 \times 7800 \times (250 \times 10^{-2})^2}{16 \times 10^{-3} \times 1.2 \times 10^{-3}} = \underline{\underline{2.03 \times 10^{11}\,Nm^{-2}}}$

(ii) Energy $= \frac{1}{2}Fe = \frac{1}{2} \times 80 \times 1.2 \times 10^{-3} = \underline{\underline{0.048\,J}}$ (2)

(d)(i) It is the ratio of mass of a substance to mass of an equal volume of water. (1)

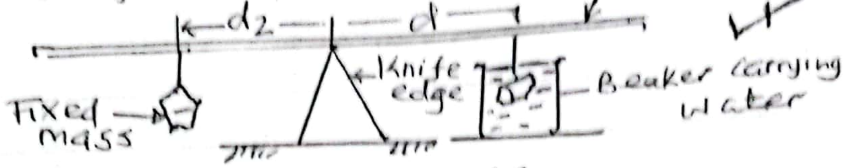
(ii) A sinker and a fixed mass are balanced onto a meter rule at its center of gravity and their distances from the pivot d and d_1 are measured.



(2)

$\Rightarrow W_1 d = W d_1$, where W_1 and W are the
i.e $W_1 = \frac{W d_1}{d}$

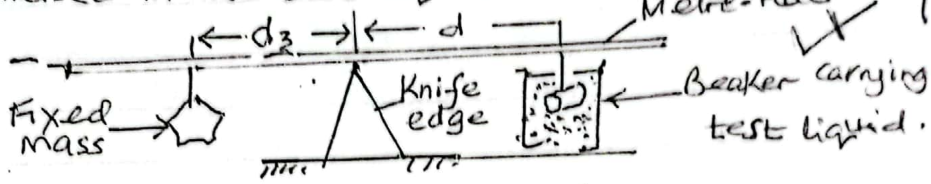
weight of the sinker and the fixed mass. Then keeping d fixed the sinker and the mass are now balanced when the sinker is fully immersed in water and the distance of the fixed mass from the pivot d_2 is measured.



$\Rightarrow W_2 d = W d_2$ i.e $W_2 = \frac{W d_2}{d}$, where W_2 is the weight of the sinker fully immersed in water.

The above procedure is repeated when the sinker is now fully immersed in the test liquid.

(4)



$\Rightarrow W_3 d = W d_3$ i.e $W_3 = \frac{W d_3}{d}$, where W_3 is the weight of the sinker fully immersed in the liquid.

$$\therefore R.D = \frac{W_1 - W_3}{W_1 - W_2} = \frac{\frac{W d_1}{d} - \frac{W d_3}{d}}{\frac{W d_1}{d} - \frac{W d_2}{d}} = \frac{d_1 - d_3}{d_1 - d_2}$$

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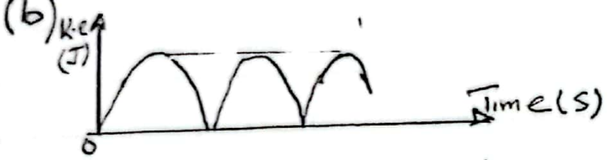
④ (a)(i) It is the periodic motion of a body whose acceleration is directly proportional to the displacement of the body from a fixed point and is directed toward the fixed point. (1)

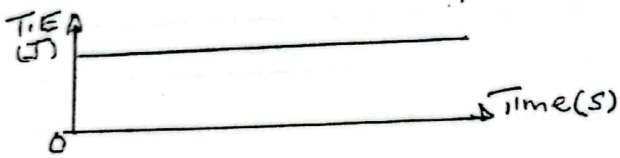
(ii) Amplitude is maximum displacement experienced by a body (particle) from the equilibrim position. (1)

Period is the time taken by the body to make one complete cycle. (1)

(b)

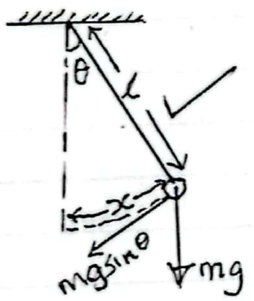


(1)



(1)

(c)(i) Consider the diagram below that shows a mass m being slightly displaced through a small angle 'θ'



$\therefore$ The restoring force, $F_R = -mg\sin\theta$

$\Rightarrow ma = -mg\sin\theta$

$\therefore a = -g\sin\theta$

But for small angle θ, $\sin\theta = x/l$

$\Rightarrow a = -\frac{g}{L}x$, Hence S.H.M is being executed. (6)

Now, from, $a = -\omega^2 x \Rightarrow \omega = \sqrt{\frac{g}{l}}$, But $T = \frac{2\pi}{\omega}$

$\therefore T = 2\pi\sqrt{\frac{L}{g}}$

(ii) By using a simple pendulum of a known length 'l' and allow it to oscillate. Find the time for twenty oscillations 't'. Then determine the period T.

$\therefore T^2 = 4\pi^2 \frac{L}{g} \Rightarrow g = \frac{4\pi^2 l}{T^2}$ (4)

(d)(i) Let the extension produced be x

$$\therefore (k_1 + k_2)x = mg \Rightarrow x = \frac{mg}{k_1 + k_2} = \frac{0.8 \times 9.81}{120 + 60} \quad (3)$$

$$= \underline{\underline{0.0436\ m}}$$

(ii) $T_1 = k_1 x = 120 \times 0.0436 = \underline{\underline{5.232}}\ N$ (2)

$T_2 = k_2 x = 60 \times 0.0436 = \underline{\underline{2.616}}\ N$

$\overline{\underline{20}}$

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$\overline{\underline{20}}$

5 (a) (i) - Molecules make perfectly elastic collisions.
- Intermolecular forces between the molecules are negligable.
- Duration during collision is negligable compared to the time between collisions.
- Volume of molecules is negligable compared to the volume of the container. (2)

(ii) - Intermolecular forces are negligable
- Volume of molecules is negligable compared to that of the container. (1)

(iii) Molecules that strike the wall of the vessel are retarded by the unbalanced force due to the molecules behind, so the observed pressure, P, is less than what it should have been without these forces. Hence $\frac{a}{V^2}$ accounts for the pressure defect. (3)

The volume of the molecules may not be negligable in relation to the volume of the container when they approach each other closely, thus in effect causes a reduction in the volume in which they can move freely i.e. free volume $=(V-b)$, where b is a factor called co-volume.

(b) $P_0 = \frac{1}{3}\rho \bar{c_0^2} \Rightarrow \sqrt{\bar{c_0^2}} = \sqrt{\frac{3P_0}{\rho}}$

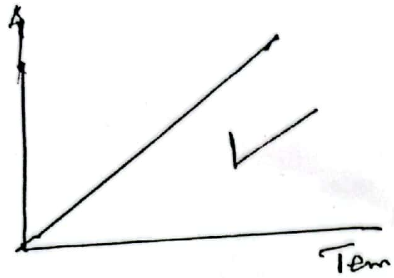
$\therefore \sqrt{\bar{c_0^2}} = \sqrt{\frac{3\times1.01\times10^5}{1.5}} = 4.494\times10^2 \text{ m s}^{-1}$

But $\sqrt{\bar{c^2}} \propto \sqrt{T}$ $\therefore \frac{\sqrt{\bar{c_1^2}}}{\sqrt{\bar{c_0^2}}} = \frac{\sqrt{T_1}}{\sqrt{T_0}}$ (5)

$\Rightarrow \sqrt{\bar{c_1^2}} = 4.494\times10^2\times\sqrt{\frac{420}{273}} = \underline{6.912\times10^2 \text{ ms}^{-1}}$

(c)(i) When the temperature is increased, the average velocity of the molecules increases and number of collisions made with walls of the container per second increase. Consequently the momentum change per second of the molecules increases as they strike the walls. This increases the force exerted on the walls and hence pressure of the gas increases. (2)

(ii)



(4

When a gas is cooled at constant pressure, its volum. reduces and become more and more dense. The kinetic energy of ~~its~~ molecules keeps on reducing untill it turns into a vapour.

(d) $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

$\therefore 144(400)^{1.40-1} = 137(V_2)^{1.40-1}$

$\Rightarrow V_2^{0.40} = \frac{144 \times 400^{0.40}}{137} = \underline{\underline{453.1}}$ cm³

(3

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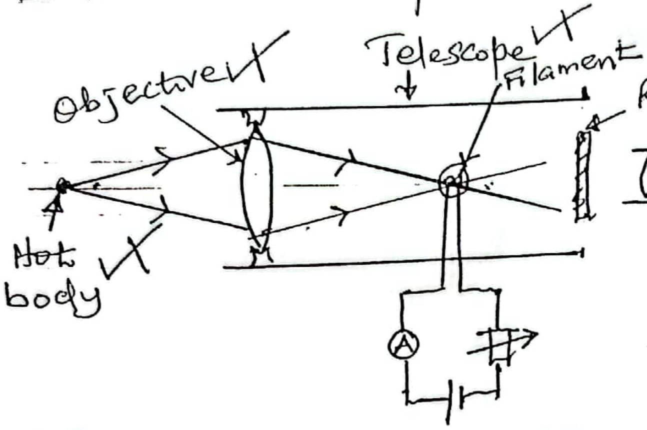
6 (a)(i) – Value of the property of the material should be measurable.
– Value of the property of the material should change appreciably for small temperature changes. Any Two (2)
– Value of the property of the material should change linearly with temperature change.
– Value of the property of the material should change continously with change in temperature.

(ii) – It is very accurate
– Measures temperature over a wide range (2)

(b)



Any Four (2)

The eyepiece is focused onto the filament. The hot body is focused by the objective such that the image lies in the same as the filament. Where by if the Image of the hot body is brighter than the filament as viewed through the eye-piece then the filament appears dark against a bright background And if the filament is brighter than the Image of the hot body then it appears bright against a dark background. The rheostat is adjusted until light from the hot body merges with that from the filament and at this moment the temperature of the hot body is read off the ammeter that is calibrated in degrees Celsium. (4)

(c)(i) It is the amount of heat that is required to change the state of a given mass of a solid into a liquid at constant temperature. (1)

(ii) During fusion, the heat is used to weaken the bond between molecules (atoms) of a solid and thus the regular structure of the solid is broken down. Then during vaporization the heat is used to break the bonds and do work against external pressure. Therefore specific latent heat of vaporization is higher that that of fusion. (3)

(d) Heat used to melt the ice + Heat used to raise the temperature of melted to 40°c = Heat given out by the water in the flask from 70°c to 40°c

$\therefore 0.05L + 0.05 \times 4200 \times 40 = 0.2 \times 4200 \times (70-40) + C(70-40)$

$\Rightarrow 0.05L + 8400 = 25200 + 30C$ or $0.05L - 30C = 16800$ (1)

New mass of water in the flask $= 0.2 + 0.05 = 0.25kg$

$\therefore 0.08L + 0.08 \times 4200 \times 10 = 0.25 \times 4200 \times 30 + C(40-10)$

$\Rightarrow 0.08L + 3360 = 31500 + 30C$

or $0.08L - 30C = 28140$ ——— (2) (6)

From (1) an (2), $L = \underline{\underline{3.78 \times 10^5 \, J\,Kg^{-1}}}$

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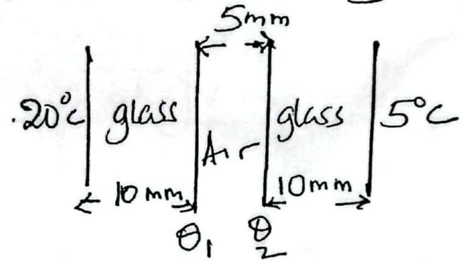
(7) (a) (i) It is the rate of heat flow through a conductor per a unit cross-sectional area for a temperature gradient $1\,Km^{-1}$ (1)

(ii) In metals there are free electrons that move randomly and collide with atoms giving up their energy. And atoms at the hot end gain energy and then vibrate at higher amplitudes thus colliding with neighbouring atoms that in turn are made to vibrate at higher amplitudes thus colliding with their neighbouring atoms and in process energy is transfered from the hot end to the relatively cool end. (3)

(b) (i)



$$\frac{dQ}{dt} = \frac{k_g A}{L_g}(20-\theta_1) = \frac{K_a A}{l_a}(\theta_1-\theta_2) = \frac{k_g A}{L_g}(\theta_2-5)$$

$$\Rightarrow \frac{0.6A}{0.01}(20-\theta_1) = \frac{0.02A}{0.005}(\theta_1-\theta_2)$$

$$\therefore 16\theta_1 - \theta_2 = 300 \quad \text{—(1)}$$

Also $$\frac{0.6A(20-\theta_1)}{0.01} = \frac{0.6A(\theta_2-5)}{0.01}$$ (6)

$$\therefore \theta_1 + \theta_2 = 25 \quad \text{—(2)}$$

$$\Rightarrow 15\theta_1 = 275 \quad \therefore \theta_1 = \underline{\underline{19.12°c}}$$

$$\theta_2 = \underline{\underline{5.88°c}}$$

(ii) $$\frac{dQ}{dt_g} = \frac{k_g A\cdot\Delta\theta}{l_g}, \quad \frac{dQ}{dt_a} = \frac{K_a\cdot A\cdot\Delta\theta}{L_a}$$

$$\frac{dQ}{dt_a} : \frac{dQ}{dt_g} = \frac{K_a}{L_a}A\cdot\Delta\theta : \frac{K_g}{L_g}A\cdot\Delta\theta$$ (3)

$$= \frac{K_a L_g}{K_g L_a} = \frac{0.02\times0.01}{0.6\times0.005} = \underline{\underline{0.0667}}$$

(7:100)

(c)(i) The power radiated by a black per a unit surface area is directly proportional to the forth power of its absolute temperature. (1)

(ii) Power received by planet $= \frac{\pi r_p^2}{4\pi R^2} \times 4\pi r_s^2 \sigma T_s^4$

$$= \frac{r_s^2 \sigma T_s^4 \times \pi r_p^2}{(40 R_e)^2}$$

At equilibrium power received = Power radiated

$$4\pi r_p^2 \sigma T_p^4 = \frac{r_s^2 \sigma T_s^4 \times \pi r_p^2}{(40 R_e)^2}$$ (6)

$$T_p^4 = \frac{r_s^2 \cdot T_s^4}{4 (40 R_e)^2}, \quad T_p = \left(\frac{(7 \times 10^8)^2 \times (6000)^4}{4 \times (40 \times 1.5 \times 10^{11})^2}\right)^{1/4}$$

$$\simeq \underline{\underline{45.83 \text{ K}}}$$

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(8) (a) Half life is the time taken for half the number of radioactive atoms to disintegrate. (1)

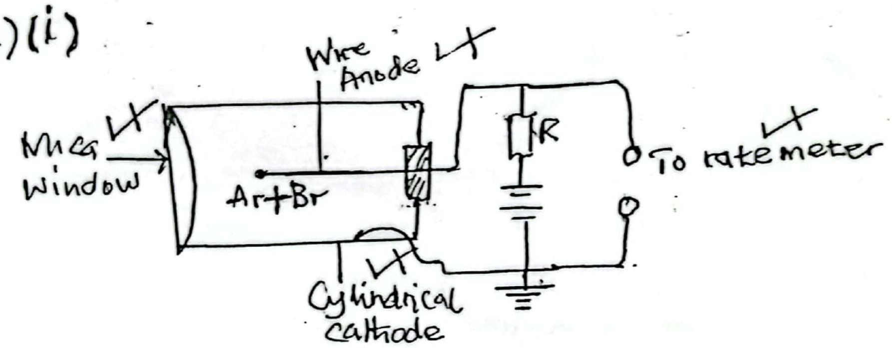
Decay Constant is the fractional rate of disintegration of radioactive atoms (nuclei) (1)

(b) From, $N = N_0 e^{-\lambda t}$ We have, $\frac{N}{N_0} \times 100 = 100 e^{-\lambda t}$

But $\lambda = \frac{0.693}{T_{1/2}} = \frac{0.693}{4.5 \times 10^9} = 1.54 \times 10^{-10}\ yr^{-1}$ (4)

$\Rightarrow \frac{N}{N_0} \times 100 = \frac{100}{e^{1.54 \times 10^{-10} \times 4.0 \times 10^9}} = \frac{100}{e^{0.616}} = 54.0\%$

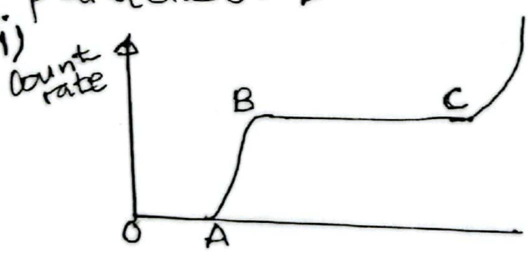
(c)(i)



Any four (2)

Ionising plate are let to enter the tube through the mica window and then Ionize the air inside the tube. Positive Ions move toward the cathode as electrons are accelerated towards the wire anode. On reaching the anode a discharge occurs and a current is made to pass through the external circuit via resistor 'R'. A pulse is registered by the rate-meter that is use to show the presence of particles. (4)

(ii)



(1)

Before point A being refered to as the threshold voltage the p.d is not enough to cause a discharge. The from A toward B number of ion-pairs that can cause discharge increases as the p.d increases. Between B and C all the ion-pair produced can cause discharge irrespective of the intensity of the particles that are introduced in the tube. And beyond C there is continuous discharge taking place. (2

(iii) The suitable range is B to C, because all particles irrespective of their intensity can be detected. (2)

(d) The activity of a dead sample A is determined. Then the activity of a fresh sample of the same mass, A_0 is also determined. Using the expression $A = A_0 e^{-\lambda t}$, the age of the material (sample) is got from a known half-life of carbon. (3)

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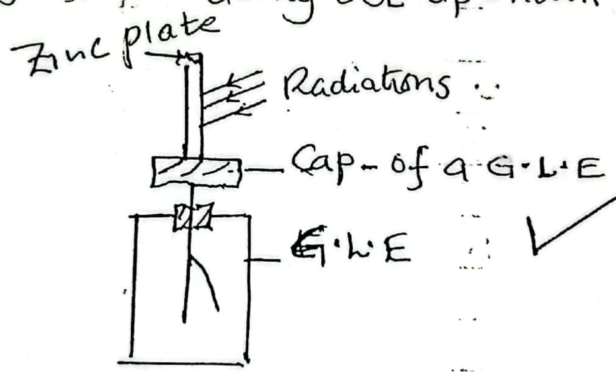
9 (a) - For a given metal surface there is a minimum frequency called threshold frequency of the incident radiation below which there is no emission of electrons from the metal surface. (4)

- The number of photo-electrons emitted from a metal surface per second is directly proportional to the intensity of the incident radiations.
- Photo-electrons are emitted carrying kinetic energy ranging from zero to a certain maximum that is directly proportional to the frequency of the incident radiations and independent of their intensity.
- There is no time lag between irradiation of a metal surface and emission of electrons from the metal surface.

(b) This is done using set-up shown below.

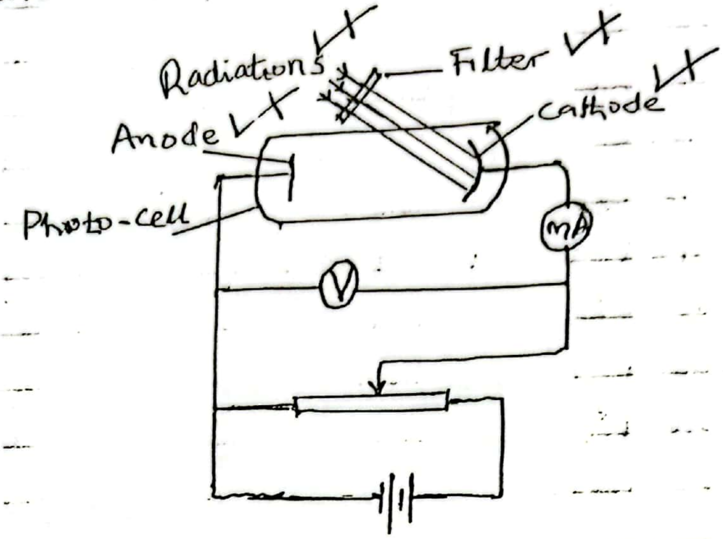


(1)

Radiations are incident onto the zinc plate placed onto the cap of a positively charged gold leaf electroscope (G.L.E) and in turn to the zinc plate placed to the cap of a negatively charged G.L.E. Whereby when the plate is on the cap of a positively charged G.L.E, the leaf does not change and for the negatively charged G.L.E, the leaf instead falls. This implies that the p'cles emitted are negatively charged which are electrons. (4)

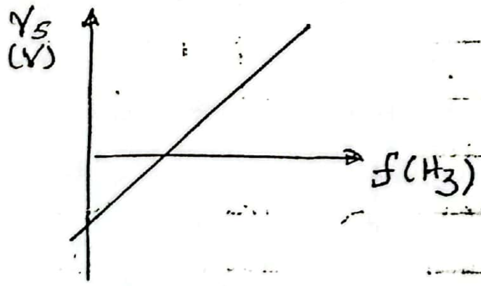
(c)(i) Work function is the minimum energy required to eject an electron from a metal surface and (1) threshold frequency is the minimum frequency of the incident radiations below which no electron that are emitted. (1

(ii)



(2

Radiations of a known frequency 'f' are incident onto the cathode and electrons are emitted that leads to a current flowing through the external circuit. The p.d across the tube is varied until when the milli-ammeter registers zero current and the p.d registered by the voltmeter 'V_s' is noted. The above procedure is repeated for different values of f. Then from a suitable table of result a graph of V_s against f is plotted that takes on a shape like the one below.



(4

Such a linear graph verifies Einstein's equation.

(d) $\frac{hc}{\lambda_0} = W_0$

$$\Rightarrow \lambda_0 = \frac{hc}{W_0} = \frac{6.6\times10^{-34}\times3\times10^{8}}{4.0\times1.6\times10^{-19}}$$

(Longest wavelength)

$$= \underline{\underline{3.094\times10^{-7}\,m}}$$

(3

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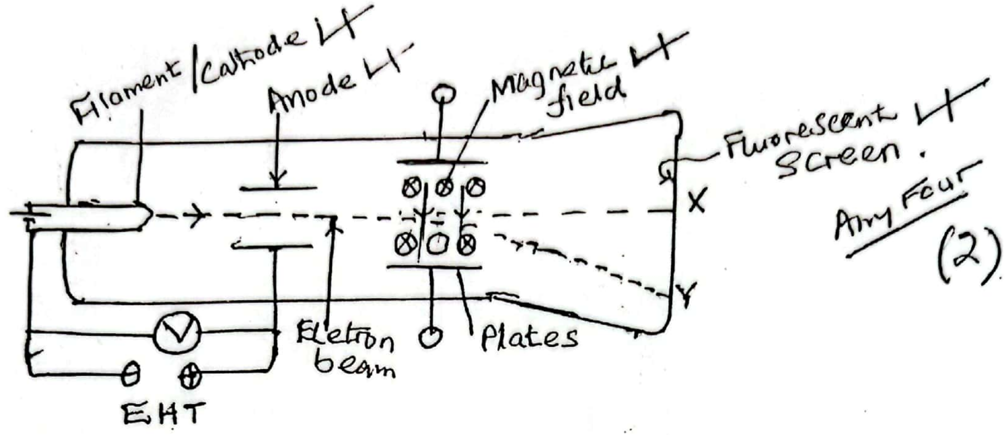
10 (a) It is the charge per a unit mass of an electron and its SI unit is $C\,Kg^{-1}$ (2)

(b)



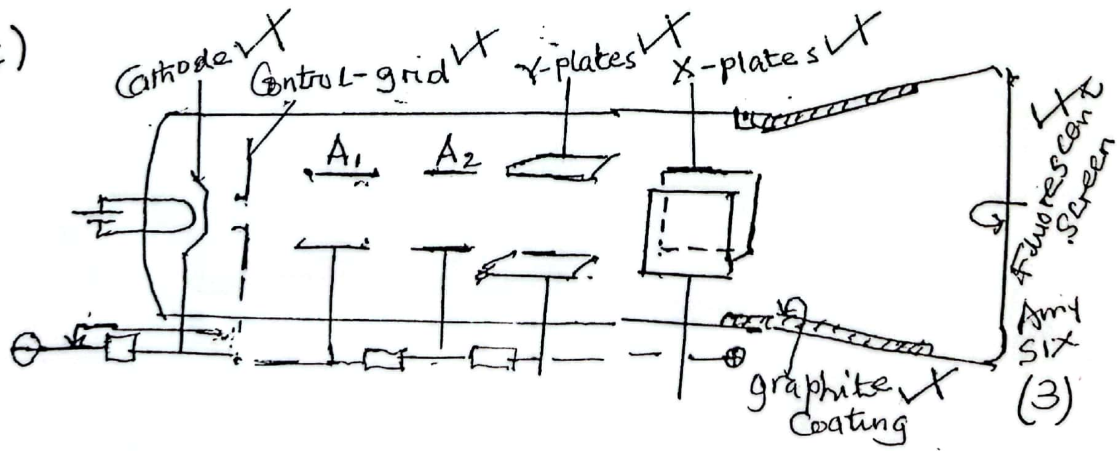
(2)

Electrons are emitted thermionically from the filament (cathode) and then are accelerated by the high V_a through the tube. Where by in the absence of the electric field E and magnetic field density B between the plates the beam is able to strike the screen centrally at X. A magnetic field of density B is applied such that the beam now strikes the screen at Y. An electric field of intensity E is now applied such that the beam is brought back at X.

i.e $\frac{1}{2}mV^2 = eV_a \Rightarrow \frac{e}{m} = \frac{V^2}{2V_a}$ and $V = \frac{E}{B}$ (4)

$$\therefore \underset{(\text{Sp. charge})}{e/m} = \frac{E^2}{2V_a B^2}$$

(c)



(3)

The filament heats the cathode that emits electrons. Then the Control grid regulate the number of electrons that is transmitted through the tube per a second, hence brightness forming at the Screen. The two anodes A_1 and A_2 decelerates and focuses the beam. Then the Y and X plates deflect the beam vertical and horizontally respectively. Then the graphite coating shields the beam from external fields and it acts as a return path for electrons. And it is at the fluorescent Screen where the flash of light is formed. (4

(d)(i) – Used to measure both A.c and d.c Voltage.

– Used to determine phase difference between Signals.

– Used to measure small time interval between Signals

Any Two (2

(ii) $V_{r.m.s} = \frac{V_0}{\sqrt{2}}$, $V_0 = \frac{10}{2} \times 0.5$

$= \underline{2.5\,V}$

$\therefore V_{r.m.s} = \frac{2.5}{\sqrt{2}} = \underline{\underline{1.77}}\,V$ (3

20.