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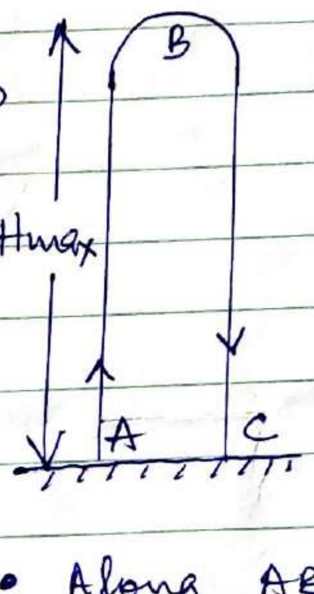
1 (a) (i) Range is the distance between the point of projection and apoint on the plane through the point of projection where the projectile lands. 01

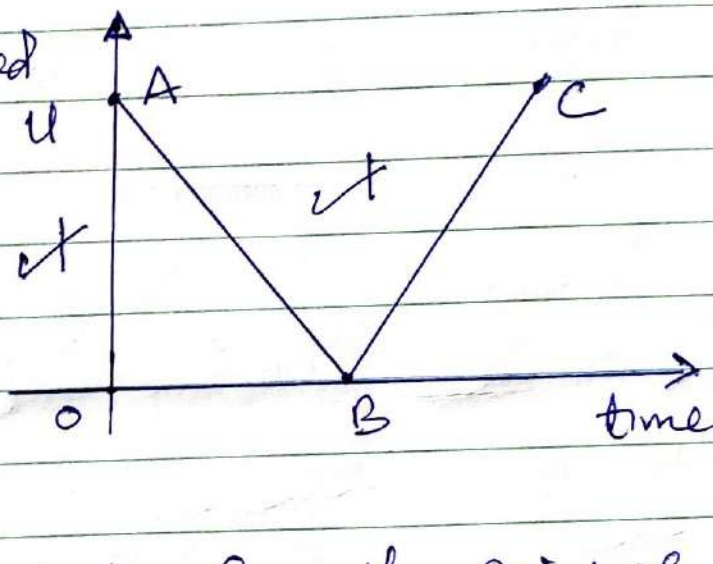
(ii) Time of flight is the time taken by the projectile to describe the trajectory.

OR

It is the time taken by the projectile to move from the point of projection to apoint on the plane through the point of projection where the projectile lands. 01

(b) (i)





01

(ii)
- Along AB the ball rises from the point of projection vertically upwards, the speed decreases from its initial value to zero at B, the Ball is momentarily at rest when at maximum height.
- Along BC the ball falls back to the point of projection. the speed increases from zero to maximum as the ball strikes the ground. 02

c (i) Acceleration due to gravity is the constant rate of change of velocity with time for a body falling freely in the earth's gravitational field.
OR It is the force that acts on one Kg mass falling freely in the earth's gravitation force. units ms^{-2} or NKg^{-1} 01

(ii) • The equatorial radius of the earth is greater than the Polar radius. A body at the equator is slightly further away from the centre of the earth and experiences a smaller gravitational attraction.
• The effect of rotation of the earth about the polar axis, the observed weight of a body at the equator is less than that at the poles since part of it provides the centripetal force towards the centre of the centre. 02

d)(i) Work – Energy theorem states that the work done on a body by a constant force is equal to the change in Kinetic energy of the body. [Work done] = [change in K.E] 01

(ii) Newton's laws of motion:
• Every body continues in its state of rest or uniform motion in a straight line unless acted on by some external force.

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- The rate of change of momentum of a body is directly proportional to the external force acting on the body and takes place in the direction of the force. ✓
- If a body A exerts a force on body B, then B exerts an equal and opposite force on A. ✓

03

(e) (i) Given distance $S = 12.5m$ $F = ?$

$m = 2000Kg$

$u = 10ms^{-1}$

$V = 0$

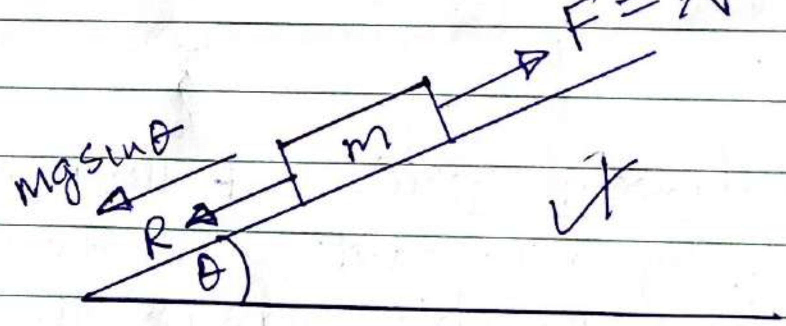
using $F.S = \frac{1}{2}mV^2 - \frac{1}{2}mu^2$ ✓

$(F)(12.5) = (\frac{1}{2})(2000)[0^2 - 10^2]$ ✓

$\therefore \underline{F = -8000N}$ ✓

04

(ii) Given $\theta = \sin^{-1}(\frac{1}{10})$.



Given $\theta = \sin^{-1}(\frac{1}{10})$. $m = 2000Kg$

$R = 200N$ $V = 10ms^{-1}$ ✓

let P = power developed by the engine.

at constant speed, $a = 0$ ✓

$R + mg\sin\theta = P/V$ ✓

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$$\Rightarrow P = V[R + mg\sin\theta]$$

$$10\left[200 + 2000 \times 9.81 \times \frac{1}{10}\right]$$

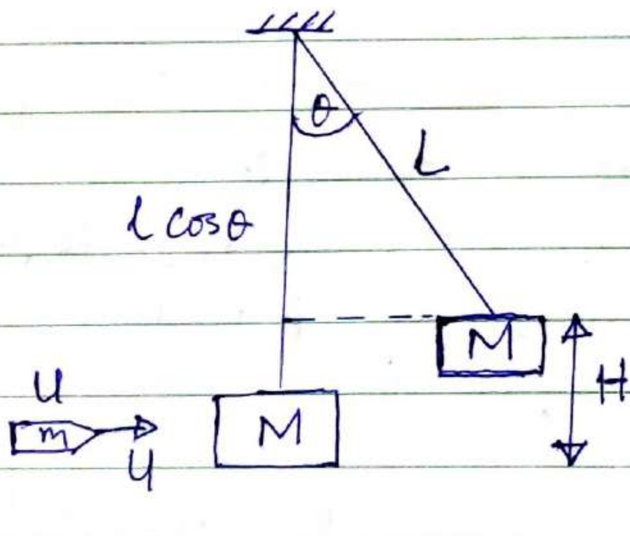
$$\therefore \underline{P = 2.16\,KW}$$ 04

2(a) (i) The total linear momentum of a system of interacting bodies on which no external force are acting, remains constant. 01

(ii) • In a perfectly inelastic collision, the colliding bodies stick together and move with a common velocity and some kinetic energy is lost.

• In a perfectly elastic collision, the colliding bodies seperate and move independently, kinetic energy is conserved.

02



mass of bullet $m = 0.02\,Kg$

mass of block $M = 0.5\,Kg$

speed of bullet $u = 200\,ms^{-1}$

let V = common velocity.

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(i) $H = l - l\cos\theta \Rightarrow \cos\theta = \left(1 - \frac{H}{L}\right)$

But $H = \frac{V^2}{2g}$ $\therefore \cos\theta = \left[1 - \frac{V^2}{2gL}\right]$.

∴ the angle of swing depends on common velocity V, length of string L and acceleration due to gravity g. ✓ 01

(ii) Common velocity $V = \frac{mu}{m+M}$ ✓

$= \frac{(0.02)(200)}{(0.02+0.5)}$ ✓

$\therefore V = 7.69\,ms^{-1}$ ✓ 03

(c)(i) Friction is the force that opposes the relative sliding motion between two surfaces in contact. ✓ 01

(ii) • When two surfaces are in contact, their irregularities / projections interlock at contact points. the actual area of contact is very small which creates very high pressure at the contact points ✓

• The molecules are pushed so close that the attraction between them welds the surfaces at contact points. ✓

• Any attempt to slide one surface relative to the other is resisted due to the

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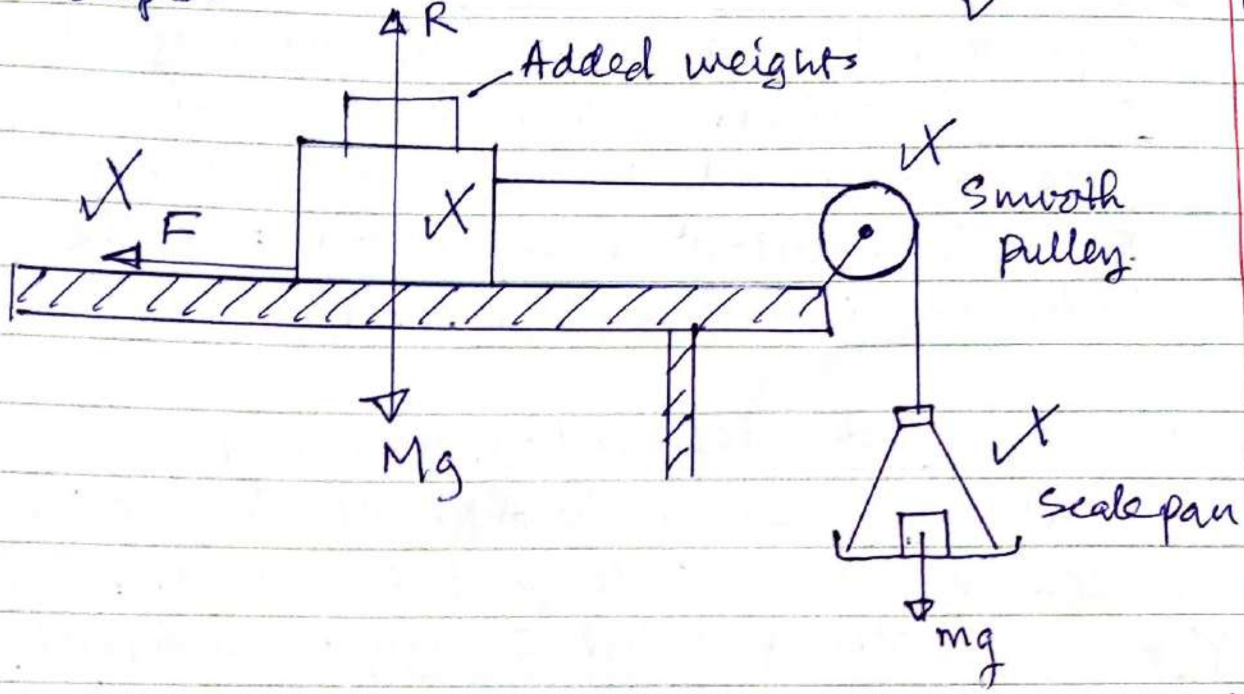
interlockings hence an opposing frictional force develops.

03

(iii)



- A wooden block of known mass M is placed on a table and connected to the scale pan by a string passing over a smooth pulley as shown in the figure above.
- Small masses m are added to the scale pan at a time and the block given a slight push until it moves with a constant speed.
- the normal reaction R is varied by adding some small masses/weights on top of the block and the corresponding values of m on the scale pan noted.
- the experiment is repeated for different values of m and M and the results tabulated.
- A graph of m against M is plotted whose slope S = the coefficient of kinetic friction.

04

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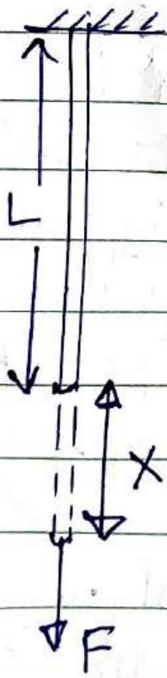
2(d) (i) • During elastic deformation, molecular seperation increases, elastic potential energy is gained. when the deforming force is removed, the molecules fall back to their equilibrium seperation and the body regains shape/size.

• During plastic deformation, molecular seperation increases so much that the molecular planes slide past each other. Some elastic Potential energy is dissipated as heat hence the body never regains its shape/size.

02

(d)(ii) consider a wire of length l, cross section A stretched by an extension x when a force F is applied.



$$\text{stress} = \frac{F}{A} \quad Nm^{-2}$$

$$\text{strain} = \frac{x}{L}$$

$$\text{Youngs modulus } E = \frac{FL}{Ax}$$

$$E.P.E \text{ stored} = \frac{1}{2}Fx$$

$$= \frac{1}{2}\left(\frac{EAx}{L}\right)\cdot x$$

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$$= \frac{EAx^2}{2L} \text{ Joules.}$$

E.P.E stored per unit volume $= \frac{EAx^2}{2L} \div AL$

$W = \frac{1}{2}Fx$

$\frac{W}{V} = \frac{1}{2}\frac{Fx}{AL}$ $\quad = \frac{EAx^2}{2L} \times \frac{1}{AL} = \frac{1}{2}\frac{Ex^2}{2L^2}$

$= \frac{1}{2}\left(\frac{F}{A}\cdot\frac{x}{L}\right)$

$= \frac{1}{2}$ stress x Strain $\quad = \frac{1}{2}(\text{stress}) \times (\text{Strain})$ 03

3(a) Keplers' laws

- The orbit of each planet is an ellipse which has the sun at one of its foci.
- Each planet moves in such away that the Imaginary line Joining it to the sun sweeps out equal areas in equal times.
- The Squares of the periods of revolution of the planet about the sun are proportional to the cubes of their mean distances from it. $(T^2 \propto r^3)$. 03

(b)(i) Given a satellite of mass m, in a circular orbit of radius, R round a planet of mass M;

By Newton's law of gravitation:

$$F = \frac{GmM}{R^2} \text{ ------ } (1)$$

The force of attraction provides centripetal force

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$$F = \frac{mV^2}{R} \quad \text{.....(ii)}$$

$$\Rightarrow \frac{GmM}{R^2} = \frac{mV^2}{R} \iff \frac{GM}{R} = V^2.$$

But $V = \frac{2\pi R}{T}$ where V = linear speed
T = period

$$\Rightarrow \frac{GM}{R} = \frac{4\pi^2 R^2}{T^2}$$

$$\therefore R^3 = \frac{T^2 GM}{4\pi^2}.$$

04

b(ii) • considering a satellite of mass M_s at a distance r from the centre of the earth of mass M_e

$$G.P.E = -\frac{GM_sM_e}{r} \quad \text{.....(i)}$$

$$K.E = \frac{1}{2}M_sV^2 = \frac{GM_sM_e}{2r} \quad \text{...(ii)}$$

Total mechanical Energy $= (G.P.E + K.E)$

$$= -\frac{GM_sM_e}{2r} \quad \text{..(iii)}$$

- If a satellite encounters air resistance in the earth's atmosphere, it works against friction and its total mechanical energy decreases ie r decreases in equation (iii)
- A decrease in r leads to an increase in K.E in equation (ii) hence an increase in the satellite's speed.

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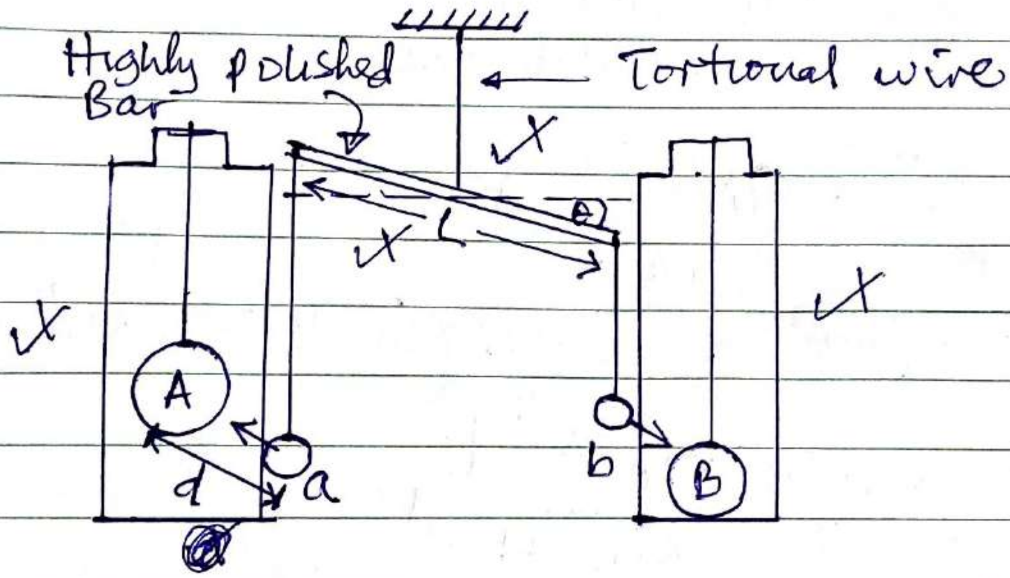
C(i) Measurement of universal gravitational constant, G.



- Two Identical small gold spheres a and b each of known mass m are suspended at the ends of a highly polished bar of known length l. ✓
- Two Identical large lead spheres A and B of known mass M each are then respectively brought near a and b. ✓
- A couple is setup in the polished bar which then deflects through a small angle θ measured by lamp and scale method. ✓
- the distance d between the large and small spheres is measured and the value of G calculated from $G = \frac{C\theta d^2}{MmL}$ Nm^2Kg^{-2} ✓

where C = tortional constant of the Suspension wire.

06

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3 c(ii) $T_s = 8.65 \times 10^4 s$

$M_e = 5.97 \times 10^{24} Kg$

$G = 6.67 \times 10^{-11} Nm^2 Kg^{-2}$

$R = ?$ orbital radius.

using

$$R^3 = \frac{G M_e T^2}{4\pi^2}$$

$$\Rightarrow R^3 = \frac{(6.67 \times 10^{-11})(5.97 \times 10^{24})(8.65 \times 10^4)^2}{4\pi^2}$$

$$R^3 = 7.56 \times 10^{22}$$

$$R = 4.23 \times 10^7 m$$

let H = height of satellite above earth

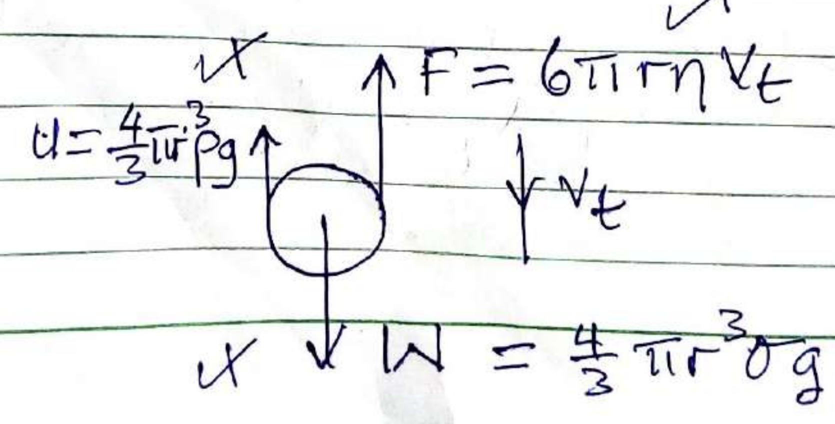
$$\Rightarrow H = (4.23 \times 10^7 - 6.4 \times 10^6)$$

$$\therefore H = 3.59 \times 10^7 m$$ 04

4(a) (i) Terminal velocity is defined as the maximum constant velocity attained by an object falling through a viscous fluid. units ms^{-1}. 01

(ii) Coefficient of viscosity is defined as the frictional force per $1 m^2$ of fluid in a region of unit velocity gradient units Nsm^{-2}. 01

b(i)



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when falling with terminal velocity, $a = 0$,

$\Rightarrow W = U + F$

$$\frac{4}{3}\pi r^3 \sigma g = \frac{4}{3}\pi r^3 \rho g + 6\pi r \eta V_t$$

$$\frac{4}{3}\pi r^2 g [\sigma - \rho] = 6\pi \eta V_t$$

$$\therefore V_t = \frac{2[\sigma - \rho] r^2 g}{9\eta} \ ms^{-1}$$

03

b(ii) • Viscosity in liquids is due to intermolecular forces of attraction which relax with increasing temperature hence liquid viscosity decreases with increase in temperature

• viscosity in gases is due to transference momenta/collisions which depend on molecular speed. from the Kinetic theory, increase in temperature increases the mean Kinetic energy of the molecules hence gaseous viscosity increase with temperature.

04

4(c) (i) Archimedes principle states that when abody is wholly or partially immersed in a fluid, it experiences an upthrust equal to the weight of fluid displaced.

01

(ii) Determination of liquid density using archimedes principle;

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- A suitable object is first weighed in air to find its weight W_a.
- It is then immersed in the liquid to determine its weight in the liquid W_L.
- It is then immersed in water to find the weight W_w in water.
- upthrust in liquid $= (W_a - W_L)$ and upthrust in water $= (W_a - W_w)$.
- Density of the liquid is then calculated from

$$\frac{\text{Density of liquid}}{\text{Density of water}} = \frac{(W_a - W_L)}{(W_a - W_w)}.$$

05

4(a) $W_a = (0.12 \times 9.81) = 1.18N$

$W_w = 0.63N$

$W_L = 0.75N$

(i) upthrust in water $= W_a - W_w$

$= (1.18 - 0.63) = 0.55N$

But upthrust = weight of water displaced

$\Rightarrow 0.55 = V\rho_w g$ where V = Volume of water displaced = Volume of Block

$$\Leftrightarrow V = \frac{0.55}{(1000)(9.81)} = 5.61 \times 10^{-5} m^3$$

$$\text{Density of Block} = \frac{\text{mass of block}}{\text{Volume of Block}}$$

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$$= \frac{0.12}{5.61\times10^{-5}} = 2139\,Kgm^{-3}.$$ 03

4(a)(ii) let ρ_o = density of oil

$$\Rightarrow \frac{\rho_o}{1000} = \frac{(1.18-0.75)}{(1.18-0.63)}$$

$\therefore$ Density of oil, $\rho_o = 782\,Kgm^{-3}$. 02

5(a)(i) Specific latent heat of vaporization is defined as the amount of heat required to cause 1 Kg mass of a substance to change from liquid to vapour without change in temperature. units JKg^{-1} 01

(ii) Determination of specific latent heat of vaporization of water Electrical Method.

- water is heated in a vacuum jacketed vessel U by the heating coil R. Its vapour then passes down through tube T and is condensed by cold water flowing through K.
- when the apparatus has reached its steady state, the liquid is at its boiling point and the heat supplied by the coil is used evaporating the liquid.
- the liquid emerging from the condensor is collected for a measured time and weighed.
- If I and V are the current through the heater coil and the P.d across it, M

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is the mass of condensed water collected in time t seconds, h is the rate of heat loss to surroundings, then

$IVt = ml_v + h \cdot t$ ...... (i)

- If I' and V' are the new ratings and m' is the mass of water that evaporates in the same time t,

$I'V't = m'l_v + h \cdot t$ ..... (ii)

- Specific latent heat of vaporization of water is then calculated from

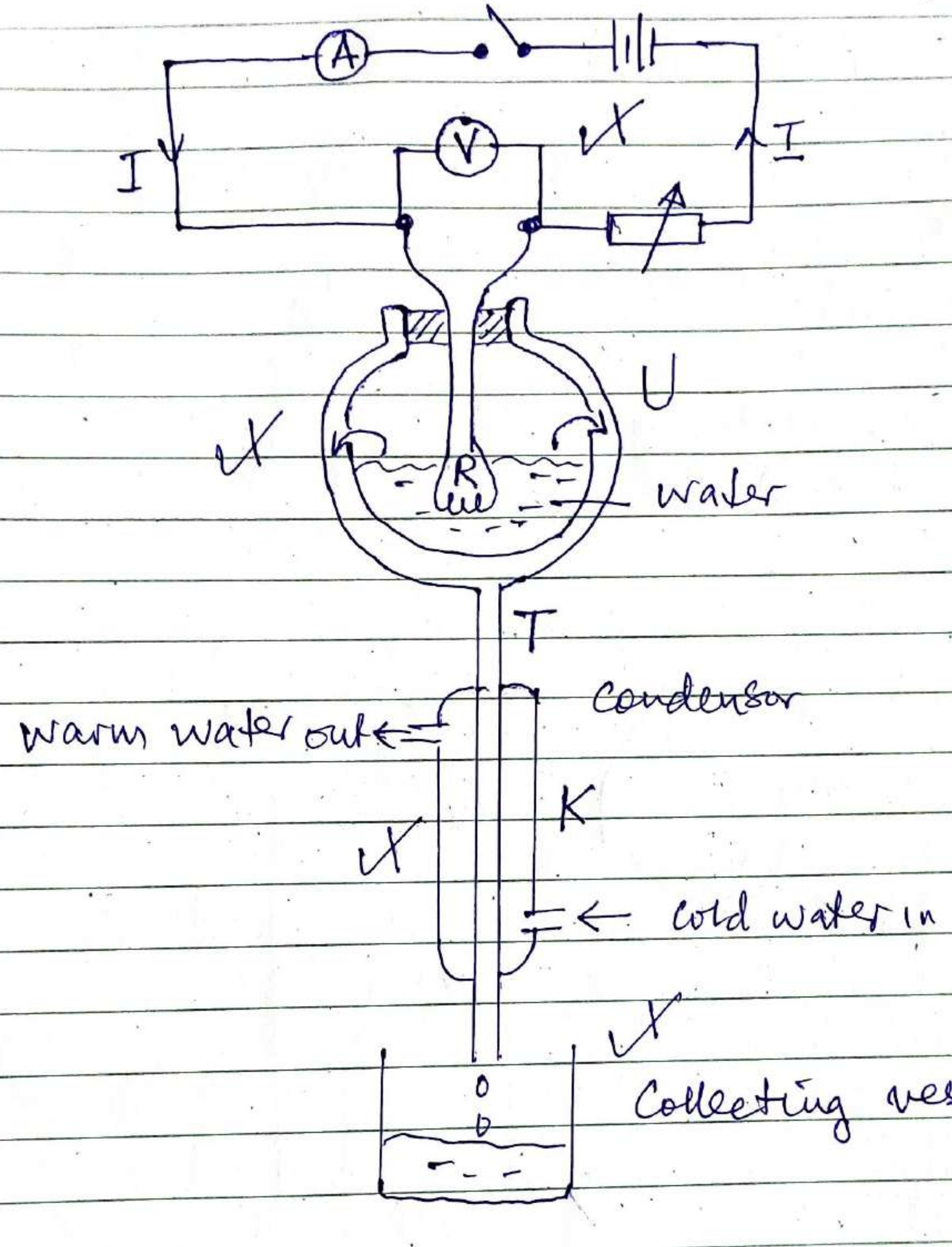
$$l_v = \frac{(IV - I'V')t}{(m - m')} \text{ JKg}^{-1}.$$

(iii) Advantages of the method;

- Heat capacity of the apparatus is not required since the apparatus absorbs no more heat at steady state.
- Heat losses to the surroundings can be eliminated by repeating the experiment using different power ratings.

02

(ii)



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5(b) Latent heat of fusion
During change of state from solid to liquid, the latent heat supplied at constant temp increases the amplitude of vibration of the molecules, weakens the intermolecular forces of attraction and molecular spacing increases as well. the molecules then move freely in the liquid state.

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Latent heat of vaporization

During change of state from liquid to vapour, the latent heat supplied at B.pt weakens the intermolecular forces, increase molecular spacing indefinately, the molecules gain freedom to move about independently.

the vapour expands and does work against the atmosphere.

Hence specific latent heat of vaporization is greater than the specific latent heat of fusion.

04

5(c) for water; $\Delta\theta = (20.0°c - 16.0°c)$ $C_W = 4200\, JKg^{-1}K^{-1}$

$M_W = 0.10 Kg$

$V_1 = 20.0V$

$I_1 = 1.50A$

$t_1 = 60$ seconds

$\Rightarrow I_1V_1 = \frac{M_W}{t} C_W \Delta\theta + h$ ---- (i)

$\Rightarrow (20)(1.50) = \left(\frac{0.10}{60}\right)(4200)(4) + h$ -- (i)

For the liquid

$\Delta\theta = 4°c$

$M_L = 0.12 Kg$

$V_2 = 13.0V$

$I_2 = 1.20A$

$t_2 = 60\, s$

$C_L = ?$

$\Rightarrow I_2V_2 = \frac{M_L}{t} C_L \Delta\theta + h$ ---- (ii)

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$\Rightarrow (13.0)(1.20) = \left(\frac{0.12}{60}\right)(C_L)(4) + h$ --- (ii)

from (i) rate of heat loss, $h = 2.0W$

Substituting for h in (ii) gives specific heat heat capacity of liquid; $C_L = 1700\,Jkg^{-1}K^{-1}$.

5(d) using $P = \frac{1}{3}\rho\bar{c}^2$ But $\rho = \left(\frac{Nm}{V}\right)$ 05

$\Rightarrow PV = \frac{1}{3}(Nm)\bar{c}^2$

$\frac{PV}{N} = \frac{2}{3}\left(\frac{1}{2}m\bar{c}^2\right)$

where m = mass of one molecule
N = No of molecules.

But $PV = nRT$ for an Ideal gas

$\Rightarrow \frac{3PV}{2N} = \frac{1}{2}m\bar{c}^2$

$\Rightarrow \frac{3nRT}{2N} = \frac{1}{2}m\bar{c}^2$ for one mole of an Ideal gas $n = 1, N = N_A$

$\Rightarrow \frac{3RT}{2N_A} = \frac{1}{2}m\bar{c}^2$

But $\frac{R}{N_A} = K_A$

maxwell Boltzmann's constant

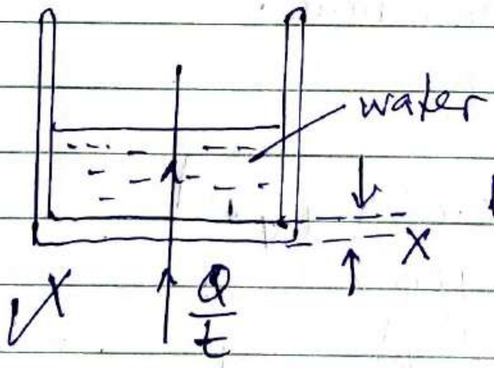
$\therefore \frac{1}{2}m\bar{c}^2 = \frac{3}{2}K_BT$ 03

6(a)(i) Thermal conductivity of amaterial is defined as the rate of flow of heat at right angles to $1m^2$ cross section of amaterial in a aregion of $1Km^{-1}$ temperature gradient. 01

(ii) In metals, heat transfer is by two processes;

- Atomic Vibrations – when atoms absorb heat energy, they vibrate with increasing amplitude and pass on the vibrational kinetic energy to the neighbours hence transfering heat energy.
- free electrons – when free electrons absorb heat energy, their translational kinetic energy increase. The electrons then move faster and transfer thermal energy quickly by collisions with atoms and other electrons. 03

6(b)(i)



let $\Delta\theta$ = the temperature difference between inner and outside.

$X = 2.0mm\ (2.0 \times 10^{-3} m)$
$A = 3.0 \times 10^{-2} m^2$
$m = 1.00kg$
$\frac{d\theta}{dt} = 0.25Ks^{-1}$.

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Rate of heat flow $\frac{Q}{t} = KA\frac{\Delta\theta}{X} = mC_w\frac{d\theta}{dt}$

thermal conductivity of copper $= 385\,Wm^{-1}K^{-1}$

$\Rightarrow \frac{(385)(3.0\times10^{-2})(\Delta\theta)}{(2.0\times10^{-3})} = (1.00)(4200)(0.25)$

$\therefore \Delta\theta = 0.18K$ — 03

(ii) Let l_v = specific latent heat of vaporization of water.

mass of water that boils per second
$= \frac{(1.00 - 0.94)\,Kg}{120\,s} = \left(\frac{0.06}{120}\right) Kgs^{-1}$

$\frac{Q}{t} = \frac{ml_v}{t}$ assuming the rate of heat flow remain constant.

$\Rightarrow mC_w\frac{d\theta}{dt} = \frac{ml_v}{t}$

$\Rightarrow (1.00)(4200)(0.25) = \left(\frac{0.06}{120}\right) l_v$

$\therefore l_v = 2.10\times10^{6}\,JKg^{-1}$ — 03

½ ma for u

6c(i) Determination of thermal conductivity of a piece of rubber.

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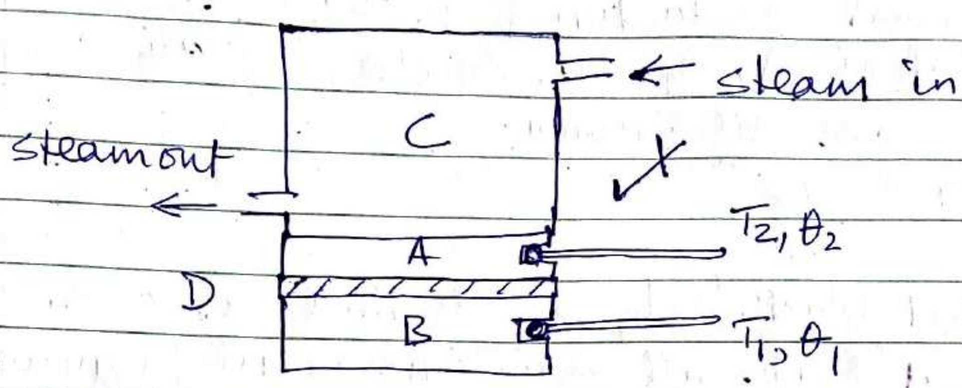

- The specimen D made inform of athin disc of large surface area is placed on athick brass slab B containing athermometer T_1 and heated from asteam chest C whose thick base also contains athermometer T_2.
- Steam is passed until the temperature
- readings θ_1 and θ_2 are steady. the rate of heat flow from C to B is equal to the rate of heat loss by B to the surroundings.

$$\frac{Q}{t} = KA\frac{(\theta_2-\theta_1)}{X} \quad \text{------ (i)}$$

- D is then removed and B heated to a temperature slightly above θ_1, allowed to cool and atemperature time graph plotted.
- the rate of cooling of B at atemperature $\theta=\theta_1$ is determined $\left(\frac{d\theta}{dt}\right)_{\theta=\theta_1}$
- Rate of heat loss $\frac{Q}{t} = M_B C_B \left(\frac{d\theta}{dt}\right)_{\theta=\theta_1}$ ---- (ii)

from (i) and (ii)

$$KA\frac{(\theta_2-\theta_1)}{X} = M_B C_B\left(\frac{d\theta}{dt}\right)_{\theta=\theta_1}$$

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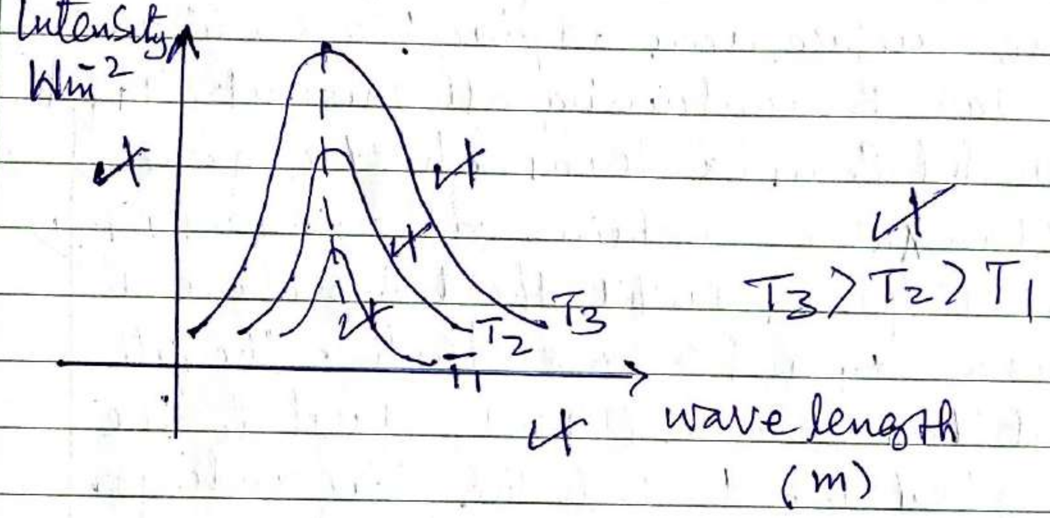
- The thermal conductivity K can be calculated if $A, \theta_1, \theta_2, X, M_B, C_B$ and $\left(\frac{d\theta}{dt}\right)_{\theta=\theta_1}$ are all known. 06

6c(ii) Aperfect black body is defined as one which absorbs all radiations of all frequencies incident on it. 01

6(d)



03

7(a) • Asaturated vapour is one which is in dynamic equilibrium with its own liquid whereas an unsaturated vapour is one which is not in dynamic equilibrium with its own liquid.

- An unsaturated vapour obeys pressure law at high temperatures whereas the saturated vapour does not. 02

b(i) Determination of S.V.P of a liquid at a particular temperature.

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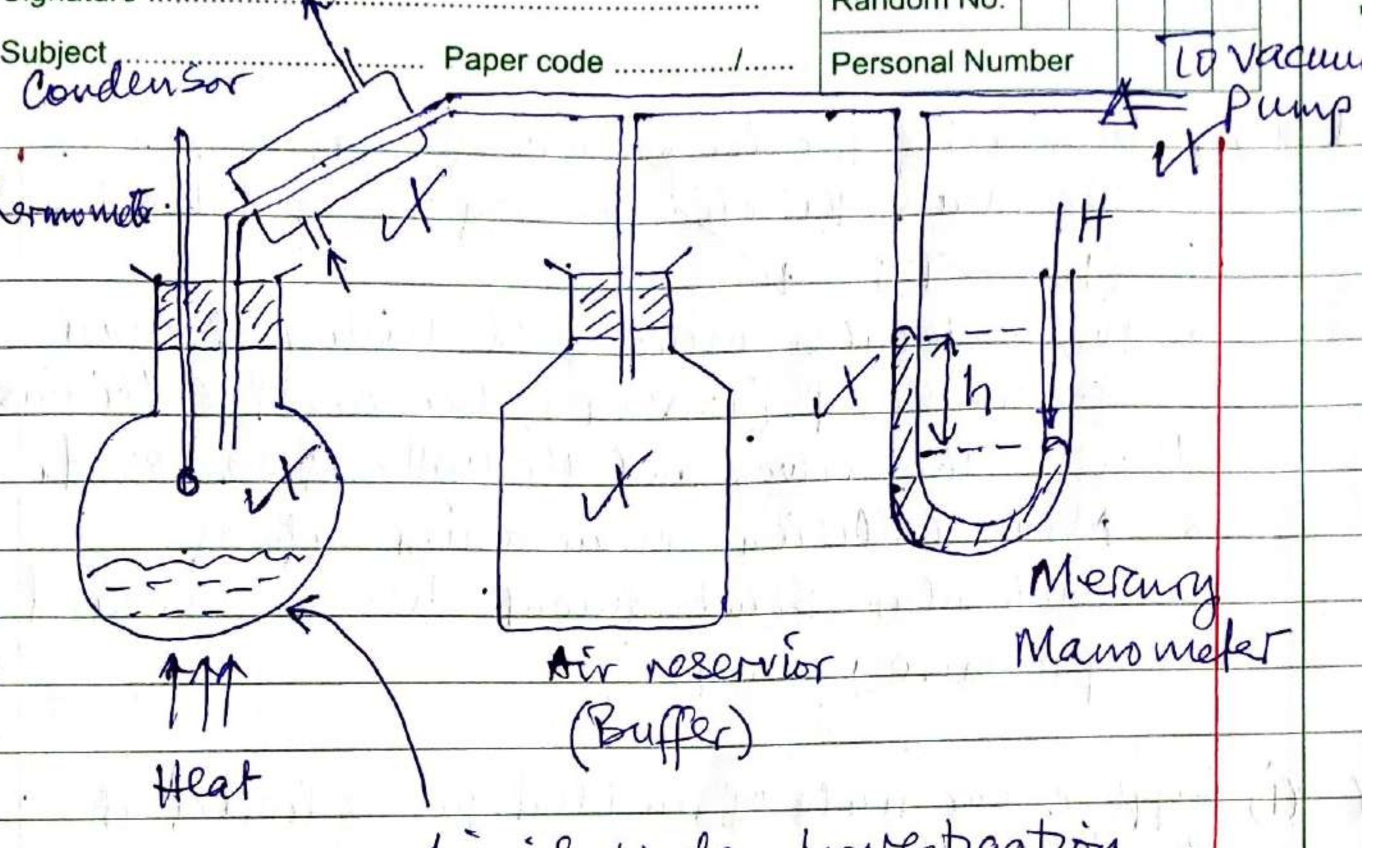

- using the apparatus shown above, the pressure above the liquid in the flask is reduced to some desired value using a vacuum pump.
- the liquid is then heated gently until it starts boiling at a temperature determined by the pressure inside the apparatus.
- the vapour is condensed and returned to the flask thereby preventing a pressure build up and establishing equilibrium.
- the thermometer registers the temperature of the saturated vapour and the pressure P above the boiling liquid $P = (H - h\rho g)$ where H = Atmospheric pressure and ρ is the density of mercury.
- Since a liquid boils at a temperature such that its SVP is equal to the external pressure, then P is the SVP at that particular temperature.

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7b(ii) • Increasing the temperature of a gas increases the mean kinetic energy of the molecules. ($K.E \propto T$) ✓

• The molecules move with high root mean square speed ($C \propto \sqrt{T}$), increased collisions with themselves and the walls of the vessel. ✓

• More collisions mean a high rate of molecular bombardment hence increased pressure. ✓ 03

7(c)(i) Suppose one mole of an ideal gas is heated at constant volume so that its temperature rises by ΔT; $\Delta Q_V = C_V \cdot \Delta T$ ----(i) ✓

Since no external work done; $\Delta W = 0$

$\Rightarrow \Delta Q_V = C_V \cdot \Delta T = \Delta U$ ---(ii) ✓

Suppose one mole of an ideal gas is heated at constant pressure so that the temp rises by ΔT; $\Delta Q_p = C_p \cdot \Delta T$ ---(iii) ✓

from the law of thermodynamics;

$\Delta Q = \Delta U + \Delta W$ -----(iv) ✓

$\Delta Q_p = \Delta U + P\Delta V$ ✓

Substituting for ΔQ_p, ΔU and $P\Delta V = R\Delta T$

$\Rightarrow C_p\Delta T = C_V\Delta T + R\Delta T$ ✓

$\therefore \underline{C_p - C_V = R}$ ✓ 04

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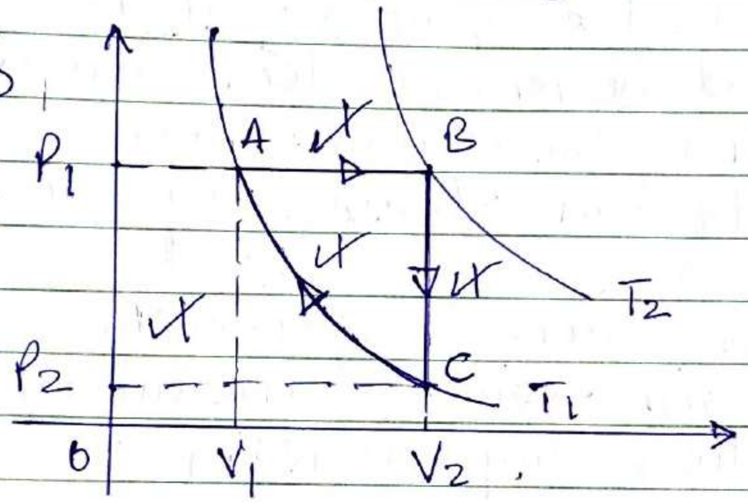
(c) (ii) $C_p > C_v$ because when a gas is heated at constant pressure, in addition to the change in internal energy (ΔU), ✓ external work must be done against the atmosphere by the expanding gas. ($\Delta W \neq 0$) ✓ 02

7(d) (i)



$\frac{1}{2}$ for axes well labelled. 02

$T_1 = 300K$ $T_2 = 325K$
$P_1 = 1.50 \times 10^5 pa$ $P_2 =$
$V_1 = 2$ litres $V_2 = 4$ litres, $(V_2 = 2V_1)$

(ii) change from B to C; $\frac{P_1}{T_2} = \frac{P_2}{T_1}$ ✓

$$\Rightarrow \left(\frac{1.50 \times 10^5}{325}\right) = \frac{P_2}{300}$$ ✓

$\therefore P_2 = 1.385 \times 10^5 pa$ ✓

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8(a)(i) A nuclide is an atomic nucleus specified by its atomic number and atomic mass. 01

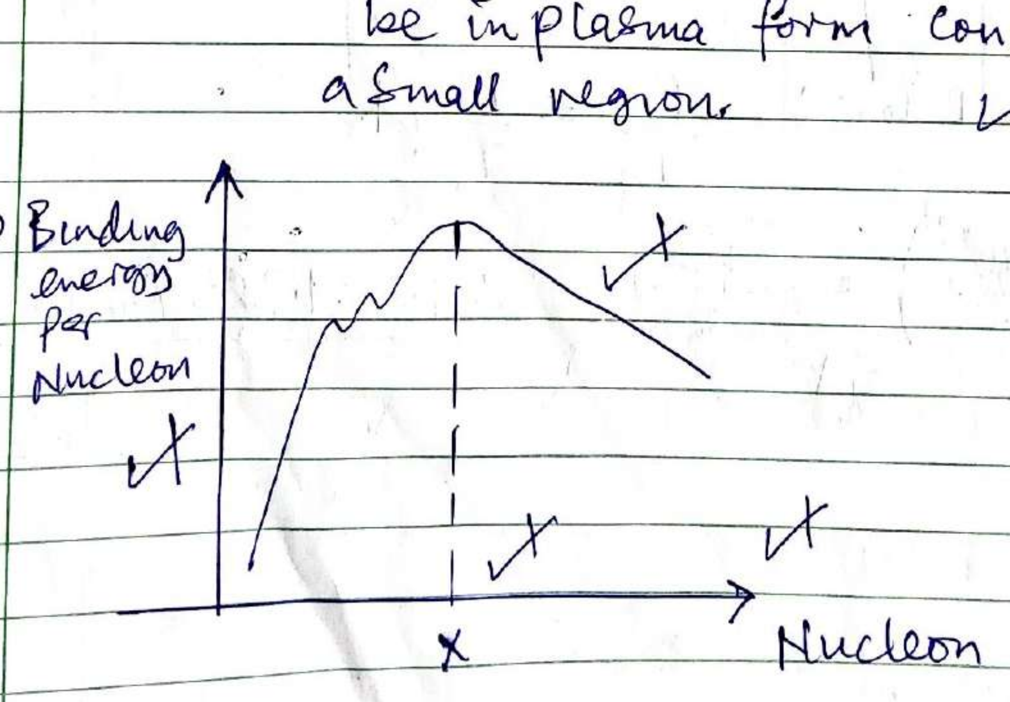
(ii) Nucleons are the constituents of the nucleus of an atom ie (protons + Neutrons). 01

(b)(i) • Nuclear fission is the splitting of a heavy nucleus into two lighter nuclei whereas nuclear fussion is the union of two light nuclei to form a heavier nucleus.

• Nuclear fission occurs spontaneously whereas fussion requires large amounts of energy at high temperatures. 02

(ii) Conditions for nuclear fussion:
• Extreme high temperatures.
• the substances to be fussed should be in plasma form confined into a small region. 02

8(c)



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- Nucleus X with high binding energy per nucleon is the most stable. ✓
- Nuclei to the left X are unstable and undergo fussion while those to the rigar of X attain stability by nuclear fission. ✓ 04

8(d) $^{2}_{1}H + ^{3}_{1}H \longrightarrow ^{4}_{2}He + ^{1}_{0}n + \text{Energy}$ ✓ ✓

mass defect $\Delta M = [2.0141 + 3.0161] - [4.0026 + 1.0087]$

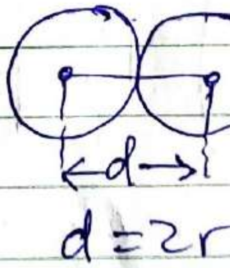
$= 0.0189U$ ✓

(i) Amount of Energy released in the reaction

$E = (0.0189)(931)$ MeV ✓

$\therefore E = 17.6 \text{ MeV } (2.81 \times 10^{-12} J)$ ✓ 05

(ii) $K.E = \frac{1}{2}mV^2 = \frac{e^2}{4\pi d^2}$ ✓ ✓



$d = 2r$ ✓

$\Rightarrow K.E = \frac{(1.6 \times 10^{-19})^2}{4\pi(1.5 \times 10^{-15} \times 2)^2 \varepsilon_0}$ ✓

$= 2.265 \times 10^{-10} J.$ ✓ 05

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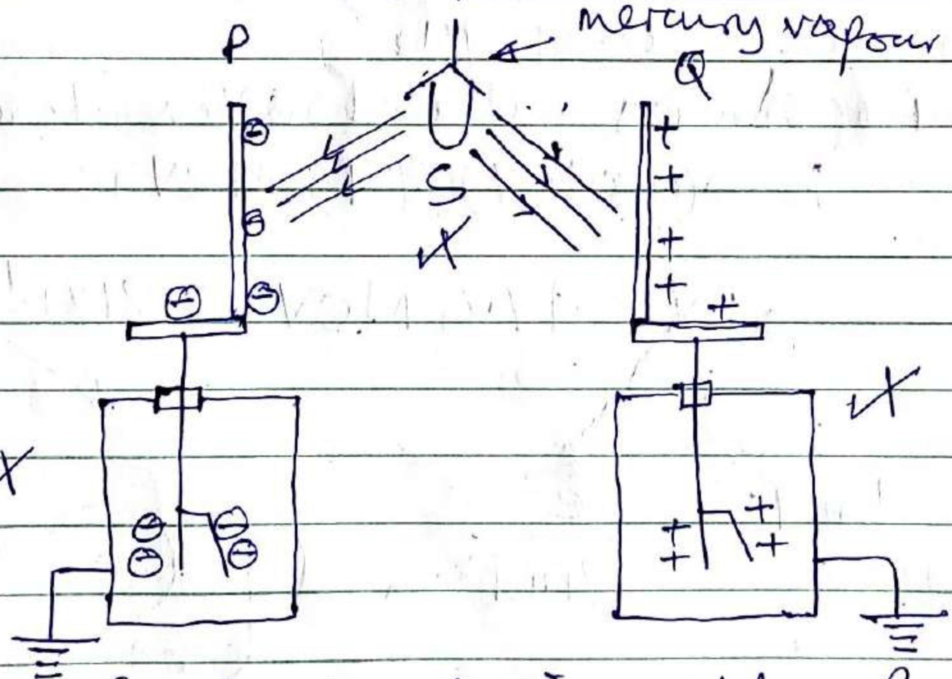
9(a) (i) Photoelectric emission is the liberation of an electron from a metal surface when exposed to Electromagnetic radiation of high enough frequency. ✓ 01

(ii) Threshold frequency is defined as the minimum frequency of radiation below which no electrons are emitted from the metal surface. ✓ 01

(b)(i) Demonstration of photo-electric emission



- Two freshly cleaned zinc plates P and Q are charged charged Negatively and Positively respectively and plated on the uncharged gold leaf electroscopes ~~each~~ A and B respectively. ✓
- Both electroscopes are earthed and the U.V light from a mercury discharge lamp is incident on both plates. ✓

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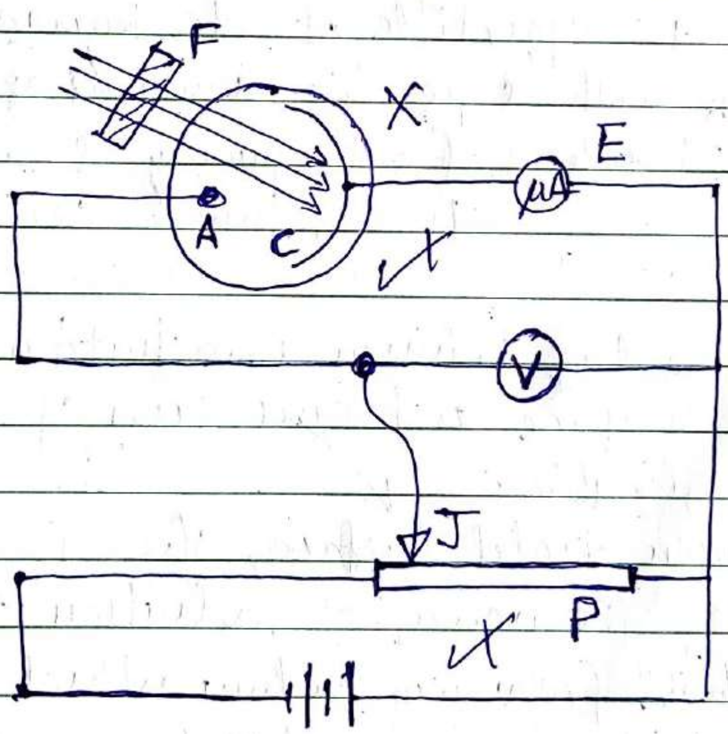
- It is observed that the leaf of Goldleaf electroscope A collapses completely while that of electroscope B remains unchanged. ✓
- in A - photoelectric emission occurs at the Zinc plate, the electrons are repelled by the negative charge causing a net charge loss. ✓
- In B the electroscope does not discharge because the emitted electrons are held back by the positive charge. ✓

04

(ii) <u>measurement of stopping potential</u>



F - Colour Filter
X - photocell
A - Anode
C - photo cathode
E - Current detector
J - Jockey P - variable resistor.

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- Incident radiation of a particular frequency is filtered at F before falling on the cathode C.
- the anode is made negative with respect to the cathode by the potential divider circuit.
- the radiation falling on C causes emission of electrons that causes a photocurrent to flow and is detected by E.
- the p.d is then adjusted until the reading of E is zero. the voltmeter reading now gives the stopping potential Vs. 05

9(c)(i) Aphoton is a particle of electromagnetic radiation with a specific amount of Energy $E = hf$; where f = frequency of radiation
h = planks constant 01

c(ii)
- The time lag between irradiation of the metal surface and emission of photoelectrons is negligable.
- for a given metal surface, there is a minimum value of frequency of radiation called threshold frequency below which no photoelectrons are emitted irrespective of the intensity of radiation.
- the K.E of the photoelectrons ranges from zero to maximum which increases with the frequency of the radiation and Independent of intensity.

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- the number of photoelectrons emitted from the metal surface persecond is directly proportional to the intensity of the incident radiation. ✓ 04

9d(i) Line spectrum refers to the dark or bright line of definite wavelength emitted by excited gaseous atoms.
This is as aresult of electrons that emit electromagnetic radiation when returning from higher energy levels to ground state. ✓ 02

(ii) Ionisation energy is the energy required to remove a loosely bound electron from agaseous atom or ion. while excitation energy is the energy that must be given to an atom in order to promote an electron from it's ground state to any of the higher energy levels. ✓ 02

10(a)(i) • Radioactivity is the spontaneous disintegration of an unstable nucleus to a stable one with release of energy in form of ionising radiations. ✓
- Decay constant is the fraction of the active nuclei disintegrating per second. units s^{-1}. ✓ 02

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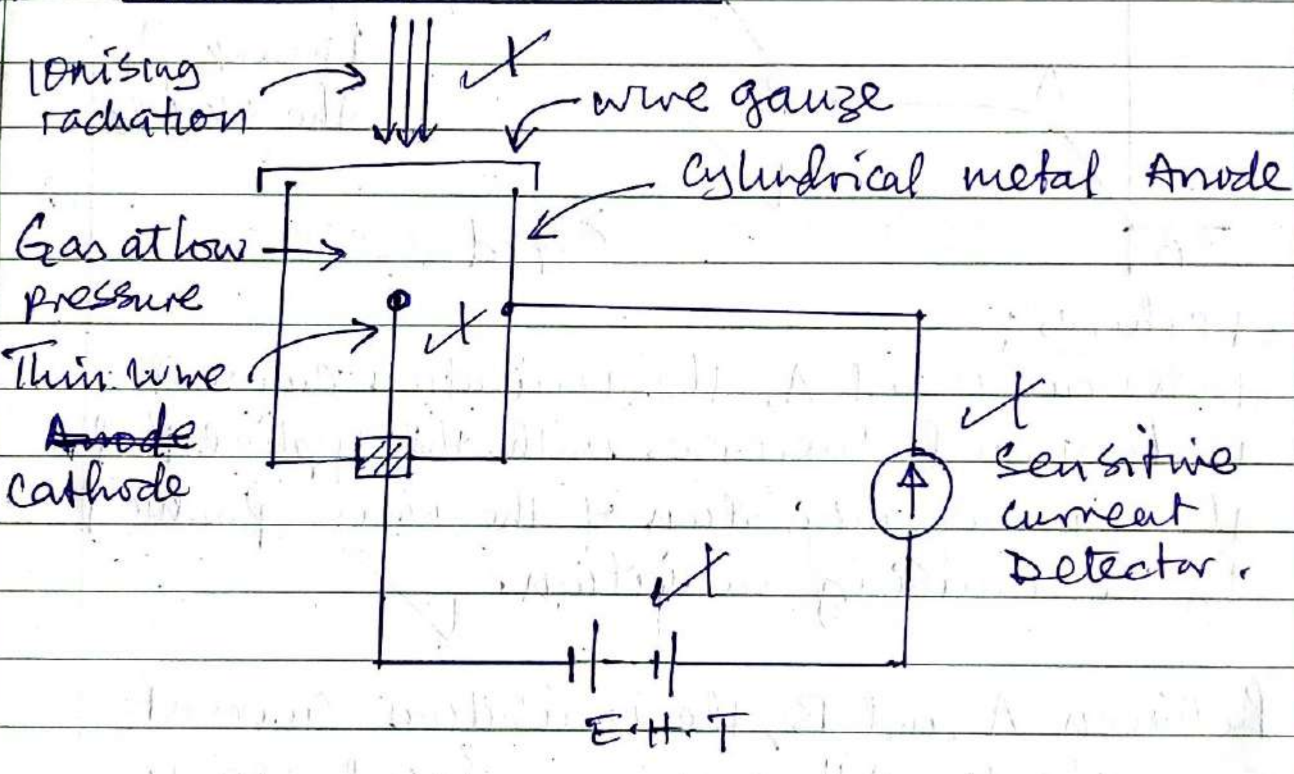
(a)(ii) Unified mass unit is defined as the mass of one-twelfth of the mass of one atom of the carbon-12 isotope.

OR $1U = \frac{1}{12} \times \left[\text{mass of one atom of Carbon-12}\right]$ 01

10(b)(i) Ionisation chamber



- Radiation entering through the wire gauze ionises the gas molecules to produce ion-pairs.
- the electrons are accelerated towards the anode while positive ions are accelerated towards the cathode by the electric field across the electrodes.
- The movement of the ions towards the respective electrodes causes a discharge

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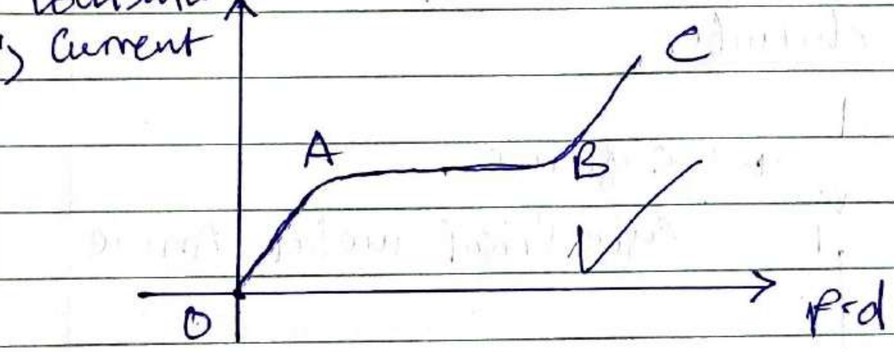
and a current pulse flows through the external circuit and is detected. ✓

- This indicates the presence of ionising radiation, the magnitude of the ionisation current is proportional to the extend of ionisation. ✓ 06

10(b)(ii)



1 mark for the sketch

Features;

- Between O and A, the ionisation current is low and increases with the applied P.d. there is recombination of the ions produced by the ionising radiation. ✓

- Between A and B, the ionisation current is constant. All ions produced reach the respective electrodes without recombination and without secondary ionisation. ✓

- Beyond B, the ionisation current increases rapidly for small changes in the applied P.d, secondary ionisation takes place leading to production of more ion-pairs hence large current. ✓

04

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10(c)(i) Detected activity $A = \left(\frac{5.40 \times 10^4}{60}\right)$ counts per second

$= 900$ counts per second.

Let A_0 = activity of the source.

Detected activity $A = \left(\frac{\text{area of reception}}{4\pi R^2}\right) A_0$

Given $R = 7cm = 7.0 \times 10^{-2}$

area of reception $= 3cm^2$
$= 3 \times 10^{-4} m^2$

$\Rightarrow 900 = \left[\frac{3 \times 10^{-4}}{4\pi(7 \times 10^{-2})^2}\right] A_0$

$\therefore \underline{A_0 = 1.85 \times 10^5 \, ds^{-1}}$ or Bq

04

c(ii) Using $A = \lambda N$ $\lambda = 4.80 \times 10^{-11} s^{-1}$

Number of $^{241}_{95}Am$ atoms with source

$N = \frac{A_0}{\lambda} = \left(\frac{1.85 \times 10^5}{4.80 \times 10^{-11}}\right)$ atoms

$\therefore \underline{N = 3.85 \times 10^{15}}$ atoms of $^{241}_{95}Am$

03