PHYSICS PAPER 1 ①

$\frac{20}{99}$

MARKING GUIDE P510/1

1(a)(i) A scalar quantity is a physical quantity defined by magnitude only while a vector quantity is defined by both magnitude and direction. 3

(ii)

Scalar quantities	Vector quantities
Temperature, volume	Force
Distance, Density	Displacement
Pressure etc	Velocity
Speed	Acceleration
Time	Weight
mass	etc

(b) $F_x = 8\cos 50^\circ + 7\cos 30^\circ - 12\cos 65^\circ - F\sin\theta = 0$

$5.142 + 6.062 - 5.071 - F\sin\theta = 0$

$6.133 = F\sin\theta$

$F_y = 8\sin 50^\circ + 12\sin 65^\circ - F\cos\theta - 7\sin 30^\circ = 0$

$6.128 + 10.88 - F\cos\theta - 3.5 = 0$

$F\cos\theta = 13.508$

$\frac{F\sin\theta}{F\cos\theta} = \frac{6.133}{13.508} \Rightarrow \tan\theta = \frac{6.133}{13.508}$ 3

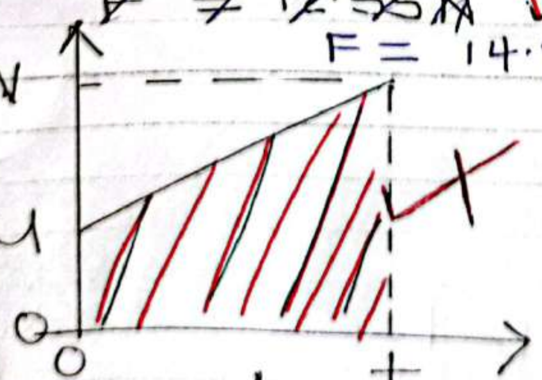
$\theta = 24.42^\circ$

$F\sin 24.42 = 6.133$ (sub for θ to get F)

$F = 6.133/\sin 24.42$ 2

$F = 14.83N$

(c)(i)



3

Distance = Area under the velocity-time graph

$S = \frac{1}{2}(u+v)t$ but $t = \frac{v-u}{a}$

$S = \frac{(u+v)(v-u)}{2a} \Rightarrow v^2 = u^2 + 2as$

(sub t)

Alternative

Distance = ave speed × time

$S = \frac{(u+v)}{2} t$ but $t = \frac{v-u}{a}$

$S = \frac{(u+v)(v-u)}{2a}$

$\Rightarrow v^2 = u^2 + 2aS$ 3

(ii) $v^2 = u^2 + 2aS$

$\Rightarrow S = \frac{v^2 - u^2}{2a}$ 2

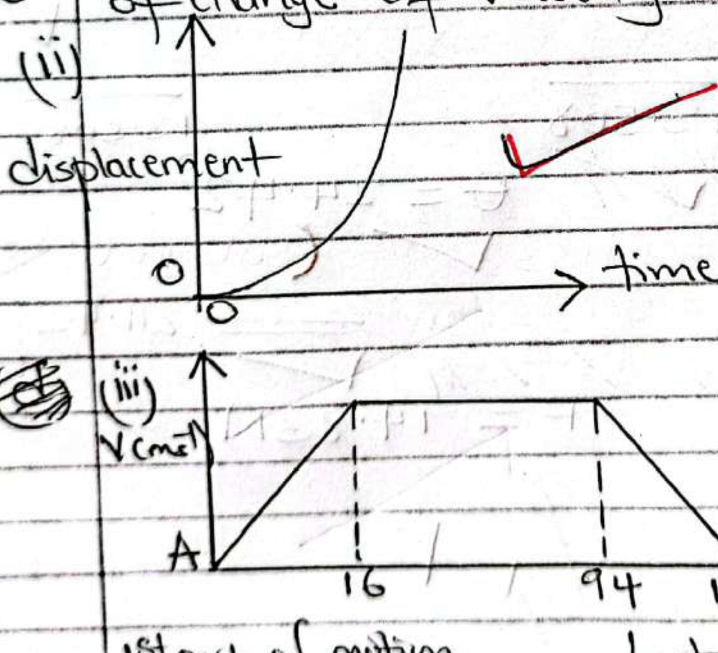
$[LHS] = [S] = L$

$[RHS] = \frac{[v^2 - u^2]}{[2a]} = \frac{L^2T^{-2}}{LT^{-2}} = L$

Since $[LHS] = [RHS]$ it is dimensionally correct.

(d) (i) Uniform acceleration is the uniform rate of change of velocity with time. 1

(ii)



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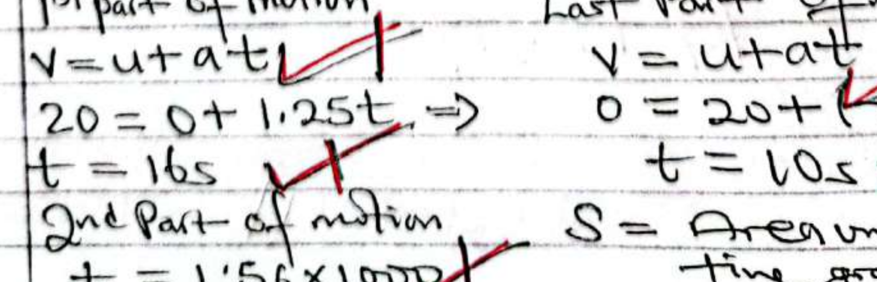
(iii)



1st part of motion

$v = u + at$

$20 = 0 + 1.25t \Rightarrow$

$t = 16s$

2nd Part of motion

$t = \frac{1.56 \times 1000}{20}$

$t = 78s$

Last Part of motion 5

$v = u + at$

$0 = 20 + (-2)t$

$t = 10s$

S = Area under velocity-time graph.

$S = \frac{1}{2}(104 + 78) \times 20$

$S = 1820m$

2(a)(i) Young's modulus is the ratio of tensile stress to tensile strain. 1

(ii) Vernier reading taken as masses are loaded and unloaded to ensure that the elastic limit is not exceeded.

Two identical wires are used to eliminate errors due to temperature changes. (any fir 3 corr

6

Both wires are suspended from ~~of~~ the same support to eliminate errors in extension due to the yielding of the support.

OR Thin wires are used to produce a measurable or a large extension when a small force is used (applied)

Long wires are used to produce measurable or large extension.

Average diameter of wire is obtained to obtain accurate cross sectional area.

Wires should be free of kinks to obtain accurate original length.

(b) Rubber consists of coiled molecules while a metal does not. When load is applied to the rubber the molecules uncoil leading to a larger extension. 2

(c)

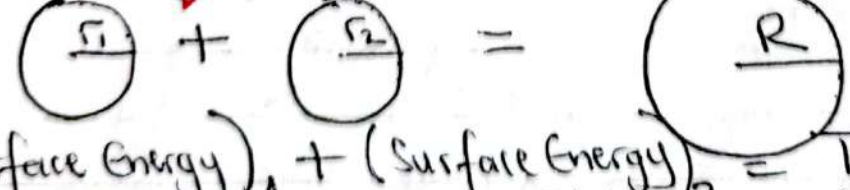
$e = e_1 + e_2 +$

(c)(i) Surface tension is the force per unit length acting in the liquid surface at right angles to the imaginary line drawn in the liquid surface. 1

(ii) Molecules in the surface are more widely spaced than those in the bulk. The surface molecules experience net attractive force downwards. This puts the molecules in a state of tension. 3

(d) (i) ~~Surface tension is the force per unit length acting in the liquid surface at right angles to one side of the imaginary line drawn in the liquid surface.~~

(ii) Liquid molecules are fairly close ~~together~~, have weak forces of attraction and move about variable positions. When temperature is increased the molecules move faster and farther apart. The force of attraction between the molecules reduces, thus the surface tension of a liquid decreases with increase in temperature. 3

(e) 

(Surface Energy)$_1$ + (Surface Energy)$_2$ = Total S.E

$$2(4\pi r_1^2)\gamma + 2(4\pi r_2^2)\gamma = 2(4\pi R^2)\gamma$$

$$r_1^2 + r_2^2 = R^2 \Rightarrow R = \sqrt{(r_1^2 + r_2^2)}$$

Excess Pressure $\Delta P = P_i - P_0 = 4\gamma / R$

$$R = \sqrt{(2.5^2 + 3.5^2)} \Rightarrow R = 4.3\,\text{cm}$$

$$\Delta P = 4 \times 2.5 \times 10^{-2} = 2.33\ \text{Pa}$$ 4

(i) Kepler's ~~third~~ law states that the square of the period of revolution of the planet about the sun is directly proportional to the cube of the mean distance between the sun and the planet. 1

(ii) $\frac{GMm}{R^2} = mR\omega^2$ but $\omega = \frac{2\pi}{T}$ and

on earth $GM = gr^2$

$\frac{gr^2 m}{R^2} = \frac{mR\,4\pi^2}{T^2} \Rightarrow T^2 = \frac{R^3 4\pi^2}{gr^2}$

but $R = h + r$

$\Rightarrow T^2 = \frac{4\pi^2 (h+r)^3}{gr^2}$ 4

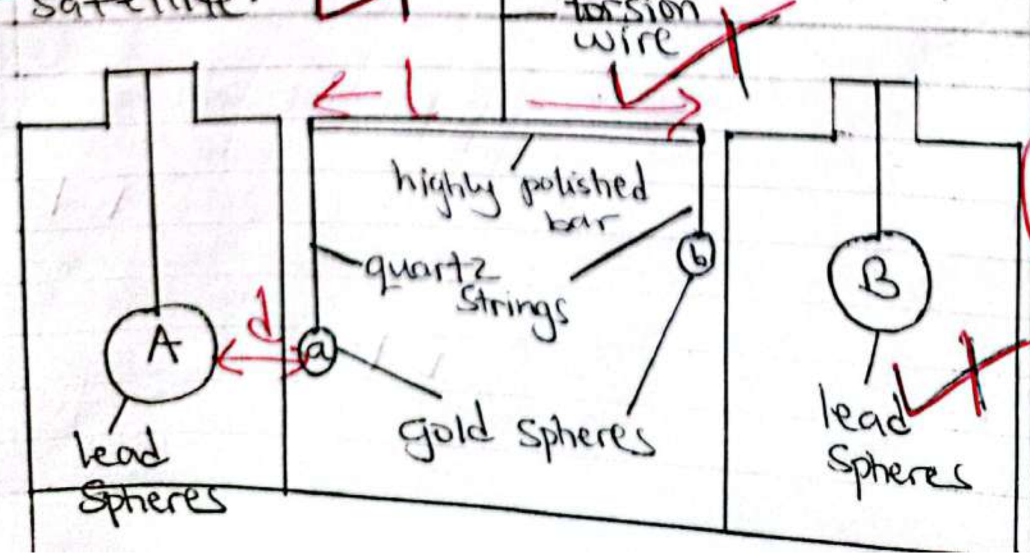
$T = \sqrt{\frac{4\pi^2 (h+r)^3}{gr^2}}$ but $\pi^2 = g$

$T = \frac{2}{r}(r+h)^{3/2}$

(iii) Frictional resistance reduces the $m.e = \frac{-GMm}{2r}$ which makes it to drop to an orbit of smaller radius hence its kinetic energy $= \frac{GMm}{2r}$ increases. This results into an increase in the speed of a satellite. 2

more increase in speed is in gm

(b)



(any 2 correct)

head
ward
arcs
miss
if
M, m
are not
ined.

Two identical gold spheres a and b each of mass, m are suspended as above from the ends of a highly polished bar of length L. Two large lead spheres A and B each of mass M are brought into position near a and b respectively. Distance, d between a and A is measured and the deflection θ of the polished bar is measured by the lamp and scale method. Torque of the couple on L = $\frac{GMm}{d^2}L$

Torque of couple $= c\theta$

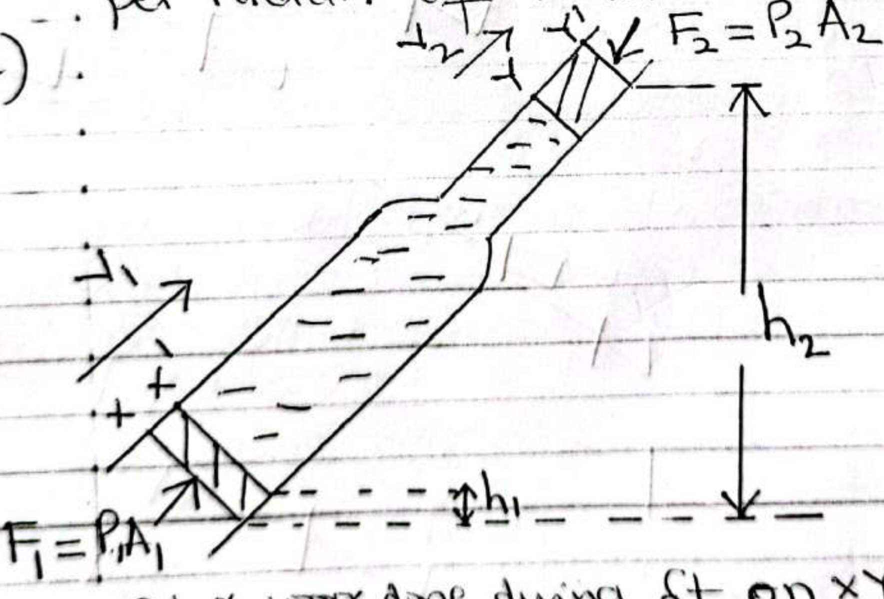
$$\frac{GMmL}{d^2} = c\theta \Rightarrow G = \frac{c\theta d^2}{MmL}$$

where C = torque in torsion of wire per radian of twist.

5%

5

(C)



W_1 At X work done during δt on XY by P_1A_1 pushing it into the tube = F×S = F×velocity×time = $P_1A_1v_1\delta t$

W_2 At Y work done during δt by fluid XY emerging from the tube against $P_2A_2 = P_2A_2v_2\delta t$

Net work done during δt by the fluid XY emerging from the tube against P_2A_2

$= P_1A_1V_1\delta t - P_2A_2V_2\delta t$

$\Rightarrow W = (P_1A_1V_1 - P_2A_2V_2)\delta t$ (net work done)

Rate at which mass flows into the tube = rate at which fluid flows out

$\rho_1A_1V_1 = \rho_2A_2V_2$, For incompressible fluid $\rho_1 = \rho_2 = \rho \Rightarrow A_1V_1 = A_2V_2$ (continuity eqn).

$W = (P_1 - P_2)A_1V_1\delta t$

As a result of work done on it the fluid gains P.e and K.e when XY moves to X'Y'

Gain in P.e = P.e of YY' − P.e of XX'

$= (A_2V_2\delta t\rho)gh_2 - (A_1V_1\delta t\rho)gh_1$

$= A_1V_1\delta t\rho g(h_2 - h_1)$

Since $A_1V_1\delta t = A_2V_2\delta t$

Gain in K.e = K.e of YY' − K.e of XX'

Gain in K.e $= \frac{1}{2}(A_2V_2\delta t\rho)V_2^2 - \frac{1}{2}(A_1V_1\delta t\rho)V_1^2$

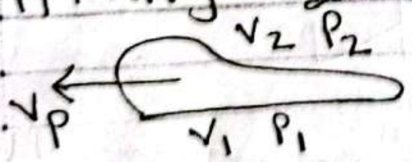
$= \frac{1}{2}A_1V_1\delta t\rho(V_2^2 - V_1^2)$

Network done on fluid = Gain in P.e + Gain in K.e 4

$(P_1 - P_2)A_1V_1\delta t = A_1V_1\delta t\rho g(h_2 - h_1) + \frac{1}{2}A_1V_1\delta t\rho(V_2^2 - V_1^2)$ (sub)

$P_1 - P_2 = \rho g(h_2 - h_1) + \frac{1}{2}\rho(V_2^2 - V_1^2)$

$P_1 + h_1\rho g + \frac{1}{2}\rho V_1^2 = P_2 + h_2\rho g + \frac{1}{2}\rho V_2^2$

(d) 

$\frac{V_p}{V_1} = 1.0 \Rightarrow V_p = V_1$

$V_p/V_2 = \frac{1}{4} \Rightarrow V_2 = 4V_p$

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

$(P_1 - P_2)A = \frac{1}{2}\rho A(V_2^2 - V_1^2) \Rightarrow$ ~~V_p~~ $4V_p$

but $(P_1 - P_2)A = F = mg =$ ~~V_2~~ 78480 net force.

$78480 = \frac{1}{2} \times 1.3 \times 8\,((4V_p)^2 - V_p^2)$ sub 4

$V_p = 31.72\ ms^{-1}$

2 Velocity attained by a body falling through viscous fluid.

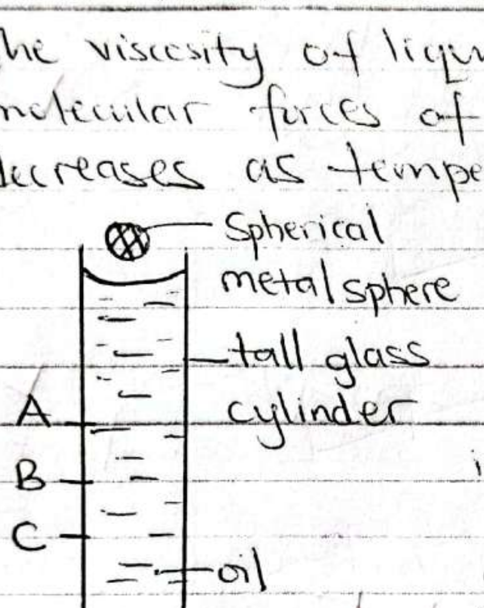
4.(a) Is the tangential force per unit area per unit velocity gradient.

OR Is the frictional force per unit area of a liquid in a region of unit velocity gradient. 1

(b) As temperature increases the viscosity of gases increases and that of liquids decreases. The viscosity of gases depends on the rate of momentum transfer by gas molecules which increases as temperature increases. The viscosity of liquids depends on inter-molecular forces of attraction which decreases as temperature increases 3

You can begin with conclusion and explain or explain then conclude.

(C)



A spherical sphere of radius r_s and density ρ_s is released centrally into the oil of density ρ_o in a tall glass cylinder. The times it takes to fall between $\overline{AB}$ and $\overline{BC}$ are measured and recorded as t_1 and t_2 respectively. Its terminal velocity $V_o = \left(\frac{AB}{t_1} + \frac{BC}{t_2}\right)/2$ is obtained. At terminal velocity, 5

Weight = Upthrust + viscous drag

$$\frac{4}{3}\pi r_s^3 \rho_s g = \frac{4}{3}\pi r_s^3 \rho_o g + 6\pi r_s \eta V_o$$

$$\eta = \frac{2 r_s^2 g}{9 V_o}(\rho_s - \rho_o)$$

Transfer marks to explaination.

(d)(i) When a body is fully or partially immersed in a fluid it experiences an upthrust equal to the weight of the fluid displaced. 1

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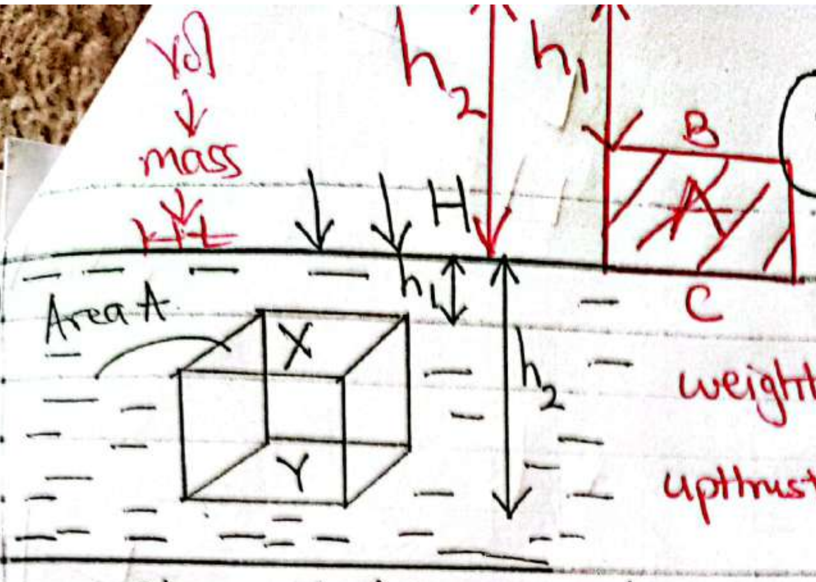


$F_B = h_1 \rho A g$, $F_C = h_2 \rho A$

Net upward force = $(h_2 - h_1)\rho g A$ = upthrust

volume of liquid displaced = $(h_2 - h_1)A$

weight of liquid displaced = $(h_2 - h_1)A\rho$

upthrust = wt of liquid displaced.

$\frac{F}{A}$

$= \rho$

consider a body of a shape of a cuboid immersed in a liquid of density ρ at a distance h_1 below the liquid surface.

Pressure at depth, $h_1 = (h_1\rho g + H)$

Force on surface X $F_x = (h_1\rho g + H)A$

Pressure at depth, $h_2 = (h_2\rho g + H)$

Upward force on surface Y, $F_y = (h_2\rho g + H)A$

Net upward force $= F_y - F_x$

$= (h_2\rho g + H)A - (h_1\rho g + H)A$

upthrust $= (h_2 - h_1)A\rho g$

4

Also $(h_2 - h_1)A$ = volume of the solid

= volume of fluid displaced

$(h_2 - h_1)A\rho$ = mass of fluid displaced

$(h_2 - h_1)A\rho g$ = weight of liquid displaced

Hence weight of fluid displaced = upthrust, hence Archimede's principle is verified.

(e) Let density of liquid

wt of metal and wax

$= (2.6\times10^{-3} + 1.0\times10^{-2})g$

= weight of liquid displaced

Also weight of liquid displaced $= \left(\frac{2.6\times10^{-3}}{8.4\times10^{3}} + \frac{1.0\times10^{-2}}{9.2\times10^{2}}\right)\rho g$

= upthrust

At equilibrium, Upthrust = weight of liquid displaced

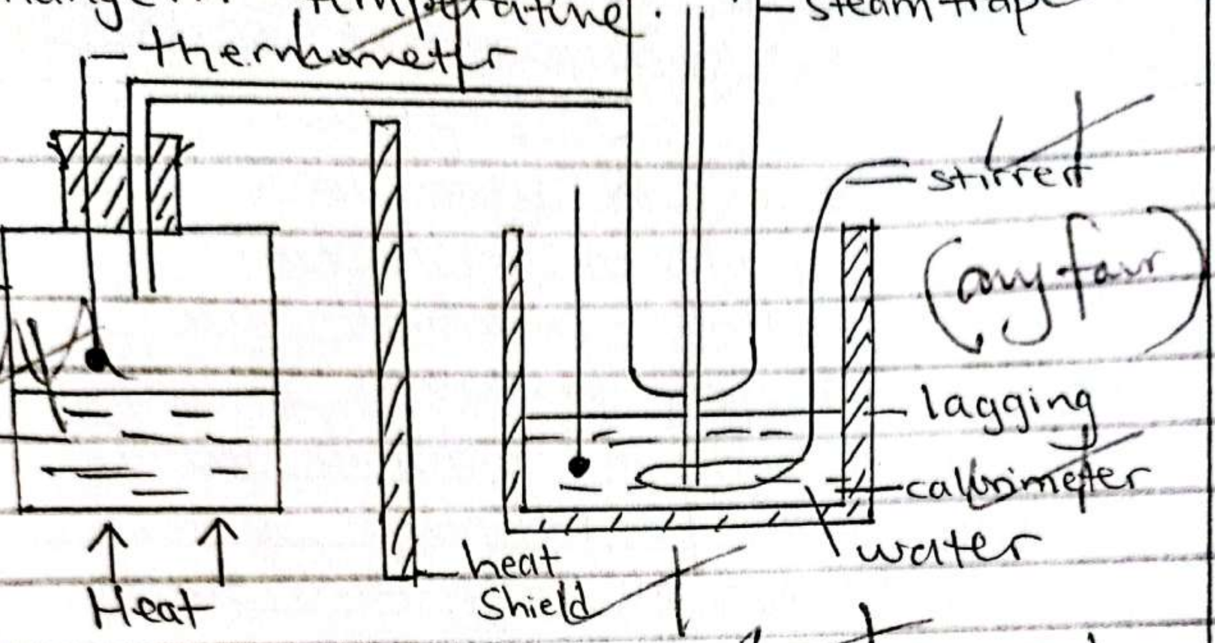
$\left(\frac{2.6\times10^{-3}}{8.4\times10^{3}} + \frac{1.0\times10^{-2}}{9.2\times10^{2}}\right)\rho g = (2.6\times10^{-3} + 1.0\times10^{-2})g$

Sub and equating

$\rho = 1.13\times10^{-3}\,kg\,m^{-3}$

5

a) Is the amount of heat energy required to change 1kg mass of a liquid to vapour without change in temperature. 1

b) 

(any four)

The initial temperature θ_1 of water and calorimeter is taken. The mass of water (m_1) in the calorimeter is determined. The water in the flask is heated to its boiling point of θ_3. Steam is passed into the calorimeter with water until there is a measurable change in temperature. The temperature θ_2 of the water in the calorimeter is recorded. The mass m of the condensed steam is found by weighing.

Heat lost by condensing steam + Heat lost by condensed water cooling = Heat gained by water + Heat gained by the calorimeter.

$$mL + mc_w(\theta_3-\theta_2) = m_1c_w(\theta_2-\theta_1) + C(\theta_2-\theta_1)$$

$$L = \frac{(m_1c_w+C)(\theta_2-\theta_1) - mc_w(\theta_3-\theta_2)}{m}$$

c_w = s.h.c of water

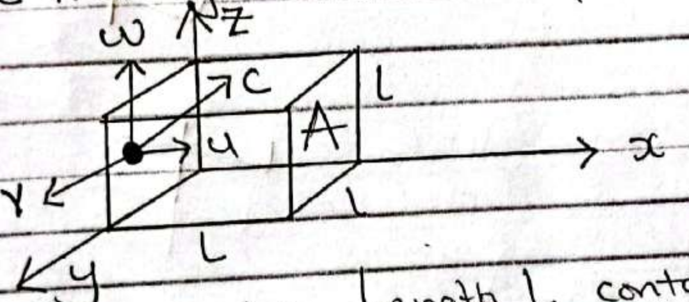
C = Heat capacity of

6

States that under conditions of forced convection the rate of loss of heat of a body is directly proportional to its excess temperature over that of the surroundings. 1

(ii). A small body has a ~~larger~~ large surface area to volume ratio with small linear dimension. Rate of temperature fall is inversely proportional to the linear dimension so the small body loses a large quantity of heat in a short time making it to cool faster. 3

(d)(i)



consider a cube length L containing N molecules of gas each of mass m. suppose a molecule moves towards A with a velocity u.

On hitting face A it bounces with the same velocity in the opposite direction.

change in momentum $= mu - (-mu) = 2mu$

Time for molecules to move across cube to opposite face and back $= \frac{2L}{u}$

Rate of change of momentum $= \frac{2mu}{2L/u}$

$= \frac{mu^2}{L}$ = Force on A

Pressure on A $= \frac{F}{A} = \frac{mu^2/L}{L^2} = \frac{mu^2}{L^3}$

For N molecules with velocities $u_1, u_2 --- u_N$

Total pressure on A $= \frac{m}{L^3}(u_1^2 + u_2^2 + --- + u_N^2)$

but $\overline{u^2} = \frac{u_1^2 + u_2^2 + --- + u_N^2}{N}$

$\Rightarrow u_1^2 + u_2^2 + --- + u_N^2 = N\overline{u^2}$

$P = \frac{mN\overline{u^2}}{l^3}$

$P = \rho\overline{u^2}$

If C is the resultant velocity with components u, v, w in x, y, z directions then

$C^2 = u^2 + v^2 + w^2$

$\overline{C^2} = \overline{u^2} + \overline{v^2} + \overline{w^2}$ but $\overline{u^2} = \overline{v^2} = \overline{w^2}$

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

$\Rightarrow P = \frac{1}{3}\rho\overline{c^2}$

(ii) The duration of a collision is negligible compared with the time spent by a molecule btn collisions.

Intermolecular attractions are negligible

The volume of the molecules themselves is negligible compared with the volume of the container. 2

The molecules are like perfectly elastic spheres.

(e) $P = \frac{1}{3}\rho\overline{c^2}$ but $PV = nRT$

$\Rightarrow T = \frac{1}{3}\frac{V\rho\overline{c^2}}{nR}$

$T = \frac{\frac{1}{3} \times 42 \times 9.0 \times 10^{-2} \times 44.72^2}{8.31}$

$T = 303.2K$ 2

20

/20

(a) A saturated vapour is a vapour which is in dynamic equilibrium with its own liquid while unsaturated vapour is a vapour which is not in dynamic equilibrium with its own liquid. 2

(b) During the day radiation is absorbed from the sun by the earth. At night earth radiates heat into the atmosphere. On cloudless nights the heat is lost to space. On a cloudy night the heat is reflected back to the earth and so feels warmer. 4

(c) Considering tap T closed.

For A, $V_1 = 0m^3$, $T_1 = 60+273 = 333K$, $P_1 =$

For B, $V_2 = 1.5\times10^{-3}m^3$, $T_2 = 60+273 = 333K$, $P_2 = 200 - P_s$

from $P_T = P_g + P_s \Rightarrow P_g = 200 - P_s = P_2$

$PV = nRT \Rightarrow n_1 = \frac{P_1V_1}{RT_1} = 0$

$n_2 = \frac{P_2V_2}{RT_2} = \frac{(200-P_s)(1.5\times10^{-3})}{333}$

When tap is opened.

$V_1 = V_2 = 1.5\times10^{-3}m^3$, $V = 3\times10^{-3}m^3$

$T = 60+273 = 333K$

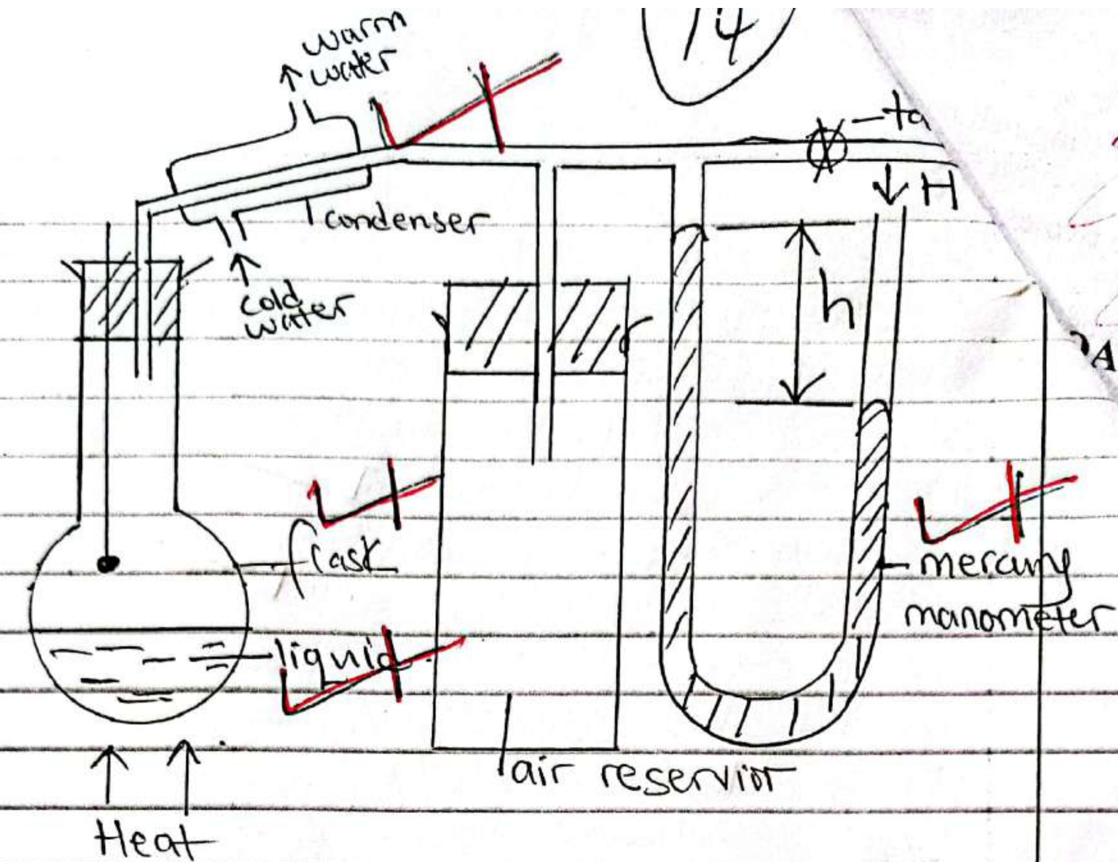
$P = 150 - P_s$

Also $n = \frac{PV}{RT} \Rightarrow n = \frac{(150-P_s)(3\times10^{-3})}{333}$

$n = n_1 + n_2$

$\frac{(150-P_s)(3\times10^{-3})}{333} = 0 + \frac{(200-P_s)(1.5\times10^{-3})}{333}$

$P_s = 100\,mmHg.$ 5



Air is pumped in or out from the reservoir by using the pump by opening the tap. The tap is closed and the liquid is heated to boiling point. The temperature θ of the vapur is determined. The difference, h in mercury levels is noted from the manometer. The pressure, P of the vapour P = H ± h is determined where H is the atm. pressure. The procedure above is repeated for different pressures. A graph of P against ~~θ~~ is plotted and the SVP of the liquid at a particular temperature can be obtained.

6

(e) $\frac{a}{V^2}$ is the pressure defect which accounts for the existence of inter-molecular forces of attraction. b is a constant that accounts for the finite volume of the molecules themselves.

3

A body emits radiation at a rate which is determined only by the nature of its surface and its temp, and absorbs radiation at a rate which is determined by the nature of its surface and temp of the surroundings. A body at constant temp is gaining heat by absorption and losing it by radiation at equal rates.

(a) When a body is in thermal equilibrium with its surroundings its rate of emission of radiation to the surroundings is equal to its rate of absorption of the radiation from the surroundings. 1

(b) Net power absorbed by sphere $= A\sigma(T_2^4 - T_1^4)$

$P = A\sigma(T_2^4 - T_1^4)$ but $\Phi = Pt$

$\frac{\Phi}{At} = \sigma(T_2^4 - T_1^4)$ also $\Phi = mc\Delta\theta$

$\frac{mc\Delta\theta}{At} = \sigma(T_2^4 - T_1^4)$ also $m = V\rho$

and $A = 4\pi r^2$, $V = \frac{4}{3}\pi r^3$

$\frac{\rho V c\Delta\theta}{At} = \sigma(T_2^4 - T_1^4)$ 5

$\frac{\rho(\frac{4}{3}\pi r^3)c\Delta\theta}{(4\pi r^2)t} = \sigma(T_2^4 - T_1^4)$

$\frac{\Delta\theta}{t} = \frac{3\sigma(T_2^4 - T_1^4)}{c\rho r}$

$\frac{\Delta\theta}{t} = \frac{3 \times 5.56 \times 10^{-8}(290^4 - 150^4)}{3.7 \times 10^2 \times 8.93 \times 10^3 (0.5 \times 10^{-3})}$

$\frac{\Delta\theta}{t} = 0.0679\ Ks^{-1}$

(c)(i) A black body is a body which absorbs all the radiation of every wavelength that falls on it and reflects and transmits none. 1

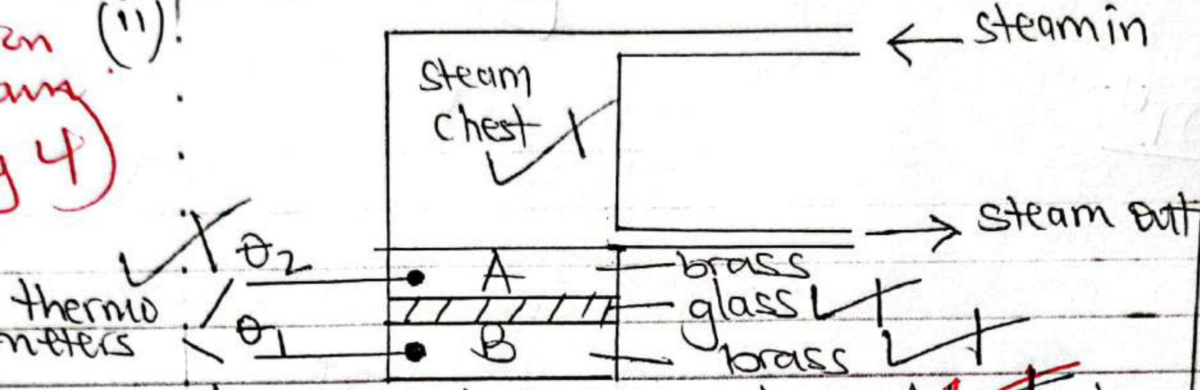
(ii) A black body can be realised in practice by punching a small hole on the lid of an empty tin blackened with soot in the inside. Radiation which enters the tin through the small hole is reflected many times, energy is absorbed at each point of incidence until it is all absorbed. 4

NS BOARD

d)(i) Thermal conductivity is the rate of heat flow through a material per unit cross sectional area in a region ~~of~~ unit temperature gradient

Direction of steam (any 4)

(ii)



Glass of cross sectional area A is made into a thin disc of thickness L and placed btn the brass slabs A and B each containing a thermometer. Steam is passed through the chest and the ~~steam is passed through~~ system is left to run until a steady state is reached. Temperatures θ_1 and θ_2 are recorded. Rate of heat flow $\frac{Q}{t} = KA(\theta_2 - \theta_1)/L$ where K is the thermal conductivity. The poor conductor is removed and the brass slab B heated directly by steam until its temperature is raises by about 10°C above θ_1. The steam chest is removed and the glass is placed ontop of B. The temperature of B is recorded as it cools until its temperature is 10°C below θ_1. A cooling graph of brass slab B is plotted. The slope of the curve at θ_1 is obtained. Slope $S = a/b$

Rate of loss of heat at θ_1 by the brass slab B, $Q/t = mc(s)$

The thermal conductivity of glass

$K = \frac{mcLs}{A(\theta_2 - \theta_1)}$ where c = s.h.c brass
m = mass of brass.

8

20

xcitation energy is the energy required to move an electron from a lower energy level to a higher energy level while ionisation energy is the energy required to remove an electron from ~~...~~ the ground state to infinity. 2

(b) $\Delta E = hf$

$\Delta E = \frac{hc}{\lambda}$ 4

$\Rightarrow \lambda = \frac{hc}{\Delta E} = \frac{6.63\times10^{-34}\times 3.0\times10^{8}}{(-2.77+4.87)\times(1.6\times10^{-19})}$ (Sub)

converting to joules

$\lambda = 5.92\times10^{-7}m$

It's in the visible region.

(c)(i) charge on ${}^{4}_{2}He = 2e$

charge on nucleus $= Ze$

$K.e$ of ${}^{4}_{2}He = \frac{1}{2}mv^2$ where v is the speed before collision

Electrostatic $P.e = \frac{(Z_1e)(Z_2e)}{4\pi\varepsilon_0 x_0}$

Electrostatic $P.e = \frac{(Ze)(2e)}{4\pi\varepsilon_0 x_0}$ 4

At closest distance of approach

$K.e$ of α-particle = electrostatic $P.e$ of α-particles nucleus system

$$\frac{1}{2}mv^2 = \frac{2Ze^2}{4\pi\varepsilon_0 x_0}$$

$$x_0 = \frac{Ze^2}{\pi\varepsilon_0 mv^2}$$

(ii) $\frac{1}{2}mv^2 = \frac{2Ze^2}{4\pi\varepsilon_0 x_0} = \frac{9.0\times10^{9}\times2\times79\times(1.6\times10^{-19})^2}{5\times10^{-14}}$

$K.e = 7.28\times10^{-13}J$ 3

e) (i) Most of the alpha particles passed through the metal foil undeflected. This because most space in an atom is empty. A few alpha particles are ~~deflected~~ through small angles less than 90°. This is because of the presence of the positive charge that repelled the α- particles. Very few particles are scattered through large angles greater than 90°, because the positive charge is located in a very small portion of the ~~atom~~ making the chance of a head on collision very small.

(ii) The experiment is carried out in a vacuum because the range of alpha particles in air is limited so the vacuum allows the particles to reach the foil and the detector beyond the foil a metal surface held at negative potential in a vacuum when an elm radiation of high enough frequency falls on it. electrons are ejected from

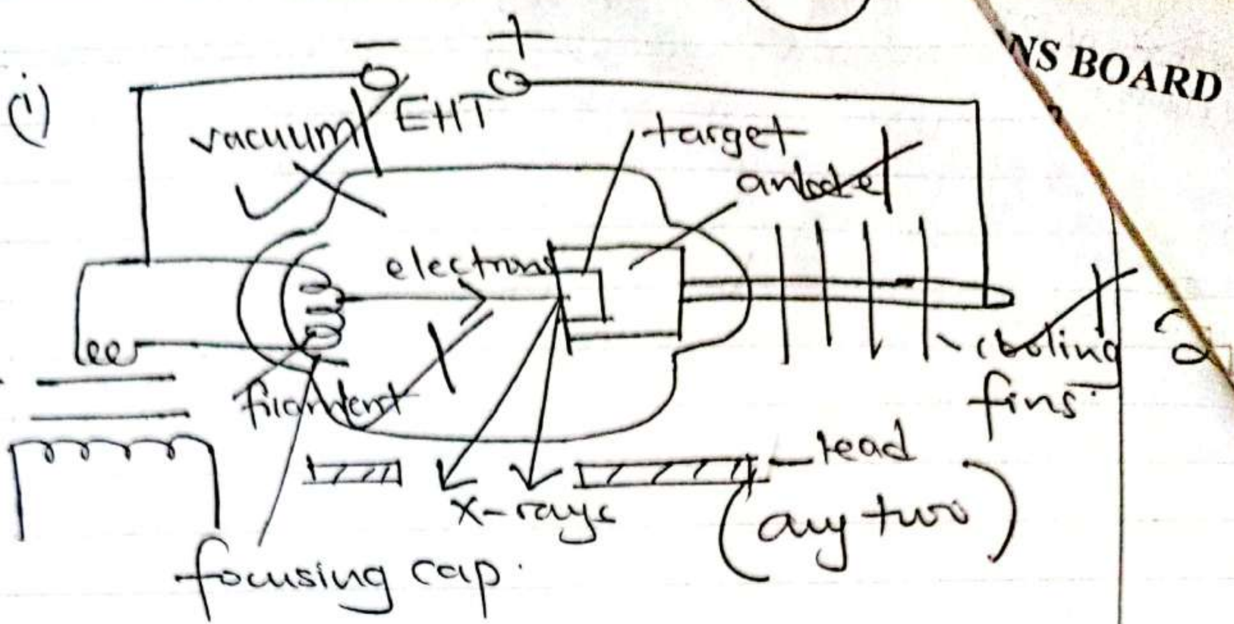
(19)

Photoelectric emission is a process by which electrons are ejected from a metal surface when electromagnetic radiation of high enough frequency falls on them. 1

(ii). Threshold frequency is the minimum frequency below which no electrons are emitted. 1

(b) Quantum theory postulates that light energy exists in discrete packets called quanta and each quantum of energy is carried by a photon ie $E=hf$. When incident on a metal surface each photon interacts with only one electron giving it all ~~its~~ energy. If the energy is equal or greater than the work function the energy is absorbed and an electron is immediately ejected. This explains the fact that photoelectric emission is instantaneous and that there exists a minimum frequency f_0, for $W=hf_0$. Increasing frequency increases the energy E of each photon and thus the K.e of the photoelectrons increases. Increasing intensity of radiation does not change the energy of the photons thus intensity does not affect K.e of photoelectrons. This explains K.e is proportional to frequency and independent of intensity. Increasing intensity increases the number of photons striking the metal surface per second. Thus more electrons are emitted per second and photocurrent increases. This explains the fact that photocurrent is proportional to intensity. 5

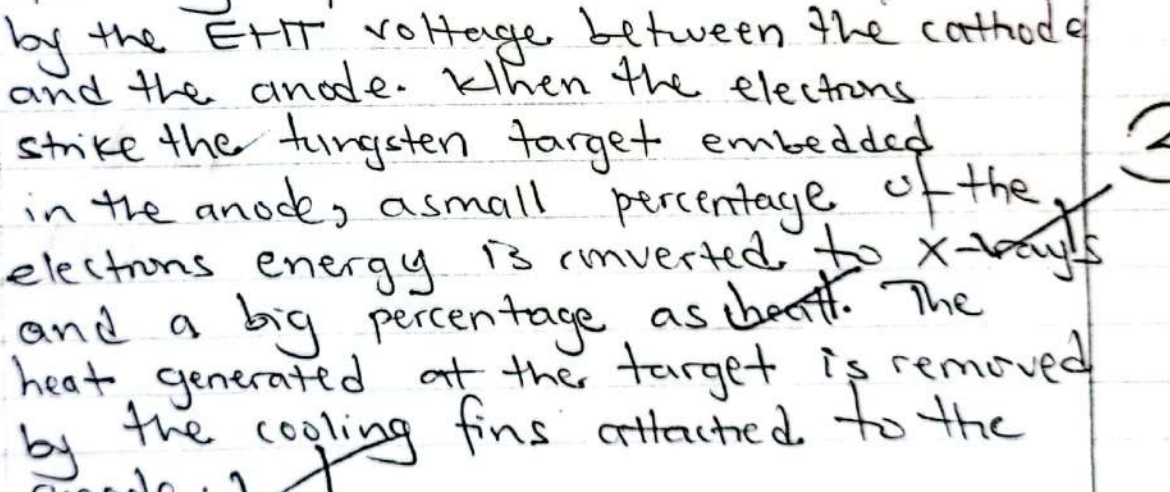
(C) (i)



(ii) The filament is heated by a low voltage source. The electrons are emitted and focused to the tungsten target by the focusing cap. The electrons are accelerated by the EHT voltage between the cathode and the anode. When the electrons strike the tungsten target embedded in the anode, a small percentage of the electrons energy is converted to X-rays and a big percentage as heat. The heat generated at the target is removed by the cooling fins attached to the anode. 3

~~(d) Explain using suitable sketch graphs how X-ray spectra in an X-ray tube are formed. (6 marks)~~

(d)



ontinous spectra is formed as a result of multiple collisions of energetic electrons with target atoms. At each collision x-rays of different wavelengths are emitted. Line spectrum is formed when a highly energetic electron knocks an electron out of the innermost shells. Electron transitions to the vacancies left results in emission of x-rays of definite wavelengths. 6

(e) $2d\sin\theta = n\lambda$

$2 \times 2.82 \times 10^{-10} \sin\theta = 8.42 \times 10^{-11}$

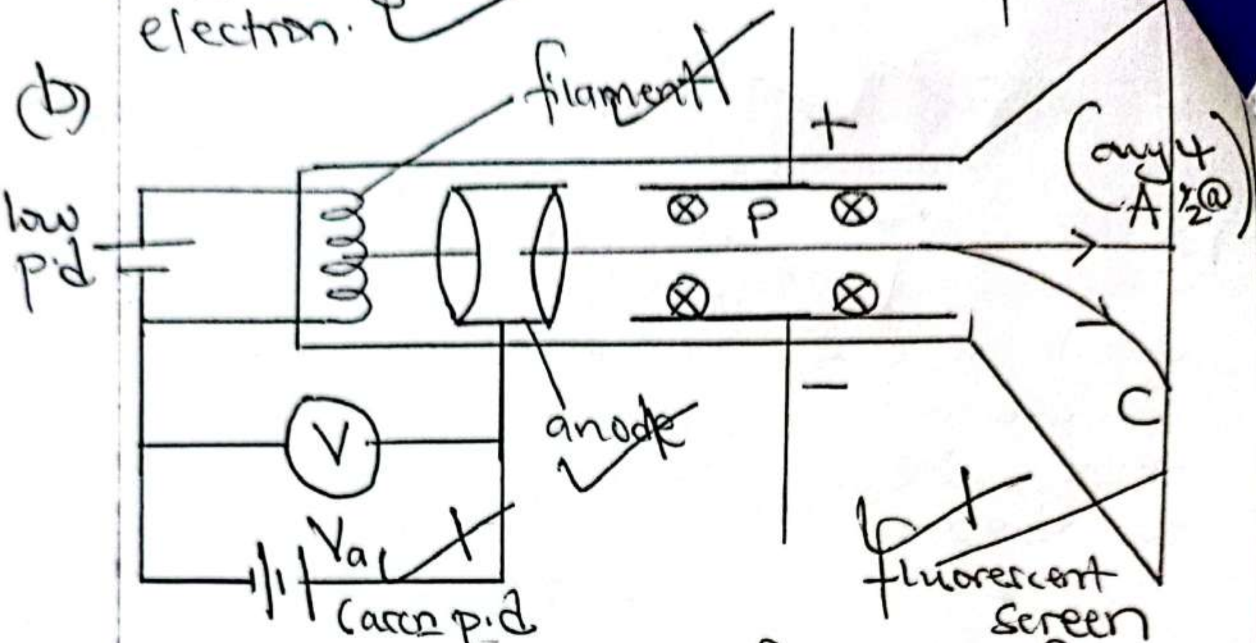
$\theta = 8.6^\circ$ 2

20

20/20

10(a) Specific charge of an electron is the charge to mass ratio of an electron.

(b)



Electrons are emitted from the filament thermionically and accelerated to the anode by the accelerating p.d V_a. With no electric or magnetic fields applied at P the electrons will reach point A on the screen, position A is noted. The magnetic field of known flux density B is applied at P to deflect the beam to C. Electric field is simultaneously applied at P and adjusted until the beam goes back to A. The p.d across the plates V and seperation d are noted. The charge to mass ratio $\frac{e}{m} = \frac{V^2}{2V_a d^2 B^2}$ where V_a is the accelerating p.d.

7

(c) With the field off:-

$F \propto V$

$F = KV_1$ but $F = kl$

$KV_1 = mg$

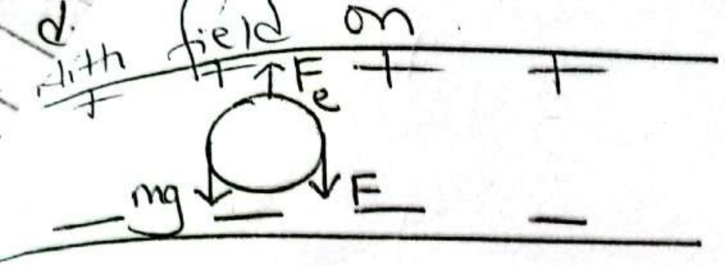
$K(4\times10^{-4}) = 1\times10^{-14}\times9.81$

$K = 2.45\times10^{-10}$

F

W

is d
linear d.
a large
time n



$F_e = F + W$

$qE = Kv_2 + mg \Rightarrow q\frac{V}{d} = Kv_2 + mg$

$\frac{q \times 1.6 \times 10^{3}}{14 \times 10^{-13}} = 2.45 \times 10^{-10} \times 8.0 \times 10^{-5} + 9.81 \times 10^{-14}$

$q = 1.03 \times 10^{-18} C$

no of electron charges $n = \frac{q}{e}$ 6

$n = \frac{1.03 \times 10^{-18}}{1.6 \times 10^{-19}}$

$n = 6.4 \simeq 6$

(d)(i) Half life is the time taken for half of the radioactive nuclei present in a source to disintegrate. 1

(ii) $N = N_o e^{-\lambda t}$ but $N = \frac{N_o}{2}$ ~~when~~

$t = T_{1/2}$

$\Rightarrow \frac{N_o}{2} = N_o e^{-\lambda T_{1/2}}$ 3

$\ln(\tfrac{1}{2}) = \ln e^{-\lambda T_{1/2}} \Rightarrow \ln(2^{-1}) = -\lambda T_{1/2}$

$T_{1/2} = \frac{\ln 2}{\lambda}$ 3

(e) $A = A_o e^{-\lambda t} \Rightarrow 8 = 32 e^{-(10\lambda)}$ 2

$0.25 = e^{-10\lambda}$

$\ln(0.25) = \ln e^{-10\lambda}$

$\lambda = \frac{-\ln 0.25}{10} = 0.1386$ per day 3

Alt: $\lambda = 1.60 \times 10^{-6} s^{-1}$

20