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Candidate's Name QUESTION ONE

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1(a)(i) Brittleness is the ability to break suddenly/easily when a force is applied (1)

(ii) Elasticity is the ability of a material to return to its original shape and size when a deforming force is removed (1)

(b) The extension is proportional to the force causing it provided the limit of proportionality/elastic limit, is not exceeded. (1)

(c)(i) Metal X; X has a bigger slope of the linear part of the graph (Bigger stress/strain ratio) (2)

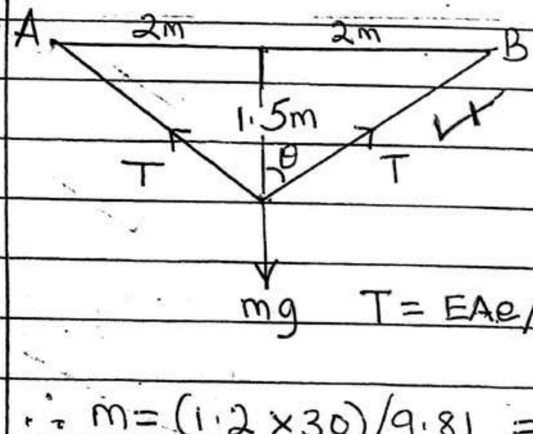
(ii) Metal X; The plastic region of graph X is greater than that for graph Y (2)

(iii) Metal X; X can withstand greater stress before it breaks (2)

(d)(i) P Since it has a larger area of cross section (2)

(ii) Q Since it will have a longer extension for a given load (2)

(e)



$BC = \sqrt{2^2 + 1.5^2} = 2.5m$

Extension $= 2 \times 2.5 - 4 = 1.0m$

$\cos\theta = 1.5/2.5 = 0.6$

$2T\cos\theta = mg \Rightarrow m = 1.2T/g$

$T = EAe/L = \frac{1.2 \times 10^{11} \times (1 \times 10^{-3} \times 10^{-6}) \times 1}{4} = 30N$

$\therefore m = (1.2 \times 30)/9.81 = 3.67kg$ (4)

(f) Water acquires a velocity (Velocity of efflux) as it moves out. It has a forward momentum, so the tank should acquire an equal and backward momentum in the same time hence the backward force (3) in this margin

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Qn 2

2 a i, Dimensions of a physical quantity is the way the quantity is related to the fundamental quantities of mass, length and time. 01

ii, $[V^2] = (LT^{-1})^2 = L^2T^{-2}$

$[\lambda g] = L \cdot LT^{-2} = L^2T^{-2}$

$\frac{[\gamma]}{[\lambda \rho]} = \frac{MT^{-2}}{L \cdot ML^{-3}} = L^2T^{-2}$ 03

(b) i, $S_1 = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2}\times 2 \times 5^2 = 25m$

$V = u + at = 0 + 2\times 5 = 10\ ms^{-1}$

$S_2 = Vt = 10\times 10 = 100m$

Total distance $= S_1 + S_2 = 25 + 100 = 125m$ 04

ii $\langle F\rangle = m\langle a\rangle = m\frac{(V-u)}{t} = 10\frac{(10-0)}{15}$

$= 6.67N$ 03

(c) *Every body continues in its state of rest or uniform motion in a straight line unless acted upon by an external force.

e.g. - A person in a car jerks forwards when the car suddenly stops. 02

- A body at rest continues to be at rest if no force is applied.

*The rate of change of momentum

Qn 2 CONT.

is directly proportional to the applied force and takes place in the direction of the force. e.g. water jet falling on the ground eventually digs a hole. 02

* Action and reaction are equal but opposite
e.g. a book placed on top of a table keeps on top of it. (any two)

(b) i, When two or more bodies collide, their total linear momentum is conserved provided no external force act on them. 01

ii, $m_1u_1 = m_1v_1 + m_2v_2$

$u_1 = v_1 + \alpha v_2$

$v_2 = \frac{u_1 - v_1}{\alpha}$

$\frac{1}{2}mu_1^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$

$u_1^2 = v_1^2 + \alpha v_2^2$

$v_2^2 = \frac{u_1^2 - v_1^2}{\alpha}$

$\therefore \left(\frac{u_1 - v_1}{\alpha}\right)^2 = \frac{u_1^2 - v_1^2}{\alpha}$ 04

$u_1 - v_1 = \alpha(u_1 + v_1)$

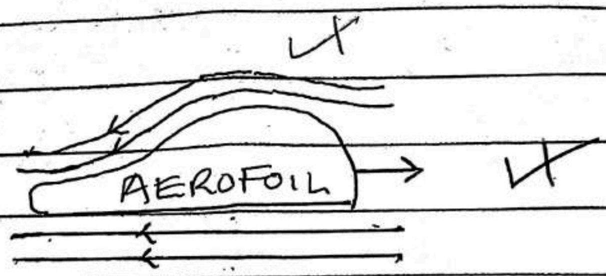
$u_1(1-\alpha) = v_1(1+\alpha)$

$\therefore u_1 = \frac{(1+\alpha)}{(1-\alpha)}v_1$

Donald

(3) **(a)** (i) It states:- For a non-viscous, incompressible fluid undergoing 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)



From the diagram above air layers on top move at a high velocity hence a low pressure being exerted, then air layers below move at a low velocity hence a high pressure is being exerted. The pressure difference causes a lift. (3)

(b)(i) $P_1 - P_2 = \frac{1}{2}\rho(V_2^2 - V_1^2) = \frac{1}{2} \times 1.2(135^2 - 120^2)$ (2)

$= \underline{\underline{2.295 \times 10^3}}\ Nm^{-2}$

(ii) Lift force $= (P_1 - P_2)\,Area = 2.295 \times 10^3 \times 28$ (2)

$= \underline{\underline{6.426 \times 10^4}}\ N$

(c)(i) It is a type of fluid flow during which fluid particles at equal distance from the axis of flow move with the same velocity parallel to the axis of flow. (2)

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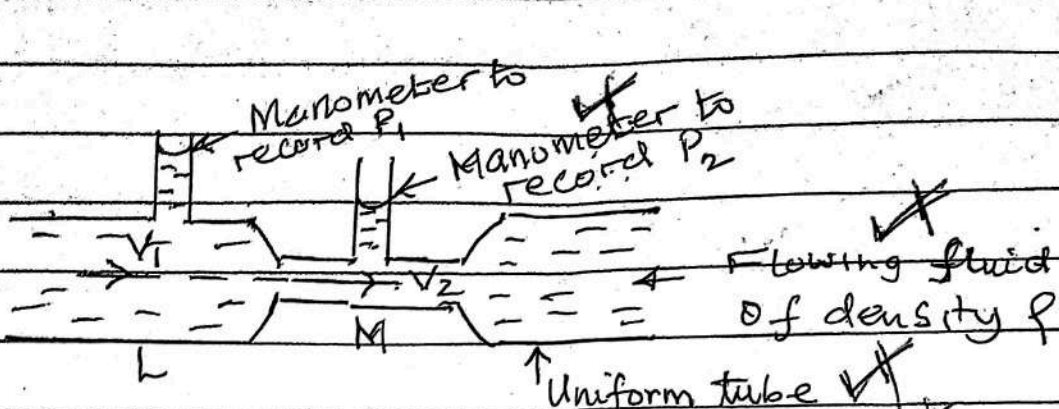
(ii)



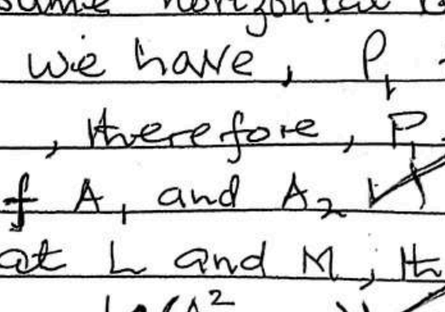
$(1\frac{1}{2})$

From the diagram above, if P_1 and P_2 are the pressures and V_1, V_2 are the velocities of the fluid at L and M on the same horizontal level, then from Bernoulli's equation we have, $P_1 + \frac{1}{2}\rho V_1^2 = P_2 + \frac{1}{2}\rho V_2^2$, since $h_1 = h_2$, therefore, $P_1 - P_2 = \frac{1}{2}\rho(V_2^2 - V_1^2)$

Now if A_1 and A_2 are the cross-sectional areas at L and M, then $A_1V_1 = A_2V_2$, hence $P_1 - P_2 = \frac{1}{2}\rho\left(\frac{A_1^2}{A_2^2} - 1\right)V_1^2$, V_1 can be got from the expression above. $(3\frac{1}{2})$

OR → Treat the Pitot-static tube.

(d)



At A, P_1 = Atmospheric pressure

$h_1 = 200$ cm, $V_1 = 0$

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At B, P_2 = Pressure at which the liquid emerges out, $h_2 = 10cm$, $V_2 = V$.

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

$(h_1 - h_2)\rho g = \frac{1}{2}\rho V^2 \Rightarrow V = \sqrt{2hg}$ (3)

$V = \sqrt{2 \times 190 \times 10^{-2} \times 9.81} = \underline{\underline{6.1\ ms^{-1}}}$

(ii) Cross-sectional area $= \pi r^2 = 3.14 \times (2.5 \times 10^{-3})^2$

$= \underline{1.96 \times 10^{-5}\ m^2}$

Rate of ~~mass~~ flow (Volume per second) $= AV$

$= 1.96 \times 10^{-5} \times 6.1$

$= \underline{1.19 \times 10^{-5}\ m^3 s^{-1}}$

Rate of mass flow (Mass per Second) $= D \times V$ (2)

$= 1000 \times 1.19 \times 10^{-5}$

$= \underline{\underline{0.119\ Kg s^{-1}}}$

20

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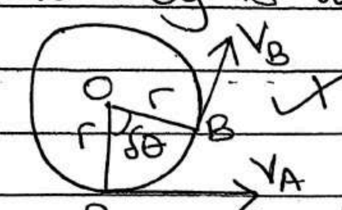
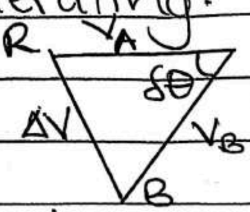
Q4

4(a)(i) Is the rate of change of angle for a body moving in a circular path. 1

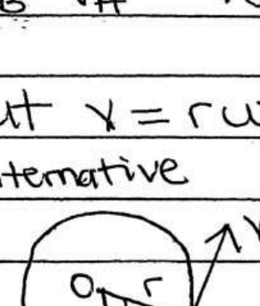
(ii) A body moving in a circular path with constant speed has a varying velocity due to continous change in direction. Therefore the body is accelerating. 3

(iii)   4

velocity change from A to B is $v_B - v_A$, for a small angle $\delta\theta$, chord AB = arc AB ⇒ change in velocity $v_B - v_A = v\delta\theta$, $a = BR = \frac{v\delta\theta}{\delta t} = v\omega$

but $v = r\omega$ ⇒ $a = v^2/r$

Alternative



Accn along AB $= \lim_{\delta t \to 0} \frac{v\cos\delta\theta - v}{\delta t} = \frac{v(\cos\delta\theta - 1)}{\delta t}$

as $\delta\theta \to 0$, $\cos\delta\theta - 1 \to 0$

accn along AB = 0

accn along AO $= \lim_{\delta t \to 0} \frac{v\sin\delta\theta - 0}{\delta t}$, as $\delta\theta \to 0$,

$\sin\delta\theta \to \delta\theta$ ⇒ accn along AO $= v\delta\theta/\delta t = v\omega$

but $v = r\omega$ ⇒ $a = \frac{v^2}{r}$

(b) (i) Is the motion of a body that moves freely under gravity after being given an initial velocity. 1

(ii) Is the angle the direction of projection makes with the horizontal. (Accept angle btn vel of projection and horizontal) 1

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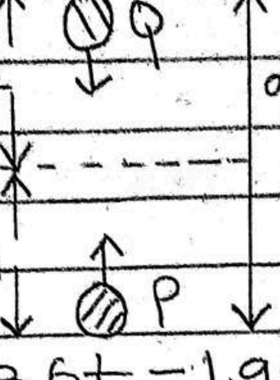
(c) (i)



$S = ut + \frac{1}{2}at^2$ ✓

$S_1 = 36t - \frac{1}{2} \times 9.81t^2$ ✓

$S_2 = 0 + \frac{1}{2} \times 9.81(t-2)^2$ ✓

but $S_1 + S_2 = 90$ ✓

$36t - \frac{1}{2}\times 9.81t^2 + 0 + \frac{1}{2}\times 9.81(t-2)^2 = 90$ ✓

$36t - 4.905t^2 + 4.905t^2 - 19.2t + 19.62 = 90$

$16.38t = 70.38$ ✓

$t = 4.2967s$ ✓ Accept 4.3s

7

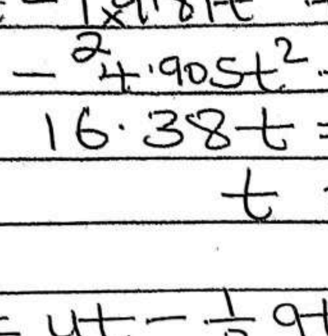
(ii) $S_1 = ut - \frac{1}{2}gt^2$ ✓

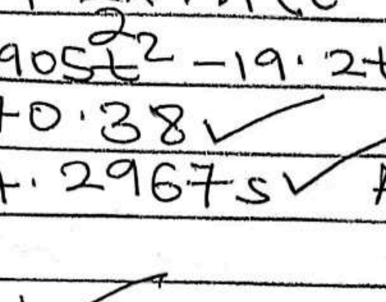
$S_1 = 36 \times 4.3 - \frac{1}{2} \times 9.81 \times 4.3^2$ ✓

$S_1 = 64.11\ m$ ✓

3

4 (a)(iii)





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arc $XZ = v\delta\theta$

$D = S \times T$

$\delta v = v\delta\theta$

arc $AB = v\delta t$

$\delta\theta = \frac{\delta v}{v}$

$AB = r\delta\theta$ (in radians)

$r\delta\theta = v\delta t$

$\frac{\delta v}{v} = \frac{v\delta t}{r}$

$\delta\theta = \frac{v\delta t}{r}$

$\frac{\delta v}{\delta t} = \frac{v^2}{r}$

$a = \frac{v^2}{r}$ ✓

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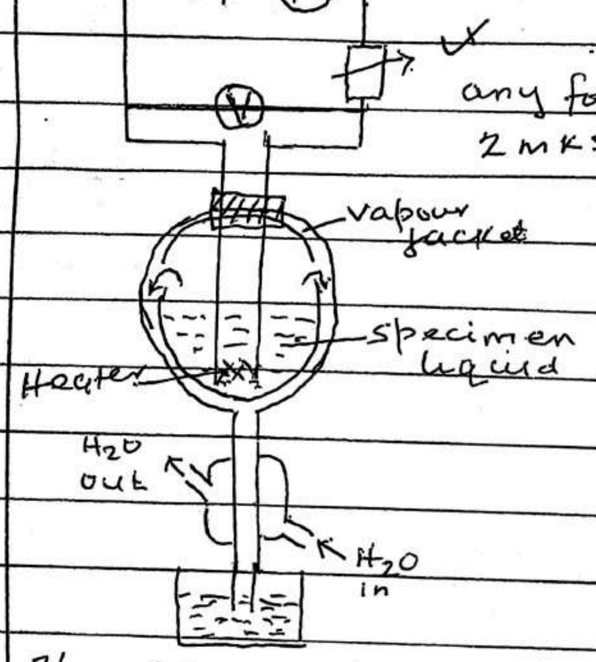
5(a)(i) Specific heat Capacity of a Substance is the amount of heat required to change the temperature of 1Kg mass of a Substance by 1K or 1°c ✓ (1)

(ii) Specific latent of vaporisation is the amount of heat required to change the State of 1Kg mass of of a liquid to vapour at Constant temperature ✓ (1)

(b)



any four 2mks

Power is Switched on and the liqui is heated until it boils ✓. A stop clock is started and mass m_1 ✓ Collected in a time is noted. The ammeter reading I_1 ✓ and voltmeter V_1 ✓ are recorded. At Steady state (7)

$I_1 V_1 t = m_1 L_v + H$ ----(1)

The Rheostat is adjusted to obtain new ammeter reading I_2 ✓ and Voltmeter reading V_2 ✓ and mass m_2 ✓ Collected in a time t

$I_2 V_2 t = m_2 L_v + H$ ----(2)

$L_v = \frac{(I_2 V_2 - I_1 V_1)}{m_2 - m_1}$ ✓

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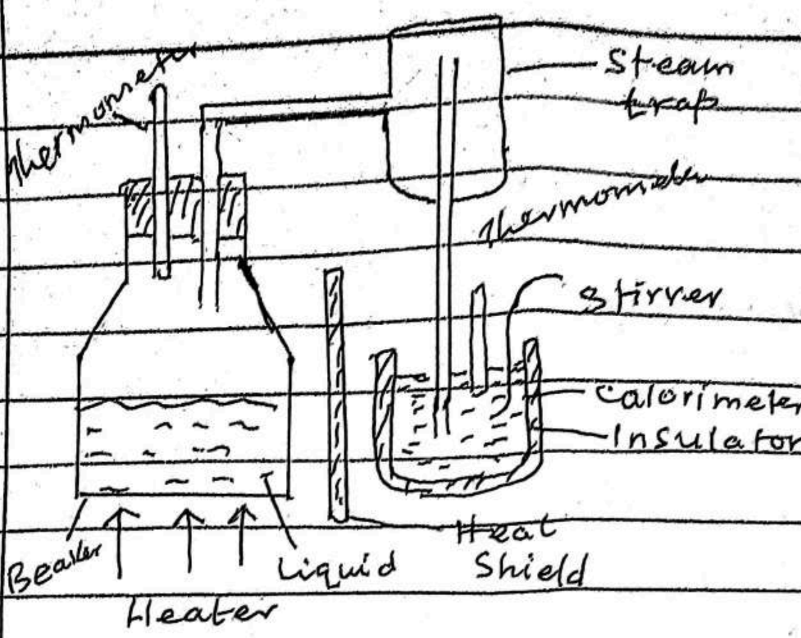

The mass m_1 of the Liquid in the calorimeter of mass M_c is noted. And their initial temp θ_1 is noted. The s.H.c C_L of liquid and C_c of calorimeter are recorded. Liquid in the beaker is heated until it boils and its boiling point θ_3 is noted. Steam through a steam is passed through the liquid in the calorimeter and content stirred until there is a measurable temp rise, the steam is removed and the final temp θ_2 of the mixture is noted. The mass m of the condensed steam is obtained (7)

$$\therefore mL + mc_L(\theta_3 - \theta_2) = m_1 C_L(\theta_2 - \theta_1) + M_c C_c(\theta_2 - \theta_1)$$

$$L = \frac{(m_1 c_L + M_c C_c)(\theta_2 - \theta_1) - mc_L(\theta_3 - \theta_2)}{m}$$

(c) $IV = mc(\theta_2 - \theta_1) + h$

$2.3 \times 3.3 = \frac{0.02}{60} \times 4200(17.4 - 15.2) + h$, $h = 4.51\,Js^{-1}$

$2.7 \times 3.9 = \frac{0.07}{60} C(17.4 - 15.2) + 4.51$, $C = 2345.5\,Jkg^{-1}K^{-1}$ (5)

(d)(i) When pressure increases, the boiling point is raised. Because boiling occurs when s.v.p = external pressure. As temp increases s.v.p increases. (3)

(ii) Increase in pressure lowers melting point, because during melting pressure weakens the intermolecular forces. Making it easier for melting to occur (3)

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QUESTION 6

a i) Is the quantity of heat required to raise the temperature of one mole of gas by 1K at constant pressure. 1

ii) Is the quantity of heat required to raise the temperature of one mole of gas by 1K at constant volume. 1

b From First law of thermodynamics;

$\Delta Q = \Delta U + \Delta W$

At constant volume, $\Delta Q = nC_v\Delta T$, $\Delta W = 0$

At constant pressure, $\Delta Q = nC_P\Delta T$; $\Delta W = P\Delta V$

$\Rightarrow nC_P\Delta T = nC_v\Delta T + P\Delta V$

For ideal gas; $PV = nRT$ & $P(V+\Delta V) = nR(T+\Delta T)$ 5

$\Rightarrow P\Delta V = nR\Delta T$

$nC_P\Delta T = nC_v\Delta T + nR\Delta T$

$C_P = C_v + R\Delta T$

$\therefore C_P - C_v = R$

c i) Adiabatic expansion is the expansion of a gas in which no heat enters or leaves the system. Isothermal expansion is the expansion of a gas at constant temperature. 2

ii) Passage of sound waves through air

Rapid escape of air from a burst tyre 01

d $C_P - C_v = R$; $C_v = 28.6 - 8.31 = 20.3$

$\gamma = \frac{C_P}{C_v} = \frac{28.6}{20.3} = 1.41$

$TV^{\gamma-1} = \text{a Constant}$. $288(400)^{1.41-1} = 273V_2^{1.41-1}$

$V_2 = 455.74\,cm^3$

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QN 8 CONT'D

$P_2 V_1 = P_1 V_3$; $P_1 V_1^{\gamma} = P_2 V_2^{\gamma}$

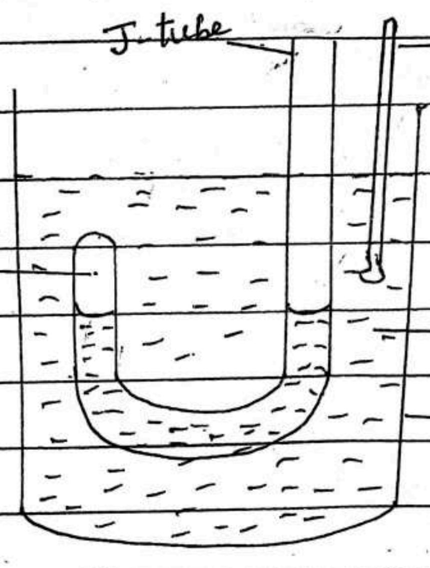
$V_2 = \frac{P_1}{P_2} \cdot V_3$; $\frac{P_1}{P_2} = \left(\frac{V_2}{V_1}\right)^{\gamma}$

$V_2 = \left(\frac{V_2}{V_1}\right)^{\gamma} \cdot V_3 \Rightarrow 455.74 = \left(\frac{455.74}{400}\right)^{1.41} \cdot V_3$ 5

$\therefore V_3 = 379.2 cm^3$

e i) Is the pressure exerted by a vapour which is in dynamic equilibrium with its own liquid. 1

ii)



A J-tube with air trapped in the closed limb is placed in a water bath in a beaker. Water in beaker is heated until it starts boiling. The water levels in the J-tube are observed to be the same. This shows that the pressure of the trapped vapour is equal to the atmospheric pressure.

Can be given on diagram

Starts boiling

Same

4

TOTAL: 20

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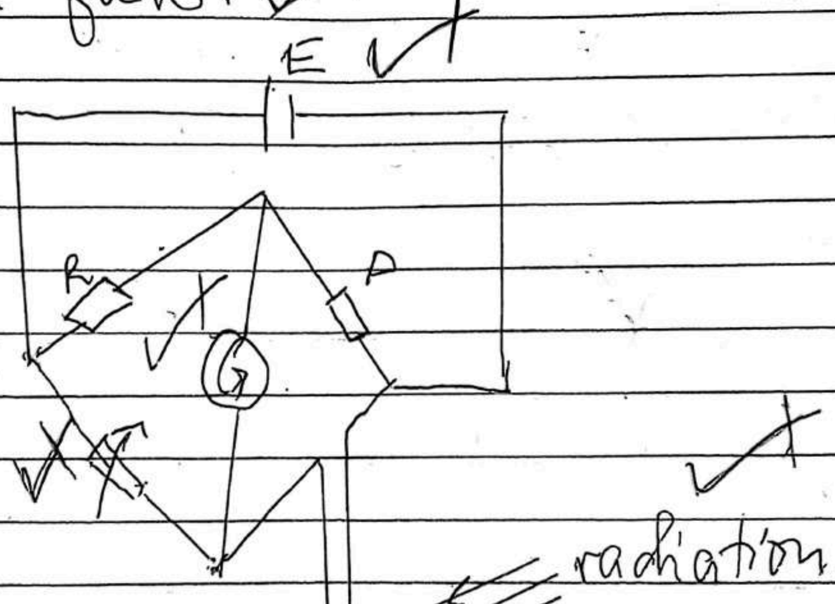
1. a)(i) Temperature gradient is change in temperature per unit length. ✓ (01)

(ii) Thermal conductivity is rate of flow of heat per unit cross-sectional area per unit temperature gradient. ✓ (01)

b) The sample is made thin in order to have measurable temperature gradient ✓ and to reduce heat loss through the sides. ✓ It has a fairly large cross-sectional area in order to have adequate rate of heat flow. ✓ (03)

c) 

(02)

R and P ✓

any 4 @ $\frac{1}{2}$

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The rheostat is adjusted until the galvanometer shows no deflection. When radiations fall on the strip, they are absorbed and its temperature rises leading to an increase in resistance. The galvanometer deflects showing the presence of radiation. (04)

d) $P_b = 4\pi r_b^3 \sigma (T_b^4 - T_s^4)$

$I \times \pi r_m^2 = 4\pi r_b^3 \sigma (T_b^4 - T_s^4)$

$T_b = 1870 + 273 = 2143$

$T_s = 30 + 273 = 303$

$1400\pi (30 \times 10^{-2})^2 = 4\pi r_b^3 \times 5.67 \times 10^{-8} (2143^4 - 303^4)$

$\therefore r_b = 5.1 \times 10^{-3}$ m

diameter $= 2r_b = 2(5.1 \times 10^{-3}) = 0.01$m 06

e) radiant energy can be; reflected, refracted, diffracted, any 3 stephen the chafe

When absorbed by matter, causes an increase in temperature.

8 6 Page

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Q8

8(a) Travel in a straight line.

Cause certain substances to fluorscene 2

Deflected by electric and magnetic fields

Produce x-rays when they strike matter

Carry a negative charge

(b) $x = ut$

$y = 0 + \frac{1}{2}at^2$ but $a = \frac{eE}{m}$ 5

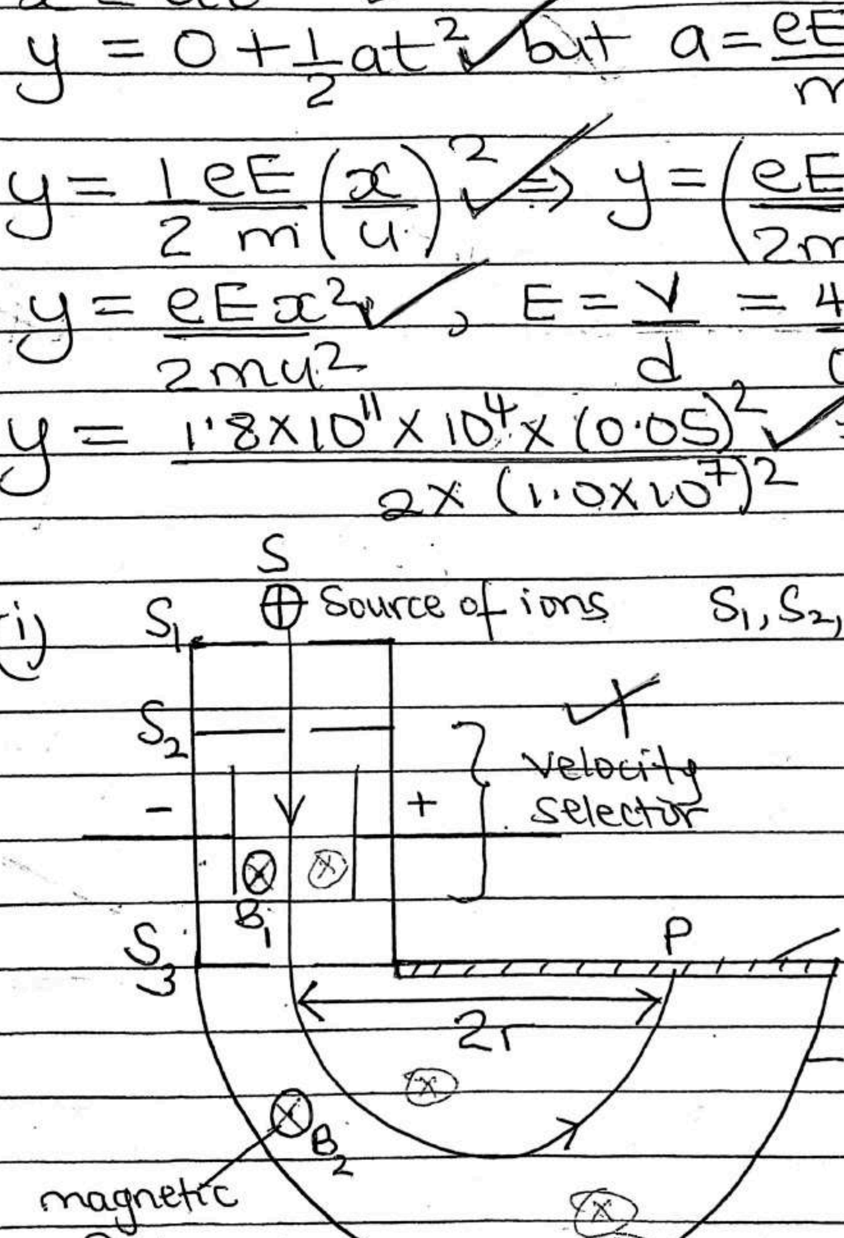
$y = \frac{1}{2}\frac{eE}{m}\left(\frac{x}{u}\right)^2 \Rightarrow y = \left(\frac{eE}{2mu^2}\right)x^2$

(C) $y = \frac{eEx^2}{2mu^2}$, $E = \frac{V}{d} = \frac{400}{0.04} = 10^4 Vm^{-1}$

$y = \frac{1.8\times10^{11}\times10^4\times(0.05)^2}{2\times(1.0\times10^7)^2} = 2.25\times10^{-2}m$ 4

$2.20\times10^{-2}m$

(d) (i)



(any 4, ½@)

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Q8

8(d)(i) Ions from source S are directed through slits S_1 and S_2 into the velocity selector having electric field of intensity E and magnetic ~~field of intensity E and magnetic~~ field of flux density B_1. Only ions of charge Q pass through slit S_3 undeflected with a velocity V given by $V = \frac{E}{B_1}$ The ions enter the deflection chamber having a uniform magnetic field of flux density B_2. The ions move along a circular path of radius r and strike the photographic plate at point P. The centripetal force is provided by the magnetic field ie $B_2QV = \frac{mv^2}{r}$

$\frac{Q}{m} = \frac{V}{B_2 r} \Rightarrow \frac{Q}{m} = \frac{E}{B_1 B_2 r}$

E
B_1
V
B_2
circular path r
6
P
$B_2QV = \frac{mv^2}{r}$
$\frac{Q}{m}$

(ii) Abundant isotopes carry more energy. On striking the photographic plate more photographic emulsions evapourate. The corresponding line (point) appears sharper 3

20

8(c) $a = \frac{eV}{md} = \frac{1.8\times10^{11}\times400}{4\times10^{-2}} = 1.8\times10^{15}$

$x = ut$; $t = 5.0\times10^{-9}$

$y = \frac{1}{2}at^2 = \frac{1}{2}\times1.8\times10^{15}\times(5.0\times10^{-9})^2 = 0.02225\,m$

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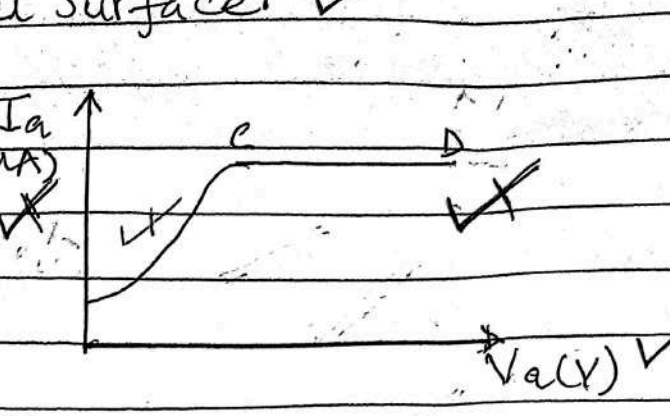
(9) (a) It is the emission of electrons by a heated metal surface. (1)

(b)(i)

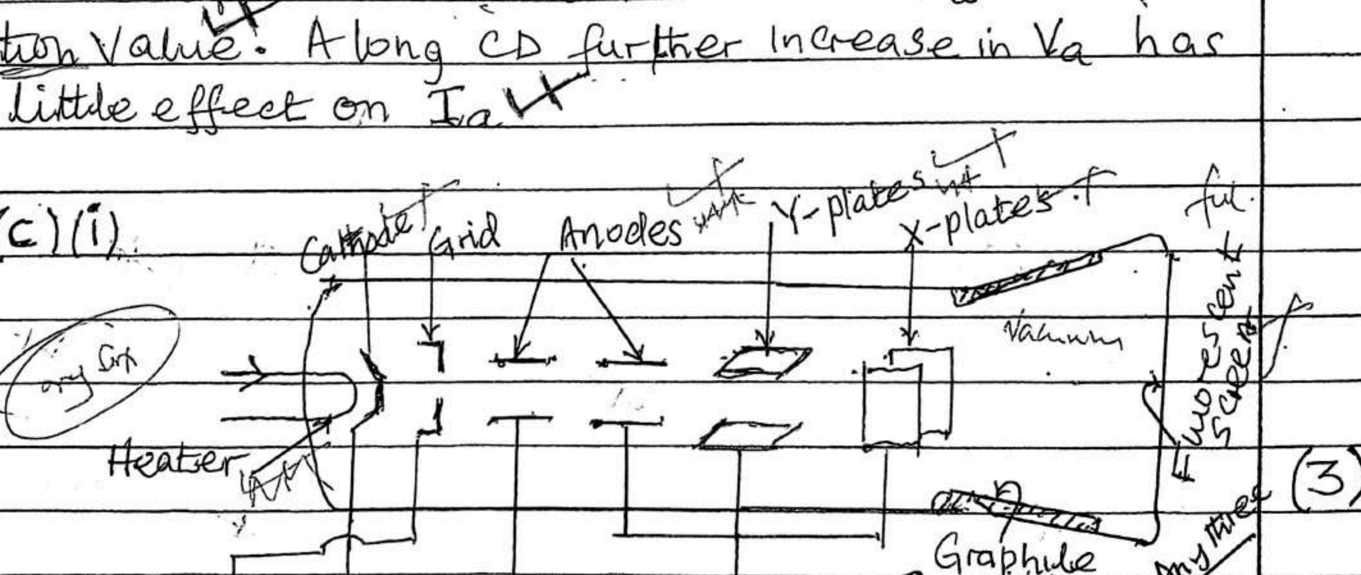


without units give (2)

(ii) When Va is small the electrons emitted by the filament crowd round it and form a space charge, since their emission speeds are small. A very small anode current Ia passes at this stage due to the few electrons that are emitted with sufficient speeds to reach the anode. When Va is increased more of the electrons reach the anode and Ia rises. And when Va is sufficiently large all the electrons emitted per second reach the anode and I_a has its saturation value. Along CD further increase in Va has little effect on Ia (5)

all electrons

(c)(i)



Any three (3)

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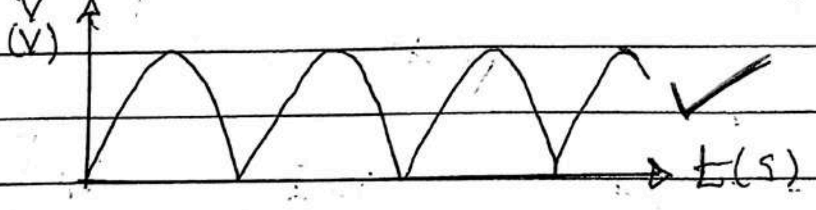
The Cathode is heated by the heater and it emits electrons thermionically. Then the grid controls the number of electrons striking the screen per second or the brightness on the screen. The anodes accelerates and focuses the electrons into a fine beam. Then the Y-plates deflect the electron beam vertically and the X-plates deflect the beam horizontally. The screen displays the formation of the trace (It glows). (3)

(ii) The time base circuit applies a saw-tooth voltage to the X-plates that causes (sweeps) the spot to travel a cross the screen from left to right at a steady speed. And the spot is made to returns to left rapidly as it falls to zero. If a voltage is now applied to the Y-plates, the variation of the voltage with time is now displayed on the screen. (2)

(d)



(1)

An alternating p.d appears across AB. In a half cycle when A is positive relative to B only diode X conducts and current flows along AXRC. Then during the other half cycle when now B is positive relative to A only diode Y conducts and the current flows along BYRC. Where by the current flows in the same direction in both half cycles as shown in the diagram above. (3)

20

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QUESTION 10

a Photoelectric emission is instantaneous ✓

For every metal surface, there is a minimum frequency below which no electrons are emitted. ✓ 2 ~~Any 2~~

Kinetic energy of the photoelectrons ranges from zero upto a maximum and the maximum K.E is directly proportional to the frequency of the incident radiation.

Photocurrent is directly proportional to the intensity of incident radiation

bi) Readily available ✓

Virtually inexhaustable supply of fuel ✓

None of the toxic and highly radioactive wastes are associated with fusion ✓ 3

~~Gives a greater energy yield per kg of fuel used~~

ii) High temperatures are needed to provide the nuclei with energy needed to overcome the repulsion forces between the protons of the atoms. ✓ 01

c Number of neutrons = 227 − 87 = 140 ✓

Mass of 87 protons = 87×1.0073 ✓ = 87.6351 ✓

Mass of 140 neutrons = 140×1.0087 ✓ = 141.218 ✓

Total mass of nucleons = 87.6351 + 141.218 5

= 228.8531 ✓

Difference in mass = 228.8531 − 223.0198 ✓

= 5.8333 u ✓

ii) The total mass of all the nucleons is greater than the mass of the nucleus. ✓ The difference in mass is the measure of the binding energy of the nucleus. ✓ 2

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QN 10 CONT'D

di) Locate bone fractures, Kill cancer cells Any 3
check for cracks and flaws in metals, study of crystal 3
structure, security checks at air port.

ii) Light of frequency, f has particles called photons each of energy, $E = hf$. When light falls on a metal surface each photon interacts with only one electron giving it all or none of its energy. If the energy is equal to or greater than the work function, the photon is absorbed and an electron is emitted without a time lag. This explains the instantaneous nature of the photoelectric emission.

If the energy of the photon is less than the work function, all of it is rejected and no emission of electrons occurs. This accounts for the existence of the threshold frequency, f_0.

Increase in intensity of the incident radiation increases the number of photons and more electrons are emitted per second. This photocurrent is proportional to the intensity. 4

Increase in frequency of incident radiation increases the energy of the photons therefore the photoelectrons have greater maximum K.E. This explains the fact that frequency of the incident radiation is directly proportional to the maximum K.E of the photoelectrons.

TOTAL: 20