SOLUTIONS TO UACE PHYSICS SEMINAR HELD AT SEETA HIGH SCHOOL – MUKONO ON SATURDAY 28TH SEPTEMBER 2024

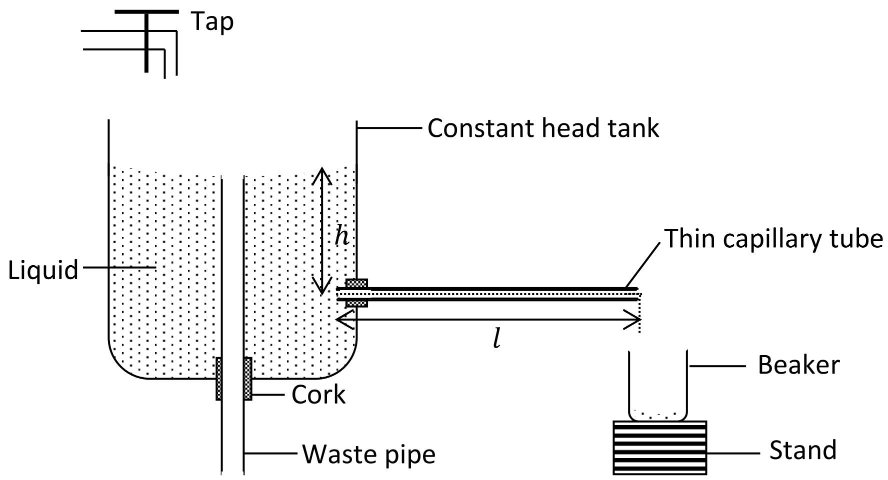
1. (a) (i) Density is mass per unit volume of a substance.
Relative density is the ratio of mass of substance to mass of an equal volume of water.

(ii) - The radius or diameter of the pipeline.

- Length of pipeline or pressure difference (pressure gradient).

- Coefficient of Viscosity of the liquid or nature of the liquid.

(b)



- ✓ A constant head tap is set to given rate of liquid flow.
- ✓ The height, *h*, is measured and recorded, the tap is opened and the liquid under test flows at a constant rate.
- ✓ The liquid is collected for a flow time, *t*, and its volume, *V*, obtained.
- ✓ The length, *l*, and internal diameter are measured and recorded and radius, *r*, of the capillary tube is calculated.
- ✓ Density, ρ, of the liquid is noted.
- ✓ Experiment is repeated for different values of *h*, values are tabulated including $\frac{V}{t}$.
- ✓ A graph of $\frac{V}{t}$ against h plotted and its slope, *S*, calculated.
- ✓ Thus $\eta = \frac{\pi r^4 \rho g}{8Sl}$ is obtainable where *g* is acceleration due to gravity

(c)

$$P_1 = \rho g h = 1005 \text{ x } 9.81 \text{ x } 0.95 = 9366.0975 \, Pa$$

$$P_2 = \rho_m g h = 13600 \text{ x } 9.81 \text{ x } 0.020 = 2668.32 \text{ Pa}$$

$$\Delta \text{P} = 9366.0975 - 2668.32 = 6697.775\text{Pa}$$

$$\frac{V}{t} = \frac{\pi r^4 \Delta \text{P}}{8\eta l} = \frac{\pi[(0.225\text{x}10^{-3})^4 \text{ x } 6697.775]}{(8 \text{ x } 4.0 \text{ x } 10^{-3} \text{ x } 3 \text{ x } 10^{-2})}$$

$$V = 5.617 \text{ x } 10^{-8} \text{ x } 60 = 3.37 \text{ x } 10^{-6} \, m^3$$

(d) (i) For an incompressible, non-viscous fluid undergoing laminar flow, the sum of pressure and potential energy per unit volume and kinetic energy per unit volume is a constant.

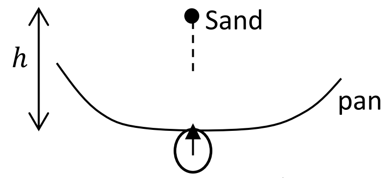
(ii) The curved shape of the aerofoil creates a fast flow of air over its upper surface than the lower surface.
- From Bernoulli's principle the pressure of air below is greater than that above and this produces a lift on the aerofoil.

2. (a) (i) States that for a system of colliding bodies their total momentum is conserved provided no external force acts on the system.

(ii) States that energy is neither created nor destroyed but it changes from one form to another.

(b) (i) Impulse is the product of force and time for which it acts. Unit $kgms^{-1}$ or Ns.

(ii)



Mass of sand pouring on a pan, $m = 11.5 \text{ x } 18.0 = 207$ g

$$F = \frac{m(v-u)}{t}$$

But from Potential energy lost=Kinetic energy gained,

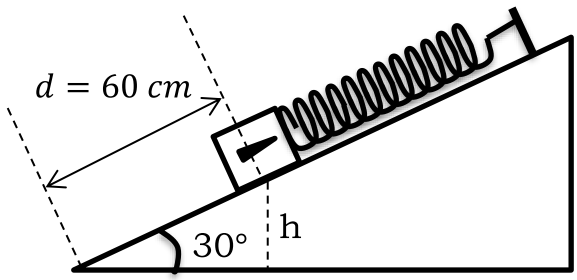
$mgh = \frac{1}{2}mV^2$, $V = \sqrt{2x0.375x9.81}$ $\quad$ $V = \sqrt{7.3575} = 2.7124\text{m}s^{-1}$

Hence, the net force $F = \frac{207}{1000}x9.81 + \frac{207}{1000}(\frac{2.7124-0}{18}) = 2.0619\ N$

(c) - Elastic materials are the ones which can regain their original shape and size after a deforming force has been removed from them. E.g Rubber band, spring.
- Plastic materials are the ones which have a tendency of remaining permanently stretched on removal of the applied force from them. E.g plasticine, mud.

(d) (i) K.E of the bullet $\longrightarrow$ K.E of the system $\longrightarrow$ gravitational P.E of the system + work done against friction + energy stored in the compressed spring + sound +heat.

(ii)



K.E lost = P.E gained + work done against friction + work done in compressing the spring.

$\frac{1}{2}\text{m}V^2 = \text{mgh} + \text{Fxd} + \frac{1}{2}\text{K}d^2$, but $h = d\ sin\ 30$

$$\frac{1}{2}0.9V^2 = 0.9x9.81x0.6sin30 + (0.32x0.6x0.9x9.81\ cos\ 30) + \frac{1}{2}x100x(0.6)^2$$

$$\text{V} = 49.6479\ \text{m}s^{-1}$$

(iii) - The force from the compressed spring, together with a component of gravity along the plane act to pull the block downwards.

- The frictional force opposes the two forces but is small, the block therefore moves downwards until it reaches the initial position.

(e) (i) Angular velocity is the rate of change of angular displacement.

OR: Is the angle swept per second by a body moving in a circular path.

- Centripetal force is the one which keeps the body moving around a circular path and is directed toward the centre of the path.

- Centrifugal force is the one which keeps the body moving round a circular path and is directed away from its centre.

(ii) - When the tube is rotated at constant speed in a horizontal circle about the vertical axis, the pressure at the closed end will be greater than that at the open end.

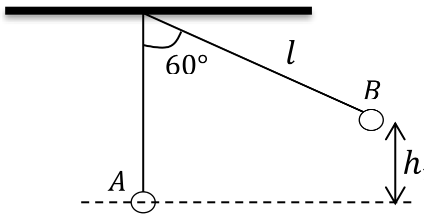
- A force due to pressure difference provides the centripetal force which makes matter of small density to move towards the centre of rotation while that of higher density to move to the closed end.

- When the rotation is stopped and the tube put vertical, less dense matter will be on top and can be separated from the dense matter.

3. (a) (i) Inertia is the tendency of a body to maintain its stable state of rest or of uniform motion in a straight line unless acted upon by some net external force.

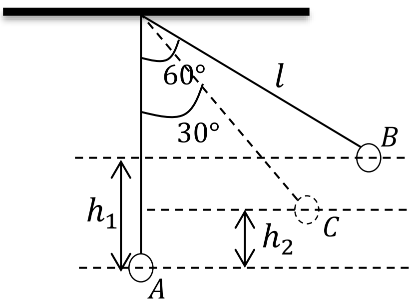
(ii) Work-energy theorem states that the work done by the resultant force on the body is equal to the change in its kinetic energy.

(b)



(i) $P.E_{max} = mgh_{max} = 0.2x9.81x0.5(1 - \cos 60) = 0.4905\text{J}$

(ii)



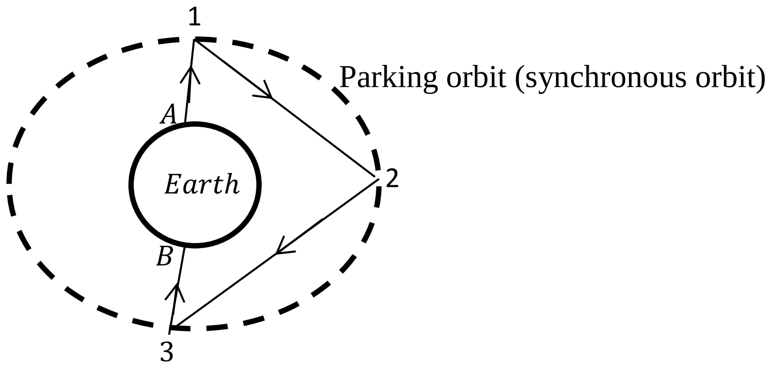
$h_1 = 0.5(1 - \cos 60)$
$h_2 = 0.5(1 - \cos 30)$

$P.E \text{ lost} = \text{mg}(h_1 - h_2) = 0.5x0.2x9.81(0.866 - 0.5) = 0.359\text{J}$

(c) (i) Gravitation constant is the force of attraction between any two **particles** of matter in the universe each of mass 1kg placed at a distance of 1m apart.

(ii) Escape velocity-is the minimum vertical velocity with which a body must be projected so as to enable it to just overcome the gravitational pull of a planet.

(d) (i)



- A set of three or more satellites are launched in a parking orbit as shown above.

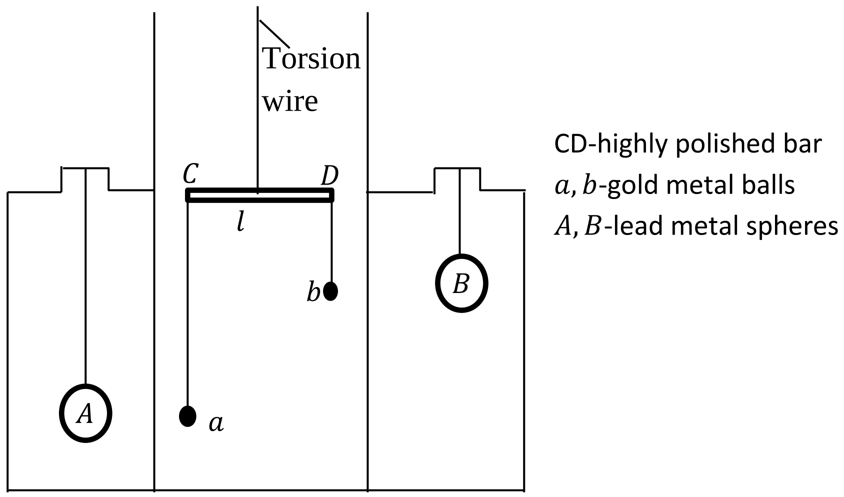
- A television signal from station A is transmitted to geosynchronous satellite 1.

- From 1 its re-transmitted to 2 to 3 and then to the observer B finally.

(ii) - Escape velocity is proportional to the mass of the planet, the moon has a small mass, so its escape velocity is very small.

- So, the atmospheric air molecules at the surface temperature of the moon is greater than the escape velocity, the air molecules escape leaving the moon with no atmosphere.

(e)



- (a,b) are gold metal balls while (A,B) are lead metal balls

- Two identical small gold spheres, (a,b) each of mass m is suspended from a highly polished bar CD of length, l, using long and short quartz strings.

- Two identical big lead spheres, (A,B) each of mass M are suspended in positions of a and b respectively.

- Due to attraction, a moves towards A and b moves towards B, this causes the bar CD to twist.

- Angle of twist **θ** is measured using lamp scale method and noted.

- If d is the measured distance between the large and small sphere, then

Moment of a couple=C **θ**, where C- torsional constant and the gravitational constant G will be obtain using the expression. $\frac{GMml}{d^2} = C\,\theta$.

4. (a) (i) Surface tension is the tangential force per unit length acting normally on an imaginary line drawn on the liquid surface.

- Free surface energy is the work done to enlarge the liquid surface by $1m^2$ under isothermal conditions.

(ii) - The dirt is held on a cloth by adhesive forces between the molecules of a cloth and dirt molecules.

- Without soap the adhesive forces between the cloth and dirt are stronger than that between the dirt and water molecules hence making it difficult to be removed.

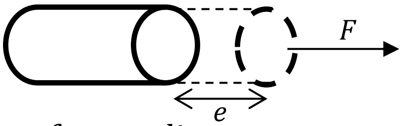
(b) (i) $r = \frac{r_1 r_2}{r_2 - r_1} = \frac{1.5x2.5}{2.5-1.5}$ = 3.75mm = $3.75x10^{-3}$m

(ii) $\Delta P = \frac{4\gamma}{r} = \frac{4(4.0x10^{-2})}{3.75x10^{-3}} = 42.667\text{N}m^{-2}$

(c) (i) -Young's modulus is the ratio of tensile stress to tensile strain.

-Work hardening is the strengthening of a material by repeatedly deforming it such that atomic planes slide over each other and this increases plane dislocations which prevents further sliding of atomic planes.

(ii) Consider a wire of length, *l*, cross-sectional area, *A*, stretched by a force, *F*, through a distance, *e*.



Work done = average force x distance

$$= \left(\frac{0+F}{2}\right)e = \frac{1}{2}\,Fe$$

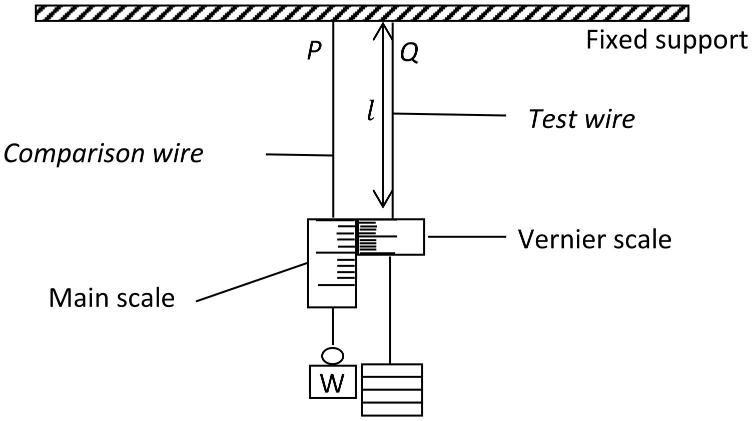
But Volume = Al.

Hence energy stored per unit volume is give1n by,

$$\frac{E}{V} = \frac{1}{2}\frac{F}{A}\frac{e}{l} = \frac{1}{2}(stress)(strain)$$

OR: $$\frac{E}{V} = \frac{1}{2}(Young's\ modulus)(strain)^2$$

(d)



-Two identical long and thin wires P and Q of the same material are suspended from a common rigid support.

-The diameter of the test wire is measured using a micrometer screw gauge at three different positions and its average diameter, *d*, obtained and the cross-section area, $A = \frac{\pi d^2}{4}$, calculated.

-Initial loads are attached to scale pan and to the end of a comparison wire to remove kinks.

-The original length, *l*, of the test wire is noted.

-Known weight, *W*, is placed on the scale pan and the extension, *e*, produced is noted.

-Experiment is repeated with different known weights, *W*, and each time loading and unloading is done to check whether elastic limit is not exceeded.

-Results are entered in a suitable table including values of $\frac{W}{A}$ and $\frac{e}{l}$.

-A graph of $\frac{W}{A}$ against $\frac{e}{l}$ plotted which is a straight line through origin showing that $\frac{W}{A} \alpha \frac{e}{l}$.

(c) (i) $P.E$ lost $=$ energy stored in the spring compressed

$$\text{mgh} = \frac{1}{2}\ \text{k}e_1 \text{ Hence,} \qquad e_1 = \sqrt{(\frac{2x0.02x9.81x2}{100})} = 0.0886\text{m}$$

on sticking on the pan; mg $= \frac{1}{2}\text{k}e_2$

$$e_2 = \frac{0.02x9.81}{100} = 0.001962\text{m}$$

Hence total compression, e $= (e_1 + e_2) = 0.0886 + 0.001962 = 9.06\text{x}10^{-2}$m

on falling

(ii) mgh $= \frac{1}{2}mV^2$ $\quad$ $V = \sqrt{(2x9.81x2)} = 6.264ms^{-1}$

K.E lost by the spring = energy released by stretching the spring

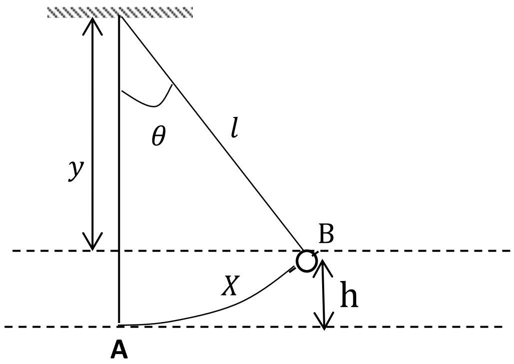
$$\frac{1}{2}(0.02)(6.264^2 - 2^2) = \frac{1}{2}x100e^2, \qquad e = 0.084m$$

5. (a) (i) Simple harmonic motion is a periodic/repetitive motion whose acceleration is directly proportional to the displacement from a fixed point and directed towards a fixed point.

(ii) Period is the time taken for a body to move round a circular path once.

(b) (i) Consider a bob suspended from a rigid support using a thread of length, *l*, and of mass, *m*, being displaced through a small angle, θ and then released.

If X represents displacement,



At A, $K.E = \frac{1}{2}mv^2$; $\quad$ $P.E = 0.$

$$M.E_A = K.E + P.E = \frac{1}{2}mv^2$$

From $X = a\sin\omega t$; $\quad$ $v = \frac{dX}{dt} = \omega a\cos\omega t$

$$M.E_A = \frac{1}{2}m\omega^2a^2cos^2\omega t$$

But $\omega t = 0$, $\quad$ so that $cos^2\omega t = 1$ and

$$M.E_A = \frac{1}{2}m\omega^2a^2, \text{ where } a = amplitude.$$

Thus the principle of conservation of mechanical energy applies to an oscillating bob.

OR: At B, $M.E = K.E + P.E$

$M.E = \frac{1}{2}mv^2 + mgh$

From $\frac{X}{l} = \theta$, in radians and $\cos\theta = \frac{y}{l} = 1 - \frac{1}{2}\theta^2$, when θ is small,

$$y = l(1 - \frac{1}{2}\theta^2)$$

$h = l[1 - (1 - \frac{1}{2}\theta^2)] = \frac{1}{2}l\theta^2 = \frac{1}{2}\frac{X^2}{l}$

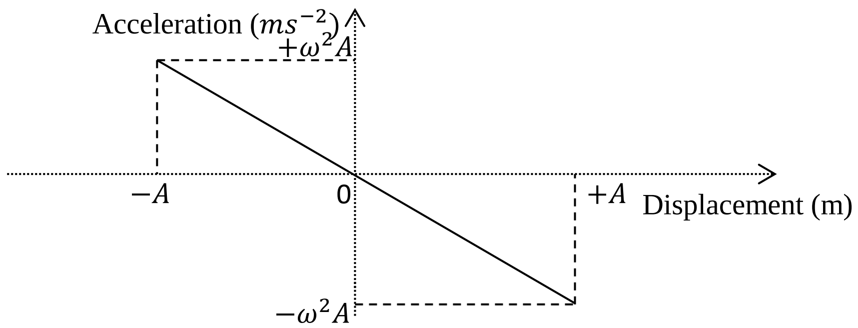
Thus $\frac{1}{2}mg\frac{X^2}{l} + \frac{1}{2}m\omega^2 a^2 cos^2\omega t$

But $\omega^2 = \frac{g}{l}$

Hence $M.E_B = \frac{1}{2}\frac{mg}{l}a^2 sin^2\omega t + \frac{1}{2}\frac{mg}{l}a^2 cos^2\omega t$

$M.E_B = \frac{1}{2}\frac{mg}{l}a^2 = constant.$

(ii)



(c) - A spring is clamped from a retort stand with its pointer besides a metre rule.

- The initial position, P_0, of the pointer is read and recorded.

- A known mass, m, is suspended from the end of the spring and the new position, P_1 of the pointer is noted.

- The mass is slightly displaced and released and is allowed to oscillate.

- The time, *t*, for 20 oscillations and the period, *T*, for one oscillation is determined.

- The experiment is repeated for other known masses.

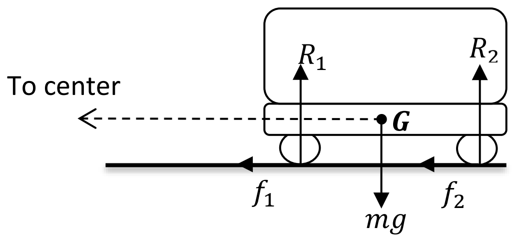
- the results are entered in a suitable table including values of T^2.

- A graph of T^2 against *e* is plotted and the slope, *S*, is calculated.

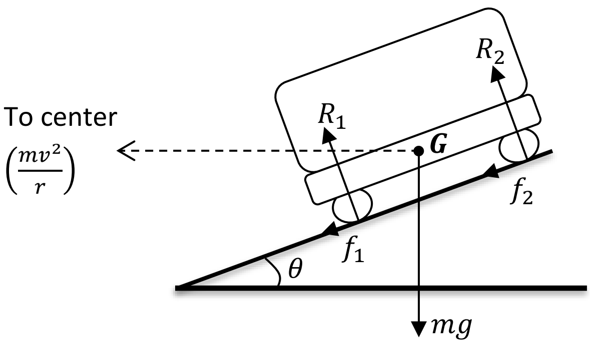
- The acceleration due to gravity, *g*, is then obtained from $S = \frac{4\pi^2}{g}$.

(d) (i) Angular displacement is the ratio of the arc length to the radius for a body moving in a circular path.

(ii)



On a level road, the centripetal force is provided by frictional force, i.e $f_1 + f_2 = \frac{mv^2}{r}$.



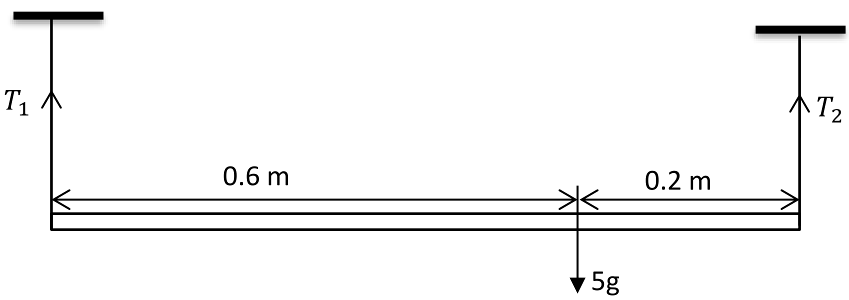
On a banked track, the centripetal force is provided by both the components of the normal reaction and the frictional forces towards the centre of the circular path, i.e

$(R_1 + R_2)sin\theta + (f_1 + f_2)cos\theta = \frac{mv^2}{r}$. This results into a greater speed hence travelling faster.

(e) (i) Stable equilibrium is one in which when a body is displaced slightly, the position of its centre of gravity and potential energy rises such that on removal of the displacing force, the body returns to its original position.

Unstable equilibrium is one in which when a body is displaced slightly, the position of its centre of gravity and potential energy is lowered such that when the displacing force is removed, it does not return to its original position.

(ii)



Resolving vertically, $T_1 + T_2 = 5g$

Taking moments at A, $5g\ X\ 0.6 = T_2\ X\ 0.8$ $T_2 = 36.79N$

$T_1 + T_2 = 5\ X\ 9.81$ $T_1 = 12.26N$

6a) (i) Fixed points are temperatures at which a particular physical event is expected to occur.

Fundamental interval is the difference between the upper fixed point and the lower fixed point of a thermometer.

Triple point of water is a unique temperature and pressure at which pure melting ice, pure water and pure water vapour co-exist in equilibrium.

Thermometric property is a physical property of a substance whose value varies linearly, uniformly and continuously with temperature changes.

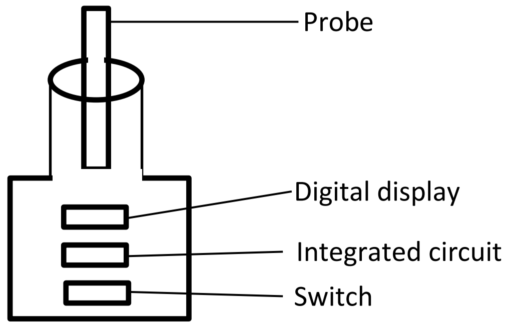
(ii) - It should vary linearly with temperature changes.

- It should vary continuously with temperature change.
- It should be measurable over a wide range using a fairly simple apparatus.
- It should be sensitive to small changes in temperature.

(iii) - The melting point of ice and the boiling point of water are not unique temperatures.

-This is because they change with pressure and the presence of impurities in ice and water.

b)



- The probe is placed in contact with the body whose temperature is required.
- The temperature changes cause a large variation in the electrical resistance of the probe
- The probe is connected to the electrical circuit.
- The circuit receives temperature reading from the probe inform of electrical signal.
- The signals are changed to digits when appears in display.

c) (i) Latent heat is the amount of heat required to change any mass of a substance from one state to another without change in temperature.

Melting point -is the process by which a substance changes at a constant temperature and pressure from solid to liquid state.

(ii) - Cooking by steaming method;

Since water has a higher specific latent heat of vaporization. This property enables steam to be used for cooking when it condenses on the food, latent heat is released directly onto the food which enables the food to be cooked at a faster rate.

- Our bodies feel cool after sweating (temperature regulation)

On a hot day the body sweats, evaporation occurs at the surface of the body, the temperature of the sweat falls to maintain evaporation. Latent heat is constantly drawn from the body and the body cools.

d) (i) $\Delta W = P(V_{stem} - V_W) = 1.01\text{x}\,10^5(\frac{5}{0.58} - \frac{5}{1000}) = 8.7022\text{x}10^5\text{J}$

(ii) $\Delta Q = \Delta U + \Delta W$ But $\Delta U = 5\text{x}\,2.25\text{x}10^5 - 8.7022\text{x}10^5 = 2.593\text{x}10^5\text{J}$

7. (a) (i) Thermal conductivity, K, is the rate of heat flow per unit cross- sectional area per unit temperature gradient.

Temperature gradient, $(\frac{\theta_1-\theta_2}{l})$ is the rate of temperature fall per unit length.

Heat current, $\frac{Q}{t}$, is the rate of heat flow through a substance.

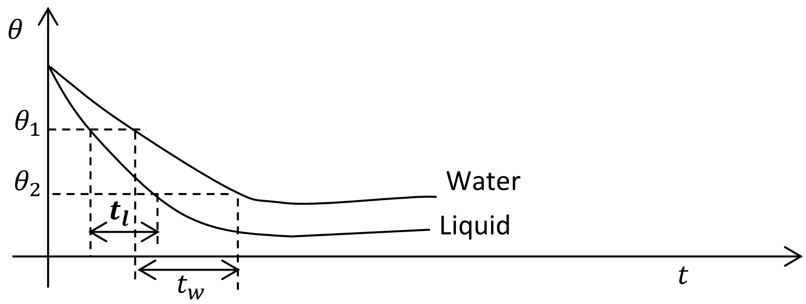
(ii) When one end of a cork is heated the adjacent atoms gain energy and vibrate with increased amplitude and loses its energy to the neighboring atoms which also ends up vibrating with increased amplitude until it reached the cold end.

(iii) When one end of metal is heated the free mobile electrons gain kinetic energy and move with increased speeds along the lattice of the metal as colliding with atoms until heat reaches the cold end. But silk lacks mobile electrons so heat flow is aided only by inter atomic vibrations only whereas in metals by both mobile electrons and inter atomic vibrations.

(b) (i) Specific heat capacity is the amount of heat required to raise the temperature of a 1kg mass of a substance by 1K.

(ii) Watermelon has got a large water content. This results into having a high s.h.c, so requires to absorb larger amount of heat to change the temperature, hence always at lower temperature.

(c) - An empty calorimeter is weighed and its mass, m_c noted.
- It is then filled with water initially at about 80°C and is then allowed to cool under standard conditions.
- Its temperature, θ is then recorded every after a suitable time, t.
- A graph of θ against t is plotted
- Then calorimeter and water are weighed to find the mass of water,m_w.
- It is then emptied and dried and equal volume of the specimen liquid initially at about 80°C is put in the calorimeter.
- The experiment repeated and a graph of θ against t also plotted on the same axis.



(Heat lost by water + calorimeter in cooling from $\theta_1 to\ \theta_2$) = (heat gained by liquid + calorimeter for the same temperature change)

$$\frac{(m_w C_w + m_c C_c)(\theta_1 - \theta_2)}{t_w} = \frac{(m_l C_l + m_c C_c)(\theta_1 - \theta_2)}{t_l}$$ where C_l can be determined.

wherec_c, c_w are specific heat capacities of the calorimeter and water respectively.

(d) $$\frac{\left(\frac{50}{1000}x4200 + C\right)(60-50)}{17x60} = \frac{\left(\frac{110}{1000}x4200 + C\right)(60-50)}{35x60}$$

$$35(21000 + 10C) = 17(4620 + 10C)$$

$$73500 + 350C = 78540 + 170$$

$$C = 28JK^{-1}$$

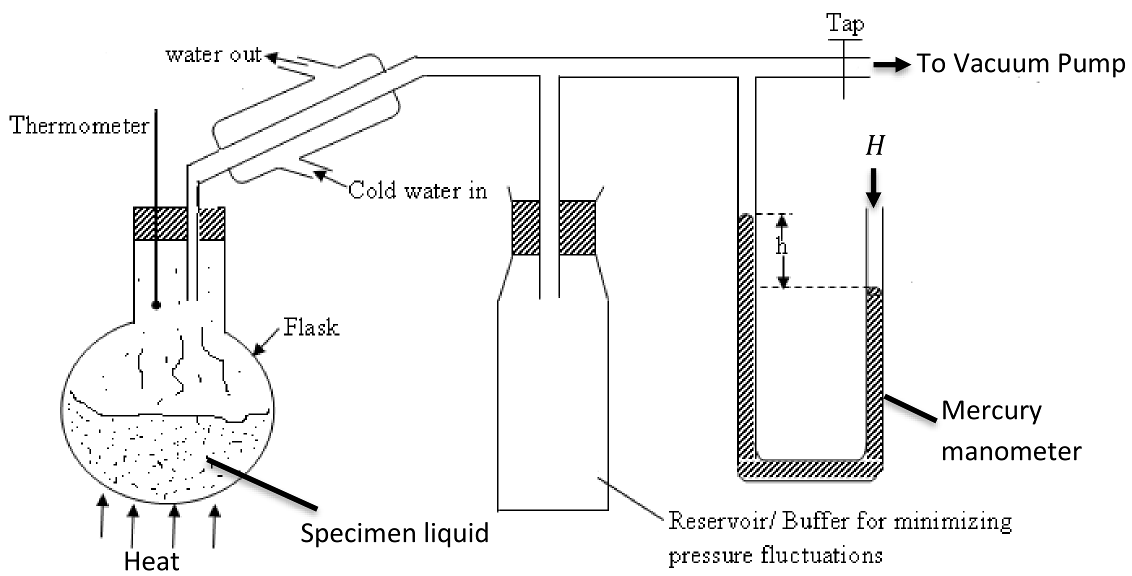
8. (a) (i) A gas is a gaseous state of a substance above its critical temperature

A vapour is a gaseous state of a substance below its critical temperature.

(ii) At lower pressure the molecules become few for the volume of the container and relatively far apart thus volume of molecules themselves becomes negligible compared with the volume of the container.

- At high temperature, the molecules become far apart and intermolecular forces of attraction become very weak. Hence intermolecular forces become negligible.

(b)



- A vacuum pump is used to withdraw air from the reservoir to a pressure lower or above the atmospheric pressure, H.
- The tap is closed and the liquid heated gently until it boils
- The temperature, θ, of the vapour and the difference in mercury level, h, are noted.

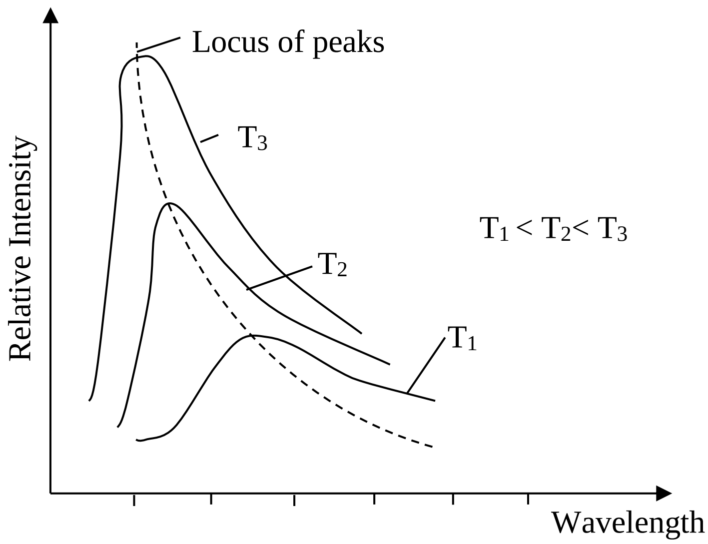
  Thus $SVP = H \pm h\rho g$ found, g is acceleration due to gravity,
  ρ, is density of the liquid.

- The tap is opened and apparatus allowed to cool for a few minutes.
- The experiment is repeated for different values of pressure above or below the liquid.
- A graph of SVP against θ is plotted and SVP at any temperature can be read from the graph corresponding to 65℃.

(c) (i) $\frac{P}{A} \propto T^4$ $(Stefan's\ law)$; The total power radiated by a black body per unit surface area is directly proportional to the fourth power of its absolute temperature.

$\lambda_{max} \propto \frac{1}{T}$ (Wien's law); Wavelength of radiation emitted by a black body at maximum intensity reduces as its absolute temperature increases.

(ii)



- As temperature increases, the wavelength of most intense radiation decreases.
- For visible spectrum from a furnace as temperature increases the wavelength shifts from Red to Yellow to Green to Blue.
- At the center of the furnace where the temperatures are very high when Red, Green and Blue combine they appear white.

(d) $P=\varepsilon A\delta T^4$, Where A = πdl,

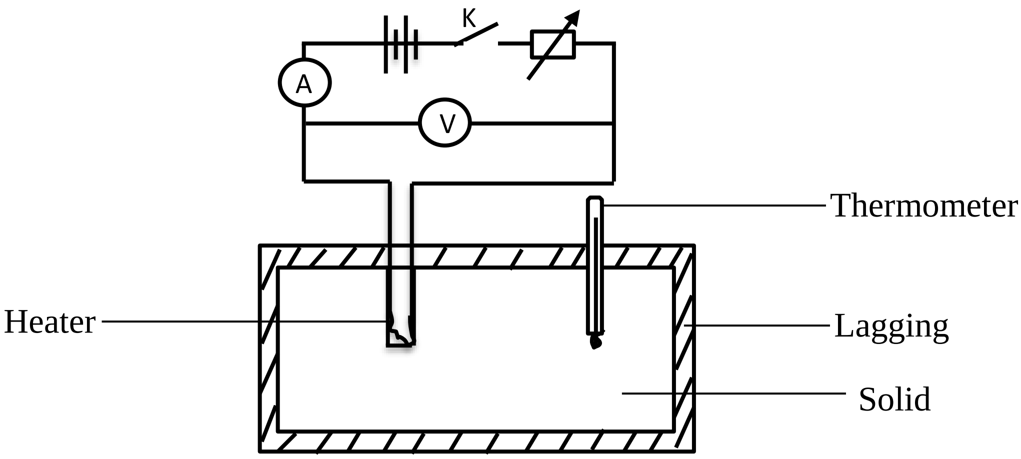
$$60 = 0.6\pi x1.0x10^{-2}x30x10^{-2}x5.7x10^{-8}T^4, T = 656.85K$$

9. (a) (i) Under conditions of forced convection, the rate at which a body loses heat is directly proportional to the excess temperature of the body over that of the surrounding.

(ii) - The rate of heat flow depends on surface area to volume ratio.

- Small pieces of wood or charcoal have a higher surface area to volume ratio than larger surfaces making them absorb heat at high rate than larger pieces.

(b) (i)



- Drill the solid into two holes, one for the heater and the other for the thermometer
- Weigh and record the mass, $m_{s,}$ fill the holes with mercury to improve the thermal contact and insert the heater and thermometer in their respective holes.
- Read and record the initial temperature, θ_1.
- Close switch k and at the same time start the stop watch, and leave the experiment until a maximum temperature is reached and noted as, θ_2 and time taken, *t*.
- The ammeter and the voltmeter reading *I* and *V* are read noted.

$m_s c(\theta_2 - \theta_1) = VIt$; c can then be calculated

(ii) $$VIT = mcd\theta + \left(\frac{0+16}{2}\right)t$$

$$520x25x60 = 2.5xcx(100 - 20) + 8x25x60$$

$$780000 - 12000 = 200c$$

$$c = 3840JK^{-1}kg^{-1}$$

(c) Because metals have low s.h.c, they absorb heat quickly from the hand leaving it a lower temperature hence feeling cold.

OR; Metals are good conductors of heat so absorbs heat from the body leaving it at lower temperature hence feeling cold.

(d) $Total\ suface\ area = (12x10) + (10x4)2 + (4x12)2$

$$120 + 80 + 96 = 296m^2$$

$$Area\ of\ walls\ and\ roof = 296 - 16 = 280m^2$$

Rate of heat flow through windows and doors

$$\frac{Q}{t} = K_g x16x\frac{\Delta\theta}{5x10^{-3}} = 3200K_g\Delta\theta$$

Rate of heat flow through roofs + walls

$$\frac{Q}{t} = K_{wr}A\frac{\Delta\theta}{l} = 0.25x280\frac{\Delta\theta}{25x10^{-2}}$$

$$= 280\Delta\theta$$

$$\%\ of\ heat\ loss\ by\ conduction\ through\ doors + windows = \left(\frac{3200K_g\Delta\theta}{3200K_g\Delta\theta + 280\Delta\theta}\right)x100\%$$

$$\frac{94}{100} = \frac{3200K_g\Delta\theta}{3200K_g\Delta\theta + 280\Delta\theta}$$

$$0.94 = \frac{3200K_g}{3200K_g + 280}$$

$$3008K_g + 263.2 = 3200K_g$$

$$K_g = 1.37Wm^{-1}K^{-1}$$

10. (a) - Decay constant is the fractional number of radioactive particles decaying per second.

- Half-life is the time taken for a radioactive sample to decay to a half of its original number of nuclei present.

- Activity is the number of disintegrations per second.

- Carbon-14 dating is the method of obtaining age of a fossil. Carbon -14 is radioactive with half-life, $t_{\frac{1}{2}}$, of 5600years.

It is absorbed by plants during photosynthesis, when a plant dies carbon -14 starts to decay, its activity, A_t of a dead plant is measured and noted.

The activity of a living plant of the same species is measured and recorded as A_0.

From $A_t = A_0(0.5)^n$, where $n = \frac{t}{t_{\frac{1}{2}}}$, then, t, is obtained.

- Uranium dating is the method of obtaining age of a rock. Every atom of uranium that decays turns into a lead atom.

When a mineral grain is formed say in the fossil below its trapping temperature, it sets the uranium – lead clock to zero.

The lead atoms created are trapped in the crystal and build up in concentration with time, the lead – uranium proportion is determined in terms of mass and from

$Nu = (Nu + Npb)\, e^{-\lambda t}$, $\quad \lambda = \frac{ln2}{t_{\frac{1}{2}}}$, $t_{\frac{1}{2}}$ is the half-life of a rock. Then t is obtained.

(b) (i) Radio-active equilibrium is a condition where the species and its successive radioactive products all disintegrate at the same numerical rate and maintain their proportions constant.

(ii) $^{44}_{19}K \rightarrow {}^{44}_{20}Ca + {}^{0}_{-1}e + E$

$$\lambda = \frac{In\ 2}{20\ x60}$$

$$N_0 = \frac{m}{M} N_A = (\frac{10X10^{-3}}{44}) x\ 6.02x10^{-23} = 1.3682\text{x}10^{20} \text{ atoms}$$

After *1hr =60x60 s*

$$\text{N} = 1.3682\ \text{x}10^{20}\ e^{\frac{-ln2}{20}x60} = 1.71\ \text{x}10^{19} \text{ atoms}$$

$$\text{A} = \lambda\text{N} = (\frac{ln2}{20x60})\ \text{x}\ 1.71\text{x}10^{19} = 6.76\text{x}\ 10^{18} \text{ atoms per second.}$$

$\text{Nk} + \text{Nc} = N_0$; $\text{Nc} = 1.3682\ \text{x}\ 10^{20} - 1.71\text{x}10^{19} = 1.1972\ \text{x}10^{20}$ atoms

(c) Nuclear fission is the breaking of unstable nucleus into two lighter nuclei with release of energy

Nuclear fusion is the union of two lighter nuclei to form one heavier nucleus with release of energy.

(d) (i) Energy released = $\frac{Q_1Q_2}{4\pi\varepsilon_0 x_0} = \frac{1.6X10^{-19}X1.6X10^{-19}X9X10^9}{1.5X10^{-15}} = 1.536\ \text{X}10^{-14}$J.

(ii) K.E $= \frac{3}{2}k_B xT$; $1.536\ \text{x}10^{-14} = \frac{3}{2}x\ 1.38x10^{-23}$T; T $= 7.42\text{X}10^8$ K.

11. (a) (i) Photoelectric effect – is the process by which electrons are emitted from a clean metal surface when illuminated with radiation of high enough frequency .

Binding energy per nucleon – is the minimum energy required to split the nucleus into its constituent nucleon to the mass number.

(ii) -States that light is emitted and absorbed in discrete amounts or packets called quanta . the energy of each quantum is hf where f –frequency of light and h- Planck's constant

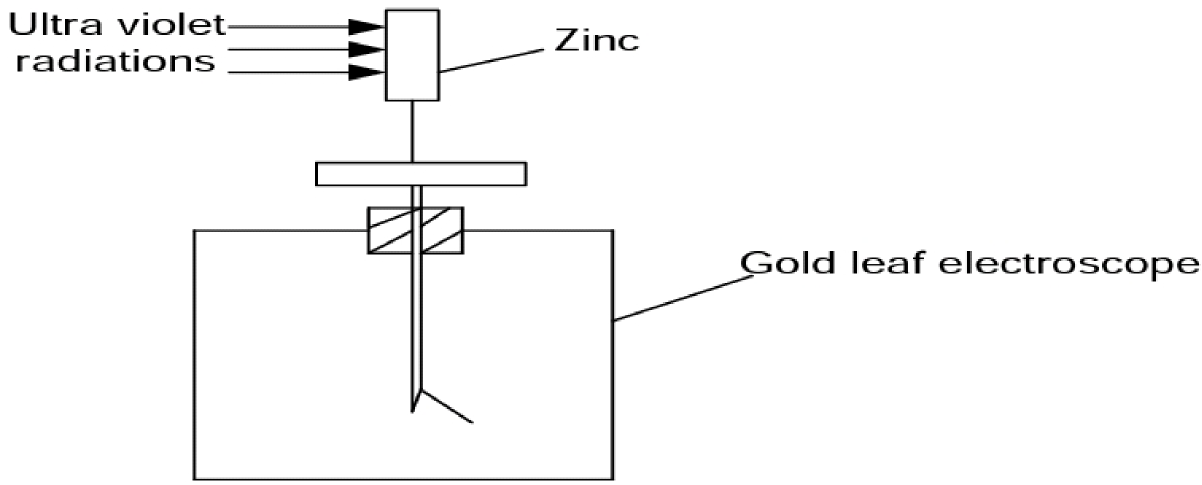
-When light is incident on a metal surface ,each quantum of light /photon interacts with one and only one electron in the surface of the metal giving it all its energy or none at all.

- If the photons energy hf hf $<$ wo – work function and hence dislodging electrons from the the metal surface .

(ii) photoelectric effect – to liberate an electron from a metal surface ,a quantum (0r packet)of energy work function which is the characteristics of the metal which has to be supplied .

Optical spectra – a line in the optical emission spectrum indicates presence of a particular frequency f of light considered in an excited atom when an electron jumps from a higher to a lower energy level .

x-ray line spectra- electron transitions from one shell to another leads to liberation of energy in packets which are characteristics of the target atom.



b)

-a cleaned negatively zinc plate is connected to the cap a negatively charged G.L.E

- The U.V is the directly incident on the zinc plate

- the gold leaf is seen to collapse ,showing that both gold leaf and plate have lost charge hence photo electric emission effect.

c) (i) Braggs law states that for constructive interference, the path difference of diffracted x-rays is equal to the integral multiple of their wavelength.

II) -When a parallel beam of x-rays is incident on a crystal whose inter atomic spacing of the atom, d, is comparable to the wavelength of x-rays.

x-ray beam undergo scattering due to diffraction producing black spot at the center due to destructive interference and the reflected x-rays beam undergoes constructive interference producing a bright spot whose path difference is an integral multiple of wavelength of the x-rays (nλ), for n=1,2,3,…………

d)

initial k.e of ${}_{2}^{4}He$= electrostatic potential

1.6x10^{-3}= $\frac{2x50\ x1.6x10^{-19x}\ 1.6x10^{-19}x9x10^{9}}{x0}$

Xo = 1.44x10^{-13}m

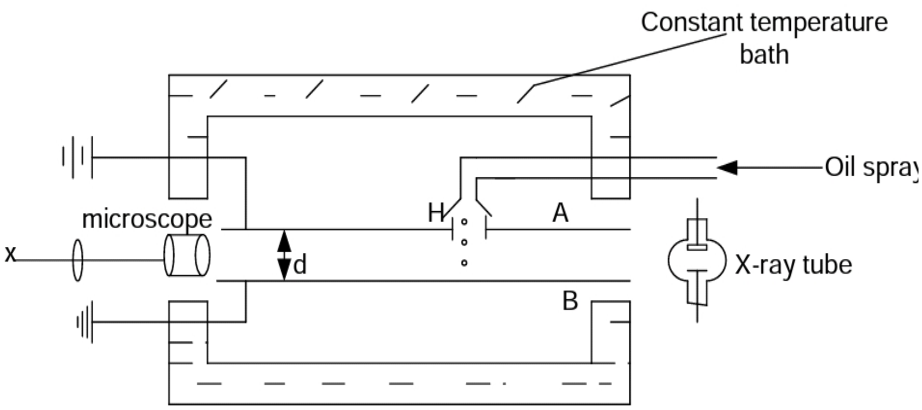
12a) i) electron volt – is the energy gained by an electron accelerated through a p.d of 1volt .

Unified atomic mass unit – is the $(\frac{1}{12})^{th}$ of the mass of one atom of carbon-12 isotope .

Specific charge – is the ratio of charge to mass of atom, /particle /ion/an electron .

Stopping potential - is the minimum p.d which reduces the photocurrent to zero.

ii)



-oil droplets are allowed to fall through the tiny hole from the oil spray into the space between metal plate AB.

-with p.d off, one oil drop is observed as it falls between the distance x, fallen in time ,t is obtained ,the terminal velocity ,Vo=$\frac{x}{t}$ is found.

$\frac{4}{3}\pi r^3\rho o g = \frac{4}{3}\pi r^3 \rho a + 6\pi\eta\, rVo$ …………………………..(i)

$r = (\frac{9\eta Vo}{2g(\rho o-\rho a)})^{1/2}$ where ρo- density of oil, ρa- density of air, η- Air resistance

-a second oil drop is selected and given a charge ,Q by x-rays

- Then p.d is switched on, and adjusted until a drop becomes stationary.

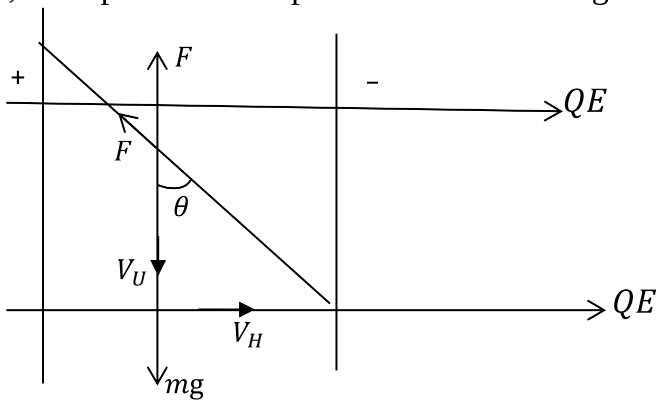
-p.d, v and separation, d, between the plates are measured and noted , electric field intensity $E = \frac{V}{d}$ is found.

$\frac{4}{3}\pi r^3 \rho o g = \frac{4}{3}\pi r^3 \rho a + QE$ ....(ii)

$Q = \frac{6\pi\eta\, Vo}{E}\left(\frac{9\eta Vo}{2g(\rho o - \rho a)}\right)^{1/2}$

-using several drops ,the experiment is repeated until the the highest multiple of charge is obtained .

b (i)



For constant velocity , mg =F

$\tan\theta = \frac{V_H}{V_U}$

$V_H = \frac{1.066}{100}$ tan 36.6° = 0.0079168ms^{-1}

(ii) $\frac{VQ}{d} = 6\pi\eta\, rV_H$

$Q = \frac{6\pi(1.82X10^{-5})(1.0X10^{-7})(0.0079168)X\ 0.5X10^{-2}}{3000X100} = 4.52X10^{-19}\ C$

c (i) in magnetic field ,

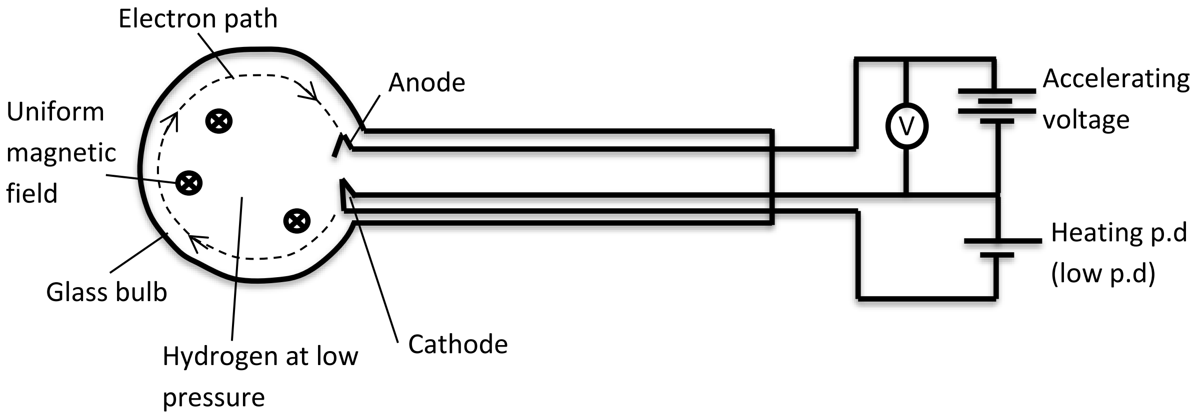
-when an electron enters a region of uniform magnetic field experiences a magnetic force $\vec{B}e\vec{U}$ which is perpendicular to both $\vec{B}$ and $\vec{U}$ vectors whose direction is given by Flemings left hand rule which provides a centripetal force causing them to describe a circular path of radius , $r = \frac{mU}{Be}$ whose velocity remain unchanged.

in electric field ,

-The electron experiences an electric force towards the positive plate and move with a vertical acceleration $\frac{eE}{m}$ which is uniform.

-And describe a parabolic path between the plates while the component of their velocity in horizontal direction remains constant.

ii)



-the cathode is heated by low voltage to emit electrons thermionically.

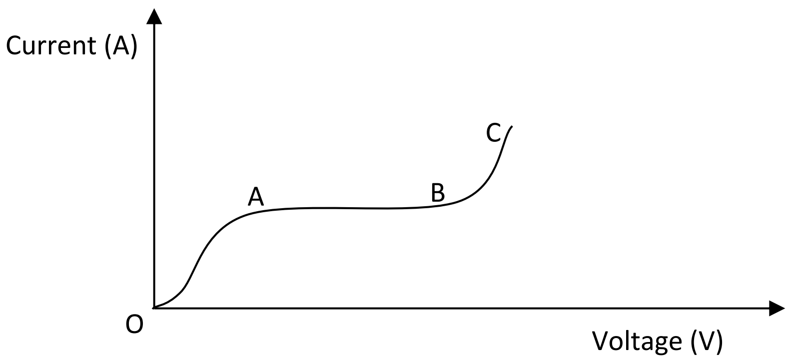
-emitted electrons are accelerated by voltage, V, towards the anode.

-on their way they collide with hydrogen atoms causing them to emit light and so reveal the path of the electrons.

-magnetic fields provide centripetal force which causes them to describe a circular path of radius, r , measured using a plane mirror

-specific charge, e/m =$\frac{2V}{B^2r^2}$ is obtained.

d)



-OA – as the applied voltage increases, the number of electrons reaching the anode increases ,leading to increase in the current gradually.

- Along AB –the electron released all reach the anode at the same time so that the current through the tube appears constant.

-Along BC – The number electrons due to ionization increase rapidly and not all electrons reach the anode at the same time, current increases gradually.

At the breaking point, a large number of electrons reach the anode and current rises sharply.

13.a(i) semiconductor –is one in which the electrical conductivity lies between that of an insulator and a conductor .

ii) Intrinsic –is a pure semiconductor

Extrinsic – is one with impurities in its crystal structure.

iii) Thermionic emission – is the production of electrons from hot metal surface.

b) The p-type semiconductor is formed by dropping a semi-conductor with a group three element (trivalent) where by the holes become the majority charge carriers .

Then the n-type semiconductor is formed by doping a semiconductor with a group five element (pentavalent) ,where by the electrons become the majority carrier.

-now a p-n junction is formed by fusing together the p-type and n-type pieces.

(ii) group iii elements- aluminum, boron.

Group iv element – Sulphur, nitrogen

c) Vrms = 2.82 , Vo =$\sqrt{2}$ Vrms = $\sqrt{2}$ x 2.82 , Vo= 3.988v

$Vo \propto l$, Vo = βl, 3.988 = βx2, β= 1.994 vm^{-1}

d) -consists of 3terminals ,emitter ,collector and base which is the thinnest and formed when melting/fusing two p-types and n-type in which n-type is the base and one ptype is emitter and another one is the collector. Or two n-tpes and a p-ype in which p-type becomes the base

-and always the base is always in the middle.