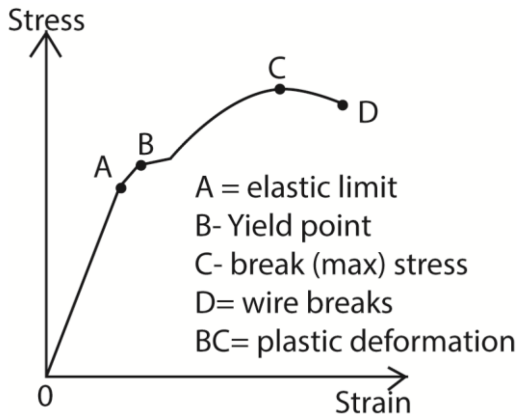
UACE Physics paper 1 set8 guide

1. (a) State Hooke's law. (01mark)
   Hooke's law state that extension is proportional to the load provided the proportionality limit is not exceeded.
   (b) A copper wire is stretched until it breaks.
   (i) Sketch a stress- strain graph for the wire and explain the main features of the graph. (04marks)



- OA – stress is proportional to strain and the material regains its length
- AB - stress is not proportional to strain but the material regains its length
- Beyond B the material becomes permanently stretched
- CD the material undergoes plastic deformation
- Beyond D the material breaks

(ii) Explain what happens to the energy used to stretch the wire at each stage. (04marks)

- During elastic deformation, atoms are slightly displaced from equilibrium position. When the load is applied to the wire, energy used to stretch wire becomes elastic potential energy
- When the wire is stretched beyond elastic limit, permanent displacement of atoms occurs. The energy is used to break some interatomic bond and some is released as heat.
- At the breaking point, energy is used to break the interatomic bonds.

(iii)Derive the expression for the work done to stretch a spring of force constant, k, by a distance, 2. (03marks)

dw = Fdx

Work done = $\int_0^e Fdx$

But F = kx

$\therefore W = \int_0^e kxdx = \frac{1}{2}ke^2$

(c)(i) Define Young's Modulus. (01mark)

Young's Modulus is the ratio of tensile stress to tensile strain

(ii) Two identical steel bars A and B of radius2.0mm are suspended from the ceiling. A mass of 2.0kg is attached to the free end of bar A. Calculate the temperature to which B should be raised so that the bars are again equal in length.
[Young's Modulus of steel = 1.0 x $10^{11}$$Nm^{-2}$)

[Linear expansivity of steal = 1.2 x $10^{-5}K^{-1}$] (05mark)

e $= \frac{Fl}{AE}$, also e = $\alpha l \Delta\theta$ where $\Delta\theta$ is temperature change

=> $\Delta\theta = \frac{F}{AE\alpha} = \frac{2 \, x \, 9.81}{\pi(2.0 \, x \, 10^{-3})^2 \, x \, 1.0 \, x \, 10^{11} \, x \, 1.2 \, x \, 10^{-3}}$ = 1.4K

(d) Why does an iron roof make cracking sound at night? (02marks)

During the day, the roof is heated, it expands and buckles since it is fixed. At night, the roof contracts due to fall in temperature. As it straightens again sound is produced.

2. (a) Define the following terms as applied to oscillatory motion

(i) Amplitude (01mark)

Amplitude is the maximum displacement of a particle from equilibrium or mean position

(ii) Period (01mark)

Period is the time taken to make 1cycle.

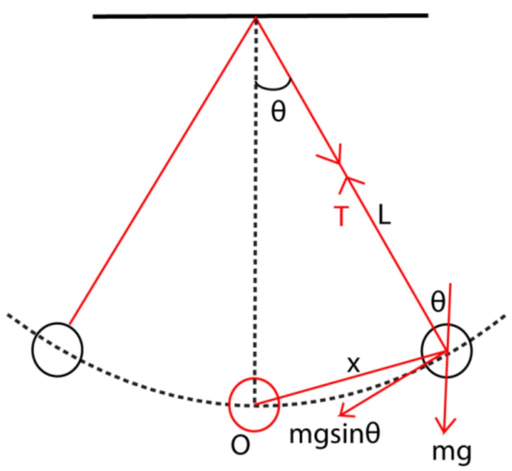
(b) State four characteristics of simple harmonic motion. (02marks)

- A periodic motion
- Acceleration is proportional to displacement
- Acceleration is directed towards a fixed point
- Mechanical energy is conserved.

(c) A mass, m is suspended from a rigid support by a straight string of length L. the mass is pulled aside so that the string makes an angle, θ, with the vertical and then released.

(i) Show that the mass executes simple harmonic motion with a period T =$2\pi\sqrt{\frac{L}{g}}$.

Suppose a body of mass, m, attached to a string is displaced through a small angle θ and then released. The resultant force on the body towards O is mgsinθ.



By Newton's 2^{nd} law

ma = - mgsinθ

a = -gsinθ

If θ is small and measured in radians θ ≈ sin θ = $\frac{x}{L}$

a = g$\frac{x}{L}$

But $a = -\omega^2 x$

$\omega = \sqrt{\frac{L}{g}}$

$T = \frac{2\pi}{\omega}$

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

(ii) Explain why this mass comes to a stop after a short time. (02marks)

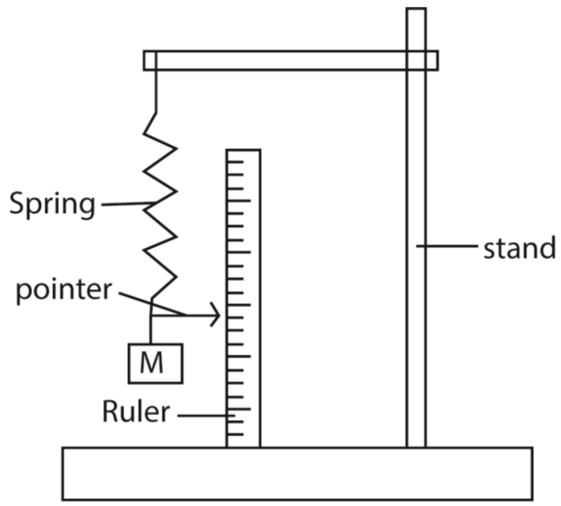
The mass comes to a stop due to the presence of dissipative forces leading to loss of energy and amplitude reduces with time.

(d) A piston in a car engine performs a simple harmonic motion of frequency 12.5Hz. If the mass of the piston is 0.50kg and its amplitude of vibration is 45mm, find the maximum force on the piston. (03marks)

Maximum force = $m\omega^2 A$ but $\omega = 2\pi f$

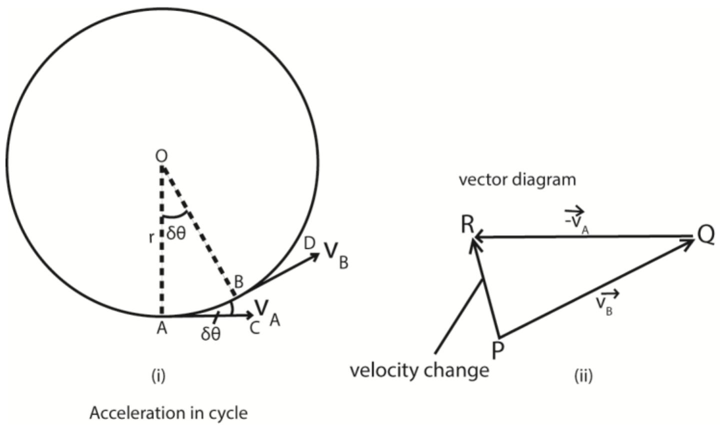
Maximum force, $F = 0.5 \times (2\pi \times 12.5)^2 \times 0.045 = 138.8N$

(e) Describe an experiment to determine the acceleration due to gravity, g, using a spiral spring, of known constant. (06marks)



- Clamp the spring on a retort stand
- Fix a horizontal pin at free end of the spring to act as a pointer.
- Place a vertical meter rule next the pointer and note the initial pointer position, P_1.
- Suspend a known mass, M, to the free end of the spring, note and record the new position of the pointer, P_2.
- Calculate extension, $e = P_2 - P_1$.
- Find the extensions for different masses
- Plot a graph of e against M
- Calculate the slope, S of the graph
- Calculate the acceleration due to gravity, g = kS (k = force constant)

3. (a) Explain what is meant by centripetal force. (02marks)
Centripetal force is the force that keeps a body moving in a circular path. It's directed towards the centre of the path.
(b)(i) Derive an expression for centripetal force acting on a body of mass, M, moving in a circular path of radius, r. (06marks)



The velocity change from A to B = $v_B - v_A$ or $v_B + (-v_A)$.

In figure 2(ii) above, PQ represents v_B in magnitude (v) and direction BD; QR represents $-v_A$ in magnitude (v) and direction (CA).

Velocity change = $v_B + (-v_A)$ = PR

When δt is small, the angle AOB or δθ is small;
Also angle PQR equal to δθ is small

PR or acceleration then points toward O, the centres of the circle.

a = $\frac{velocity\ change}{time} = \frac{PR}{\delta t} = \frac{v\delta\theta}{\delta t}$
but $\frac{\delta\theta}{\delta t}$ =ω and v = rω

a = rω x ω = rω^2 but ω = $\frac{V}{r}$
- a = $\frac{v^2}{r}$
Centripetal force = ma = $\frac{mv^2}{r}$ = mrω^2

(ii) A body moving in a circular path of radius 0.5m makes 40 revolutions per second. Find the centripetal force if the mass is 1kg (03marks)
F = mrω^2but ω = 2πf
= 1 x 0.5 x (2π x 40)^2 = 1.36 x 10^{4}N

(c) Explain the following
(i) A mass attached to a string rotating at constant speed in a horizontal circle will fly off at a tangent of the string breaks. (02marks)
If the spring breaks, the mass will not have any centripetal force and will continue in a straight line along the tangent.

(ii) A cosmonaut in a satellite which is in a free circular orbit around the earth experiences the sensation of weightlessness even though there is influence of gravitational field on earth. (03marks)

The sensation of weight is caused by the reaction of the floor on a person. In orbit, the cosmonaut and the floor have the same acceleration towards the centre of the earth. The floor exerts no supporting force on the cosmonaut. (i.e. the reaction, R = 0)

(d) (i) Derive an expression for maximum horizontal distance travelled by a projectile in terms of the initial speed, u, and the angle of projection, θ, to the horizontal. (02marks)

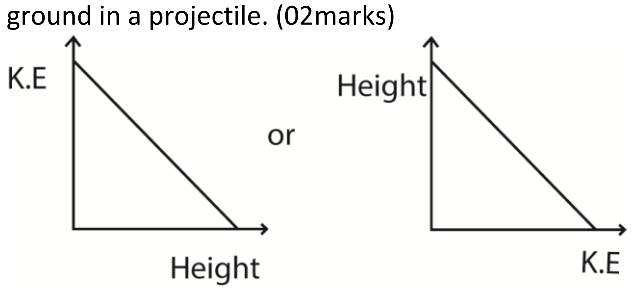
Horizontally, x = utcosθ

Vertically, y = utsinθ - $\frac{1}{2}gt^2$

But y = 0; t = $\frac{2usin\,\theta}{tg}$

∴ Range = $\frac{2u^2sin\theta cos\theta}{g} = \frac{u^2sin2\theta}{g}$

(ii) Sketch a graph to show the relationship between kinetic energy and height above the ground in a projectile. (02marks)

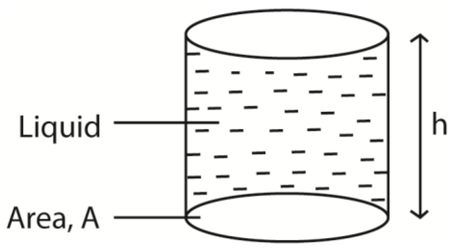


4. (a)(i) What is meant by the following terms, steady flow and viscosity? (02marks)
   - Steady flow is the flow where the velocity of the liquid past any given point is constant.
   - Viscosity is the friction between layers of a fluid.

(ii) Explain the effect of increase in temperature on viscosity of a liquid. (03marks)

- When temperature rises, the molecular separation of liquid molecules increases and the intermolecular forces decrease. The resistance to flow then decreases hence a decrease in viscosity.

(b) (i) Show that the pressure, P, exerted at a depth, h, below the free surface of a liquid of density, ρ, is given by P =hρg. (03marks)



Weight of a liquid above A = mg

But = Ahρ

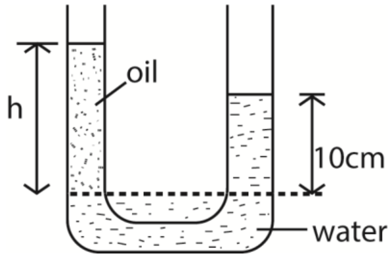
⇨ Weight = Force = Ahρg

Pressure = $\frac{F}{A} = \frac{Ah\rho g}{A}$ = hρg

(ii) Define relative density. (01mark)

Relative density is the ratio of the mass of any volume of a substance to the mass of an equal volume of water

(iii) A U-tube whose ends are open to atmosphere, contains water and oil as shown in the figure below



Given the density of oil is 800kgm^{-3}, find the value of h.

Pressure of oil and that of water at the dotted line are equal, if the density of oil = σ and that of water = ρ, then

$h\sigma g = 0.1\rho g$

h = $\frac{0.1\rho}{\sigma} = \frac{0.1\ x\ 100}{800}$ = 0.125m = 12.5cm

(c) A metal ball of diameter 10mm is timed as it falls through oil at a steady speed. It takes 0.5s to fall through a vertical distance of 0.3m. Assuming that the density of metal is 7500kgm^{-3} and that of oil is 900kgm^{-3}, find

(i) the weight of the ball (02marks)

Weight = volume x density of the ball x acceleration due to gravity

$= \frac{4}{3}\pi r^3 \sigma g = \frac{4}{3}\pi(5\ x\ 10^{-3})^3 x\ 7500\ x\ 9.81 = 3.85 \times 10^{-2}$N

(ii) the up thrust on the ball (02marks)

Up thrust = volume of water displaced x density of water x acceleration due to gravity

$= \frac{4}{3}\pi r^3 \rho g = \frac{4}{3}\pi(5\ x\ 10^{-3})^3 x\ 1000\ x\ 9.81 = 4.62 \times 10^{-3}$N

(iii) the coefficient of viscosity of the oil (03marks)

W = U + F

mg = U + $6\pi r\eta v_0$

But v0 = $\frac{0.30}{0.6}$ = 0.6ms^{-1}

η = $\frac{mg-U}{6\pi r v_0} = \frac{3.85\ x\ 10^{-2} - 4.62\ x\ 10^{-3}}{6\pi\ x\ (5\ x\ 10^{-3})\ x\ 0.6}$ = 0.6Pa (or 0.6Nm^{-2}s)

[Assume the viscous force = $6\pi\eta r v_0$ where η is the coefficient of viscosity, r is the radius of the ball, v_0 is the terminal velocity]

SECTION B

5. (a)(i) Define the terms specific heat capacity and specific latent heat of fusion (02marks)

Specific heat capacity is the amount of heat required to raise the temperature of 1kg mass of a substance by 1K of 1^0C.

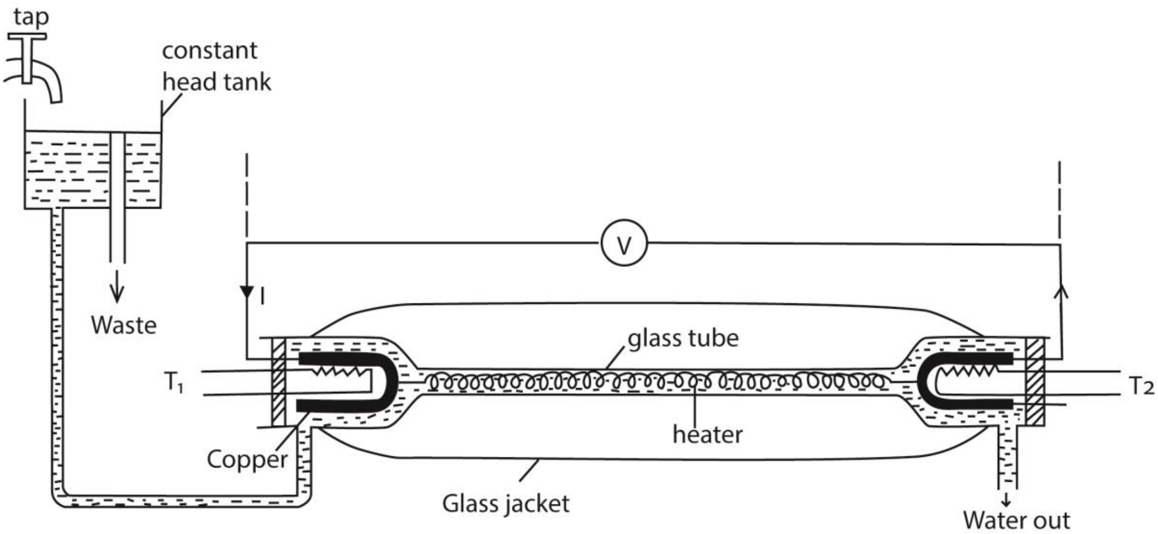
Specific latent heat of fusion is the amount of heat required to change 1kg of solid substance to a liquid at constant temperature.

(ii) Explain the changes that take place in the molecular structure of substances during fusion and evaporation (04marks)

Heat supplied during fusion breaks down the forces that keep ordered pattern of molecules is solid crystalline structure to form a liquid. The potential energy of the molecules increase but the average kinetic energy and temperature of the molecules remain unchanged.

Heat supplied during evaporation breaks molecular bonds in liquids and allow gas molecules to expand against atmospheric pressure which allows then to move independently.

(b) With the aid of a labelled diagram describe an experiment to determine the specific heat capacity of a liquid using the continuous flow method. (08marks)



- A liquid is allowed to flow at constant rate
- Power is switched on and the liquid is heated until temperatures registered by T_1 and T_2 are steady and the values θ_1 and θ_2 respectively are recorded.
- The p.d V and current I are recorded from the voltmeter and ammeter respectively
- The mass, m of a liquid collected in time t is recorded
- At steady state; $VIt = mc(\theta_2 - \theta_1) + h$ ………….. (i)
  where h is heat lost to the surrounding
- The rate of flow is changed and the voltage and current are adjusted until the steady readings of T_1 and T_2 are θ_1 and θ_2 respectively
- If m_1, V_1 and I_1 are the values mass of liquid collected in time t, voltmeter and ammeter readings respectively, then
  $V_1I_1t = m_1c(\theta_2 - \theta_1) + h$ ………….. (ii)

Subtracting (ii) from (i)

$c = \frac{(VI - V_1I_1)t}{(m - m_1)(\theta - \theta_1)}$

(c) Steam at 100^0C is passed into a copper calorimeter of mass 150g containing 340g of water at 15^0C. This is done until the temperature of the calorimeter and its content is 71^0C. If the mass of the calorimeter and its content is found to be 525g, calculate the specific latent heat of vaporization of water. (06marks)

Mass of condensed steam = 525- (340+ 150) = 35g

Heat lost by steam = heat gained water and calorimeter

$Ml_v + mc\Delta\theta = m_1c\Delta\theta + C\Delta\theta$

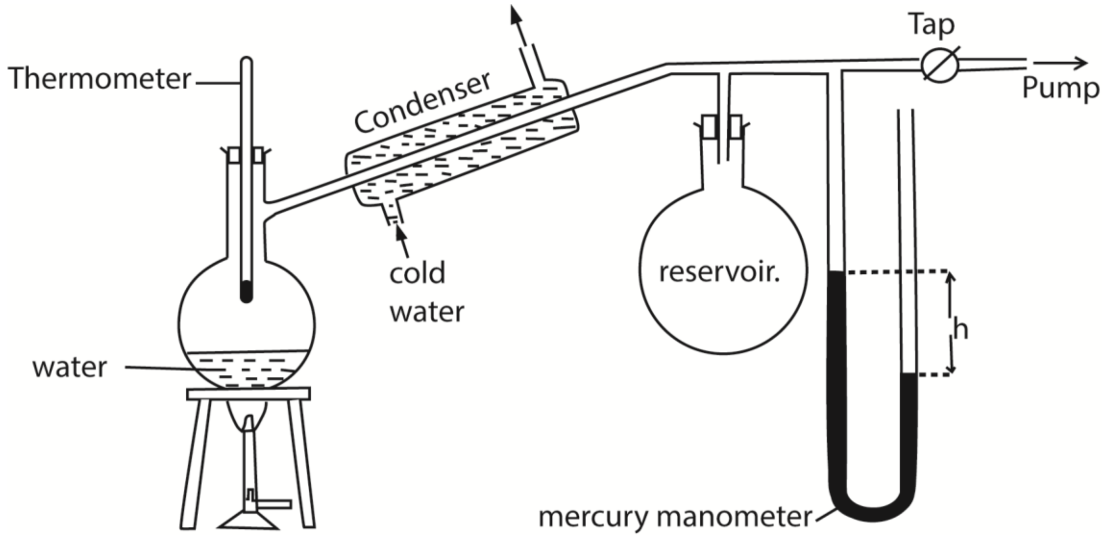
$0.035l = 0.340(100 - 71) + 0.150\ (100 - 71)$

Specific latent heat capacity, $l_v = 2.259 \times 10^6 Jkg^{-1}$.

6. (a) (i) Define saturated vapour pressure. (01mark)

Saturated vapour pressure of a liquid is the pressure exerted by vapour in dynamic equilibrium with its liquid

(ii) Describe with the aid of a diagram, how saturated vapour pressure of a liquid can be determined at a given temperature. (06marks)



- The pressure of the air in R is shown by the mercury manometer; if its height is h, the pressure in mm mercury is P = H-h, where H is the barometer height.
- The tap is opened and the pressure above water varied using the pump to a suitable value.
- The tap is closed and water in the flask in heated until it boil.
- The temperature θ and difference in mercury levels, h, are noted and recorded.
- The saturated vapour pressure, P = ($H \pm h$) is calculated
- The procedure is repeated other values of θ and h
- A graph of P versus θ is plotted and the saturated vapour pressure at a particular temperature is obtained.

(b) Use the kinetic theory to explain the following observations

(i) Saturated vapour pressure of a liquid increases with temperature. (03marks)

If a liquid is in dynamic equilibrium with its vapour, an increase in temperature increases mean kinetic energy of the molecules and hence the rate at which molecules escape from the liquid.

The density of the vapour increases implying increase in the rate of condensation until dynamic equilibrium is restored. There are now more molecules in the vapour phase than previously that are moving faster and hence higher pressure.

(ii) Saturated vapour pressure is not affected by decrease in volume at constant pressure. (03marks)

A decrease in volume leads to a momentary increase in vapour density. Consequently, the rate of condensation increases while the rate of evaporation rate is constant. When the vapour density reduces, the condensation rate also reduces. So the dynamic equilibrium is restored to the initial value.

(c) When hydrogen gas is collected over water, the pressure in the tube at 15^0C and 75^0C are 65.5cm and 105.6cm of mercury respectively. If the saturated vapour pressure at 15^0C is 1.42cm of mercury, find its value at 75^0C (04marks)

P_1= 65.5 – 1.42 = 62.08 and T_1 = 273 + 15 = 288K

P_2 = 105.6 – P, and T_2 = 273 + 75 = 348K

From $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

$P_2 = \left(\frac{P_1}{T_1}\right) T_2 = 105.6 - \frac{64.08}{288}\ x\ 348 = 28.12$cmHg

(d) Explain why the molar heat capacity of an ideal gas at constant pressure differs from the molar heat capacity at constant volume (03marks)

At constant volume, all the heat supplied goes to raising temperature (increasing internal energy of the gas) while at constant pressure, heat is used to raise the temperature of the gas (internal energy) and do external work in expansion to keep the pressure constant. Therefore the molar heat capacity at constant pressure is more than the molar heat capacity at constant volume.

7. (a) (i) Define thermal conductivity. (01mark)

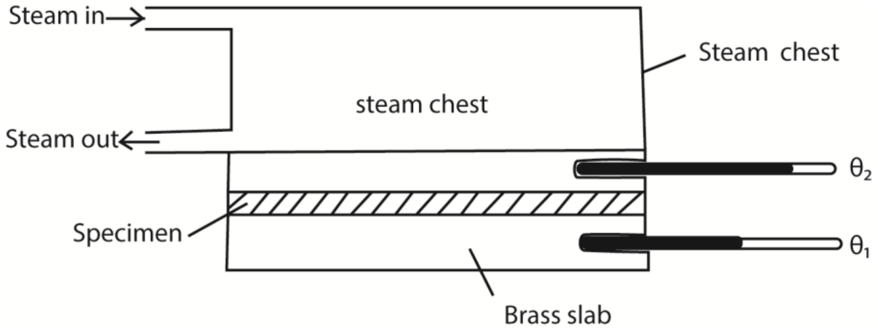
Thermal conductivity is the rate of heat transfer per unit cross section area per unit temperature gradient.

(ii) Compare the mechanism of heat transfer in poor conductor and good conductor. (05marks)

When one end of a poor conductor is heated, the atoms at the hot end vibrate with increased amplitude, collide with neighbouring atoms and lose energy to them. The neighbouring atoms also vibrate with increased amplitude, collide with adjacent atoms and lose energy to them. In this way, heat is transferred from one end to another.

Good conductors contain free electron. When heated, the electrons at hot end gain more energy and transfer the energy as they collide with atoms in solid lattice. Also, when one end of a good conductor is heated, the atoms at the hot end vibrate with increased amplitude, collide with neighbouring atoms and lose energy to them. The neighbouring atoms also vibrate with increased amplitude, collide with adjacent atoms and lose energy to them. In this way, heat is transferred from one end to another.

(b) Describe, with the aid of a diagram how you would measure the thermal conductivity of a poor conductor, stating the necessary precautions (08marks)



- Glass s cut in form of a thin disc of cross section area, A and thickness, x.
- The disc is sandwiched between a steam chest and brass slab of mass, m and specific heat capacity, c.
- Steam is passed through the chest until the thermometers register steady temperatures, θ_1 and θ_2.
- Then, $\frac{\theta}{t} = kA\left(\frac{\theta_2 - \theta_1}{x}\right)$
- The glass disc is removed and brass slab is heated directly by steam chest, until its temperature is about 10^0C above θ_1.
- Steam chest is removes and the top of the glass slab is covered by the glass disc.
- The temperature of the slab is recorded at suitable time interval until its temperature is about 10^0C below θ_1.
- A graph of temperature against time is plotted and its slope s determined at θ_1

  $\frac{\theta}{t} = mcs$

  $\therefore\ kA\left(\frac{\theta_2 - \theta_1}{x}\right) = mcs$

  $k = \frac{mcsx}{A(\theta_2 - \theta_1)}$ but A = $\frac{\pi D^2}{4}$

  $\therefore k = \frac{4mcsx}{\pi D^2(\theta_2 - \theta_1)}$

Precautions

- Sample in a thin disc
- Faces of the disc highly polished to ensure tight uniform contacts
- A thin layer of grease is smeared on faces for good thermal contact.

(c) A cylindrical iron vessel with a base of diameter 15cm and thickness 0.30cm has its base coated with a thin film of soot of thickness 0.10cm. It is then filled with water at 100^0C and placed on a large block of ice at 0^0C. Calculate the initial rate at which the ice will melt (06marks) (thermal conductivity of soot=$0.12Wm^{-1}K^{-1}$

$\frac{Q}{t} = kA\left(\frac{\theta_2 - \theta_1}{x}\right) = k_1A\left(\frac{\theta_2 - \theta_1}{x}\right) = ml_f$ where m is mass that melt per second and l_f = latent heat of fusion

Thermal conductivity of iron, k = $75Wm^{-1}K^{-1}$. A in the equation cancel

$= 75A\left(\frac{100 - \theta_1}{0.3\ x\ 10^{-2}}\right) = 0.12A\left(\frac{\theta_1 - 0}{0.1\ x\ 10^{-2}}\right)$

$\theta_1 = 99.52^0$C

Also, $kA\left(\frac{\theta_2 - \theta_1}{x}\right) = ml_f$

$75\ x\ \pi\ x\ \frac{(0.15)^2}{4}\left(\frac{100 - 99.52}{0.3\ x\ 10^{-2}}\right) = m\ x\ 3.3\ x\ 10^5$

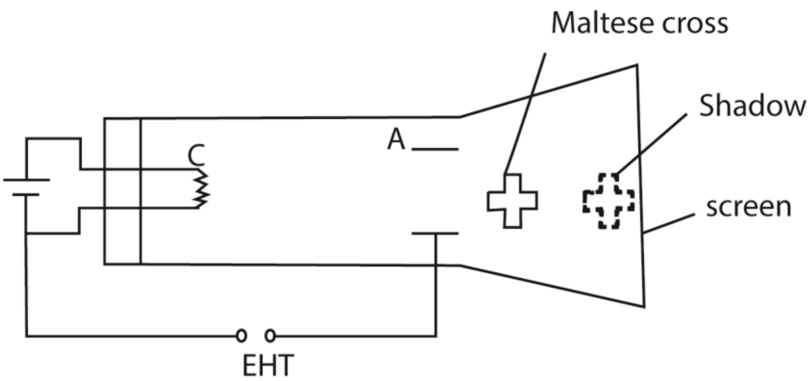
$m = 6.42 \times 10^{-4} kgs^{-1}$

SECTION C

8. (a) (i) What are cathode rays?

Cathode rays are stream of fast moving electrons

(ii) With the aid of a diagram, describe an experiment to show that cathode rays travel in straight line (04mrks)



Electrons emitted from the cathode, C are accelerated by the anode A towards a Maltese cross placed in the center of the glass tube. A sharp shadow of the Maltese cross is cast on the screen at the end of the tube. This shows that cathode rays travel in a straight line.

(b) A beam of electrons is accelerated through a potential difference of 500V. The beam enters midway between two similar parallel plates of length 10cm and are 3cm apart. If the potential difference across the plates is 600V, find the velocity of an electron as it leaves the region between the plates. (08marks)

$eV = \frac{1}{2} mu^2$

$1.6 \times 10^{-19} \times 500 = \frac{1}{2} \times 9.11 \times 10^{-31} \times u^2$

$u = 1.33 \times 10^7 ms^{-1}$

Horizontal component s constant = $u_x = 1.33 \times 10^7 ms^{-1}$

Vertically, F = eE =ma, but $E = \frac{V}{d}$

$$a = \frac{eV}{md} = \frac{1.6 \times 10^{-19} \times 600}{9.11 \times 10^{-31} \times 3 \times 10^{-2}} = 3.5 \times 10^{15} ms^{-2}$$

$v_y = u_y + at$ where $t = \frac{L}{u_x}$

$$v_y = 3.5 \times 10^{15} \times \frac{0.1}{1.33 \times 10^7} = 2.6 \times 10^7 ms^{-1}$$

$$v = \sqrt{v_y^2 \times u_x^2} = \sqrt{(2.6 \times 10^7)^2 + (1.33 \times 10^7)^2}$$

$= 2.92 \times 10^7 ms^{-1}$

Direction

tanθ =$\frac{v_y}{v_x} = \frac{2.6\ x\ 10^7}{1.33\ x\ 10^7}$ =1.7

θ = 86.6^0 to the horizontal

(c) State the laws of photoelectric emission (04marks)

- The time lag between irradiation of the metal surface and emission of the electrons by the metal surface is negligible.
- For a given metal, surface there is a minimum value of frequency of radiation called threshold frequency (f_0) below which no photo electrons are emitted from the metal however intense the incident radiation may be.
- The number of photoelectrons emitted from the surface per second is directly proportional to the intensity of incident radiation for a particular incident frequency
- The K.E of the photoelectrons emitted is independent of the intensity of the incident radiation but depends only on its frequency

(d) Explain how line emission spectra are produced. (03marks)

When a gas is heated to high temperature, atoms are excited and electrons jump to high energy levels. When the electrons fall back to the lower energy levels, they emit radiations of definite wavelength.

Alternatively

When energetic electrons penetrate the atoms, electrons from innermost energy levels are displaced to high energy levels. When the electrons fall back to lower energy levels, they emit radiations of definite wavelength of frequency

9. (a) (i) what is meant by terms: radioactive decay, half-life and decay constant? (03marks)
Radioactive decay is the spontaneous disintegration of unstable radioactive nuclei into stable nuclei with emission of radiations.
Half-life is the time taken for half the number of nuclei present to disintegrate.
Decay constant is the fraction of number of nuclei disintegration per second.

(ii) Show that the half-life, $t_{\frac{1}{2}}$ of a radioactive isotope is given by $t_{1/2} = \frac{0.693}{\lambda}$ where λ is the decay constant

(Assume the decay law N = $N_0e^{-\lambda t}$)

At t = $t_{½}$, N = $\frac{N_0}{2}$

=> $\frac{N_0}{2} = N_0e^{-\lambda t_{\frac{1}{2}}}$

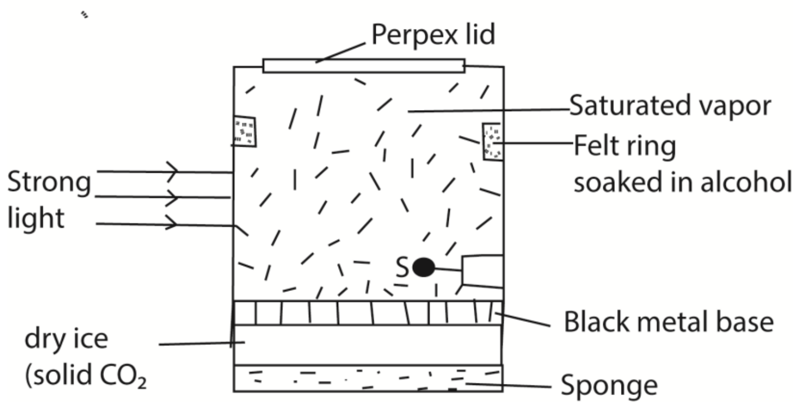
$\frac{1}{2} = e^{-\lambda t_{\frac{1}{2}}}$

$In2 = \lambda t_{\frac{1}{2}}$

$t_{½}$ = $\frac{In2}{\lambda} = \frac{0.683}{\lambda}$

(b) With the aid of a labelled diagram, describe the structure and action of a cloud chamber (05marks)

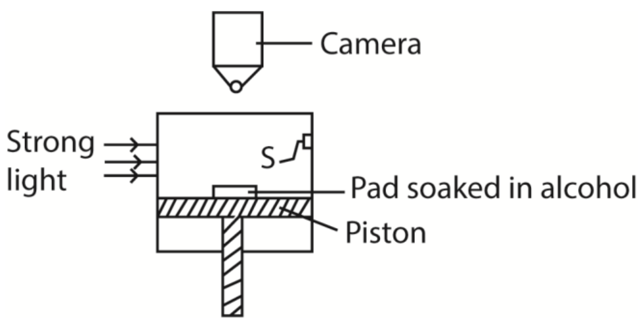
The diffusion cloud chamber



- The base of the chamber is maintained at low temperature, about -80^0c by the solid carbon dioxide while the top of the chamber is at room temperature, and so there is a temperature gradient between the top and the bottom of the chamber.
- The air at the top of the chamber is saturated with alcohol vapour from the felt ring. This vapour continuously diffuse downwards into the cooler regions so that the air at the chamber is super saturated with alcohol vapour.
- Radiations from the radioactive source S cause the ionization of the vapour.
- The ionizations from the radioactive source S cause condensation of the vapour on the ions formed, hence the path of the ionizing radiations are traced by series of small droplets of condensation.
- The thickness and length of the path indicate the extent to which ionization has taken place.
- Alpha particles produce short, thick, continuous straight tracks
- Beta particles which are less massive produce longer, thin but straggly paths owing to collisions with gas molecules
- Gamma radiations are uncharged and for ionization to take place, it must collide with an atom and eject an electron which then ionizes the vapour.

Alternatively

The Wilson cloud chamber



Mode of action

When the piston is quickly moved, the air in the chamber is saturated with alcohol vapour undergoes an adiabatic expansion and it cools.

The dust particles are carried away leaving behind air which is dust free. This is the subjected to controlled expansion making it super saturated.

It is then simultaneously subjected to ionizing radiation from a source, S. the vapour condenses on the ions formed to form water droplets around the ions

These are then illuminated and photographed by the camera.

The nature of the path formed reveals the type of ionizing agent.

(c) A radioactive isotope ${}^{99}_{43}X$ decays by emission of a gamma ray. The half-life of the isotope is 360minutes. What is the activity of 1mg of the isotope? (06marks)

$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

99g of X contain 6.02 x 10^{23} atoms

1mg of X contains $\frac{1\ x\ 10^{-3}}{99}\ \ x\ 6.02\ x\ 10^{23}$ = 6.08 x 10^{18} atoms

Activity = λN = $\frac{0.693}{360\ x\ 60}\ x\ 6.08\ x\ 10^{18}$ = 1.95 x $10^{14}s^{-1}$

(d) Explain the term avalanche as applied to an ionization chamber. (03marks)

A n avalanche is a large number of moving ionized particle created as a result o secondary ionization due to collision between ions and gaseous atoms when electrons are accelerated by high p.d whereby each ion pair formed cause further ionization of the gas.

10. (a) Define the terms below as applied to a triode

(i) space charge (01mark)

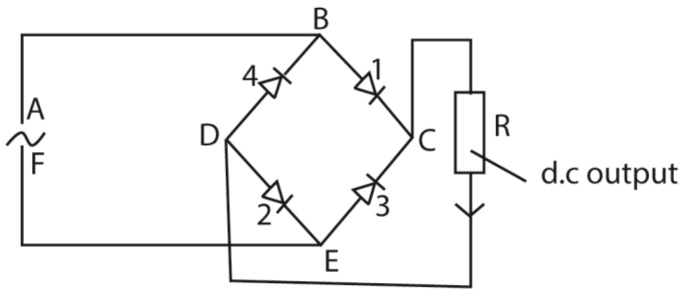
Space charge is the cloud of electrons formed around the cathode when the p.d across the tube is not enough to attract all emitted electrons.

(ii) Amplification factor (01mark)

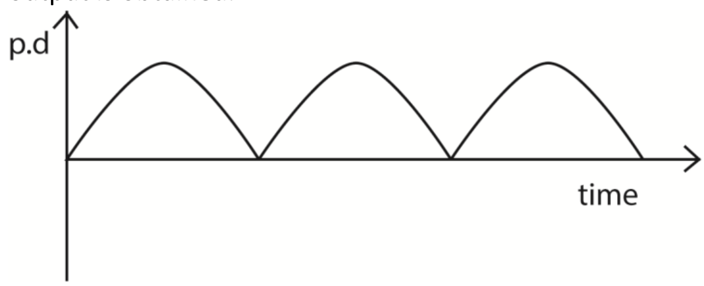
Amplification factor is the ratio of change in anode voltage to change in grid voltage at constant current

(i) Mutual conductance (01mark)
Mutual conductance is the ratio of change in anode current to change in grid voltage at constant anode voltage

(b) With the aid of a labelled diagram explain full wave rectification. (07marks)



- Four diodes are arranged in a bridge network as shown above.
- If A s positive during the first half cycle, diode 1 and 2 conduct and current takes the path ABCRDEF
- In the next half cycle when F is positive, diode 3 and 4 conduct and current flows through the path FECRDBA
- Once again current flows through R in the same direction during both cycle of input and d.c output is obtained.



(c) Derive an expression for the amplification factor, μ, in terms of anode resistance, R_a and mutual conductance, g_m, for a triode valve. (03marks)

Amplification factor, μ = $\frac{\Delta V_a}{\Delta V_g} x \frac{\Delta I_g}{\Delta I_a}$

= $\frac{\Delta V_a}{\Delta I_a} x \frac{\Delta I_g}{\Delta V_g}$

But $\frac{\Delta V_a}{\Delta I_a} = R_a$ and $\frac{\Delta I_g}{\Delta V_g} = g_m$

$\therefore \mu = R_a \, x \, g_m$

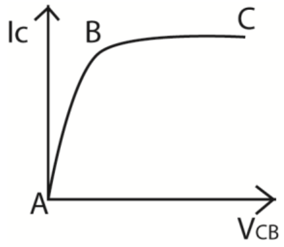
(d) A triode with mutual conductance $3mAV^{-1}$ and anode resistance of 10kΩ is connected to a load resistance of 20kΩ, Calculate the amplitude of output signal, if the input signal is 25mV. (04marks)

$g_m = 3.0 \, x \, 10^{-3} AV^{-1}, R_a = 10 \, x \, 10^3 \Omega, R_L = 20 \, x \, 10^3 \Omega$

Voltage gain = $\frac{\mu R_L}{R_L + R_a} = \frac{R_a \, x \, g_m \, x \, R_L}{R_L + R_a} = \frac{10 \, x \, 10^3 \, x \, 3 \, x \, 10^{-3} \, x \, 20 \, x \, 10^3}{20 \, x \, 10^3 + 10 \, x \, 10^3}$ = 20

Magnitude of output signal = 20 x 25 x 10^{-3} = 0.50V

(e) (i) Sketch the output characteristics of a transistor. (02marks)



(ii) Identify on the sketch in (e)(i), the region over which the transistor can be used as amplifier. (01).

Linear region BC

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