UACE Physics paper 1 set4 guide

1. (a) (i) Define dimensions of a physical quantity. (01mark)

Dimensions of a physical quantity is the way it is related to fundamental quantities; mass, length and time

(ii) In the gas equation

$$\left(P + \frac{a}{V^2}\right)(V - b) = RT$$

Where P = pressure, V= volume, T= absolute temperature and R= gas constant, what are the dimensions of the constants a and b? (04mark)

$\left[\frac{a}{V^2}\right]$ = [P] since it is added to P

$[P] = \frac{[Force]}{[Area]} = \frac{MLT^{-2}}{L^2} = ML^{-1}T^{-2}$

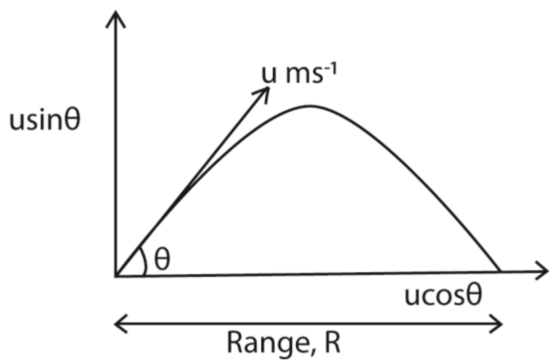
$[V] = L^3$

=> $\frac{[a]}{[L^6]}$ = $ML^{-1}T^{-2}$ => [a] = ML^5T^{-2}

[b] = [V] since b is subtracted from V

[b] = L^3

(b) A particle is projected from a point on horizontal plane with a velocity, u, at an angle, θ, above the horizontal. Show that the maximum horizontal range R_{max} is given by, $R_{max} = \frac{u^2}{g}$ where, g, is the acceleration due to gravity. (04marks)



R = ucosθ x time of flight

Time of flight = $\frac{2usin\,\theta}{g}$

∴ Range = ucosθ x $\frac{2usin\,\theta}{g}$ = $\frac{u^2 sin2\theta}{g}$

Form maximum range sin2θ = 1

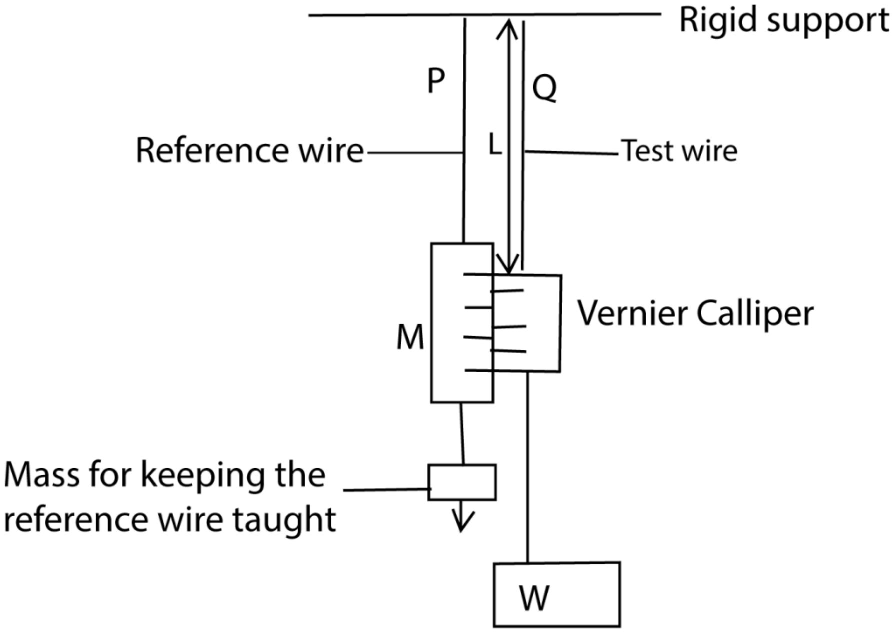
=> $R_{max} = \frac{u^2}{g}$

(c) (i) Define elastic limit of a material. (01marks)

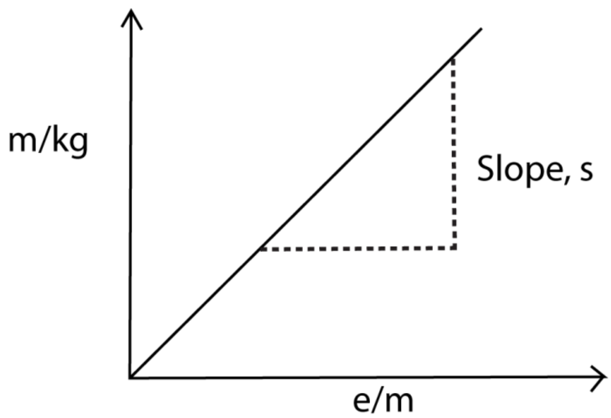
Elastic limit is the maximum load which a material can experience and still regain its original size and shape once the load has been removed.

(ii) Describe an experiment to determine Young's Modulus of a steel wire. (06marks)

Experiment to determine Young's Modulus for a metal wire



(i) Two thin, long wires of the same material and length P and Q are suspended from a rigid support.
(ii) P carries a scale M in mm and it's straightened by attaching a weight at its end.
(iii) Q carries a Vernier scale which is alongside scale M
(iv) Various loads are added to the test wire and corresponding extensions caused are read off from a vernier scale.
(v) The diameter (2r) of the wire is obtained by a micrometre screw gauge, and the cross section area of the wire A = $4\pi r^2$
(vi) A graph of mass (m) of the load against extension e is plotted



Young's modulus, Y = $\frac{gsL}{A}$

(d) Explain why tyres of a vehicle travelling on a hard surfaced road may burst. (04marks)

When the car moves on a hard surface, friction between the tyres and the surface causes overheating and the temperature inside the tyres increase. The increase in temperature increases the pressure inside the tyre which may lead to bursting.

2. (a) (i) What is meant by efficiency of a machine? (01mark)
Efficiency is the ratio of useful work done by a machine to the energy used by the machine; (expressed as percentage)

(ii) A car of mass1.2 x 10^3kgmovesup an incline at a steady velocity of 15ms^{-1} against a frictional force of 6.0 x 10^3N. The incline is such that the car rises 1.0m for every 10m along the incline. Calculate the output power of the car engine. (04marks)

F = mgsinθ +Fr

$= 1.2 \times 10^3 \times 9.81 \times \frac{1}{10} + 6000 = 7177.2N$

P = Fv

$= 7177.2 \times 15 = 1.077 \times 10^5 W$

(b) (i) Define the impulse and momentum. (02marks)

- Impulse is a product of force and time of action of the force
- Momentum is a product of mass and its velocity

(ii) An engine pumps water such that the velocity of the water leaving the nozzle is 15ms^{-1}. If the water jet is directed perpendicularly on a wall and comes to a stop at the wall, calculate the pressure exerted on the wall. (03marks)

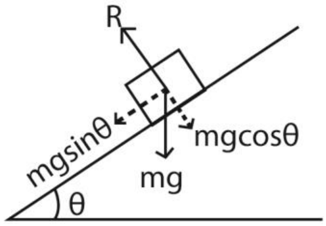
Force exerted on the wall, F = ρAV^2

Pressure = $\frac{F}{A} = \rho V^2 = 1000 \times 15^2 = 2.25 \times 10^5 Nm^{-2}$

(c) (i) Define inertia. (01mark)

Inertial is the reluctance of a body to start moving once at rest or to stop moving once it has begun to move.

(ii) Explain why a body placed on a rough plane will slide when the angle of inclination is increased. (04marks)



A body of mass, m placed on a plane inclined at an angle θ above the horizontal has its component mgsinθ downwards along the plane. Since the plane is rough, mgsinθ causes the frictional force Fr which prevents the body from sliding.
As θ increases, mgsinθ exceeds maximum Fr and the body slides.

(d) (i) State the conditions for a body to be in equilibrium under action of coplanar forces. (02marks)

- Resultant force on the body is zero
- Algebraic sum of moments at any point is zero.

(ii) Briefly explain the three states of equilibrium (03marks)

- When a body in stable equilibrium is slightly displaced, its centre of gravity is raised. When released, it returns to its original position.
- When a body in stable equilibrium is slightly displaced, its centre of gravity is lowered and it continues to fall on release- topples.

- For neutral equilibrium, the centre of gravity remains the same on displacement.

3. (a) (i) What is meant by conservative forces? (01mark)

A conservative force is one for which the work done to move a body from one point to another is independent of the path taken and only depends on initial and final position of the body.

(ii) Give two examples of conservative forces (02marks)

- Mechanical energy
- Work done to move the body round a closed path.

(b) Explain the following

(i) damped oscillations (02marks)

Damped oscillation are oscillations in which the oscillatory system loses energy to the surroundings due to dissipative forces. The amplitude of the oscillations reduces with time.

(ii) Forced oscillations (02marks)

Force oscillations are those which are maintained by external force.

(c) (i) State Newton's law of gravitation (01mark)

Newton's law of gravitation states that every particle of matter attracts every other particle with a force which is directly proportional to the product of their masses and inversely proportional to the square of their distance apart.

(ii) Show that Newton's law of gravitation is consistent with Kepler's third law. (05marks)

Consider a planet of mass M_P moving around the sun of mass M_S in a circular orbit of radius r.

Force due to gravitation, F = $\frac{GM_PM_S}{r^2}$

Force from circular motion, F = $\frac{M_PV^2}{r}$

But $\frac{GM_PM_S}{r^2} = \frac{M_PV^2}{r}$

$V^2 = \frac{GM_S}{r}$ also $V = \frac{2\pi r}{T}$

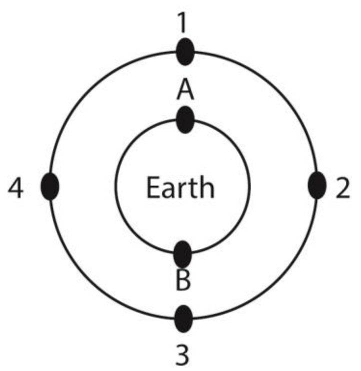
=> $\left(\frac{2\pi r}{T}\right)^2 = \frac{GM_S}{r}$

$T^2 = \frac{4\pi^2r^3}{GM_S}$ or $T^2 \propto r^3$

(d) If the earth takes 365 days to make one revolution around the sun, calculate the mass of the sun (04marks)

$M_S = \frac{4\pi^2r^3}{GT^2} = \frac{4\ x\ \pi^2\ x\ (1.5\ x\ 10^{11})^3}{6.67\ x\ 10^{-11}\ x\ (365\ x\ 24\ x\ 60\ x\ 60)^2}$ = 2.01×10^{30}kg

(e) Explain briefly how satellites are used in world-wide radio or television communication. (04marks)



- A set of satellites is launched in parking orbit as shown in the diagram above.

- A radio signal from A is transmitted to a geosynchronous satellite 1
- The signals are retransmitted from satellite 1 to geosynchronous satellite 2, then to 3 and finally to B.

4. (a) (i) What is meant by fluid element and flow line as applied to fluid flow? (02mark)
   - A fluid element is a molecule (the smallest volume) of the fluid which follows the flow.
   - A flow line is the path which individual molecule in a fluid element describes.

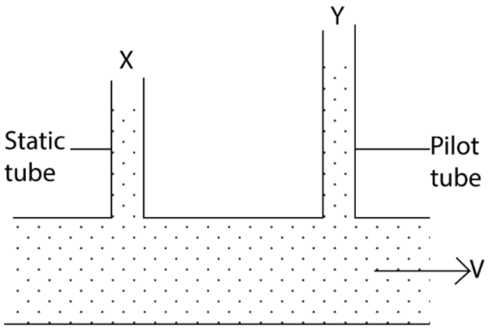
   (ii) Explain why some fluids flow more easily than others (03marks)

   Fluid flow involves different parts of a fluid moving at different velocities. Different parts of the fluid therefore slide past each other in layers. There exists frictional force between the layers which affects the flow rate. Liquids with low friction or viscosity flow faster than those with high viscosity.

   (b) (i) state Bernoulli's Principle. (01mark)

   Bernoulli's Principle states that for a streamline motion of an incompressible non viscous fluid, the sum of pressure at any point, the kinetic energy per unit volume is always constant.

   (ii) Explain how a Pilot-static tube works (04marks)



Pilot-static tube consists of a static tube which measure the static pressure and the pilot tube that measures the total pressure. Total pressure is the sum of static and dynamic pressure.

From P + $\frac{1}{2}\rho v^2 + \rho gh = constant$

Static pressure = P + ρgh

Dynamic pressure = $\frac{1}{2}\rho v^2$

Total pressure, P_y = static pressure (P_x) + dynamic pressure

= P + $\frac{1}{2}\rho v^2 + \rho gh$

For horizontal tube, h is constant

But, Total pressure, P_y = static pressure (P_x) + dynamic pressure

$$P_y = P_X + \frac{1}{2}\rho v^2$$

$$(P_y - P_x) = \frac{1}{2}\rho v^2$$

$$V = \sqrt{\left(\frac{2(P_y - P_x)}{\rho}\right)}$$

(c) Air flowing over the upper surface of an air craft's wing causes a lift force of 6.4 x 10^5N. The air flows under the wing at a speed of 120ms^{-1} over an area of 28m^2. Find the seed of air flow over an equal area of the upper surface of the air craft's wings. [Assume density of air = 1.2kgm^{-3}) (04marks)

$P_b + \frac{1}{2}\rho V_b^2 = P_u + \frac{1}{2}\rho V_u^2$

$P_b A - P_u A = \frac{1}{2}\rho\left(V_u^2 - V_b^2\right)$

$6.4 \ x \ 10^4 = \frac{1}{2} \ x \ 1.2(V_u^2 - 120^2)$

$V_u = 121.6ms^{-1}$

(d) (i) What is meant by surface tension and angle of contact of a liquid? (02marks)

- Surface tension is the force per metre length acting in the surface at right angles to one side of the line drawn in the surface.
- Angle of contact is the angle between the solid surface and the tangent plane to the liquid surface measured through the liquid.

(ii) A water drop of radius 0.5cm is broken up into other drops of water each of radius 1mm. assuming isothermal conditions, find the total work done to break up the water drop. (04marks)

Number of drops formed = $\frac{\frac{4}{3}\pi(0.5)^3}{\frac{4}{3}\pi(0.1)^3}$ = 125

Total surface area = 125 x 4πr^2 = 125π x 4 x (0.1 x 10^{-2})^2 = 1.57 x 10^{-3}m^2

Initial surface area = 4πR^2 = 4π(0.5 x 10^{-2})^2 = 3.14 x 10^{-4}m^2

Work done = γ x change in surface area

= 7.0 x 10^{-2} (1.57 x 10^{-3} – 3.14 x 10^{-4})

= 8.8 x 10^{-}5J

SECTION B

5. (a) (i) Define specific latent het of fusion (01mark)

Specific latent het of fusion is the amount of heat required to change 1kg mass of a substance from solid to liquid without change of temperature.

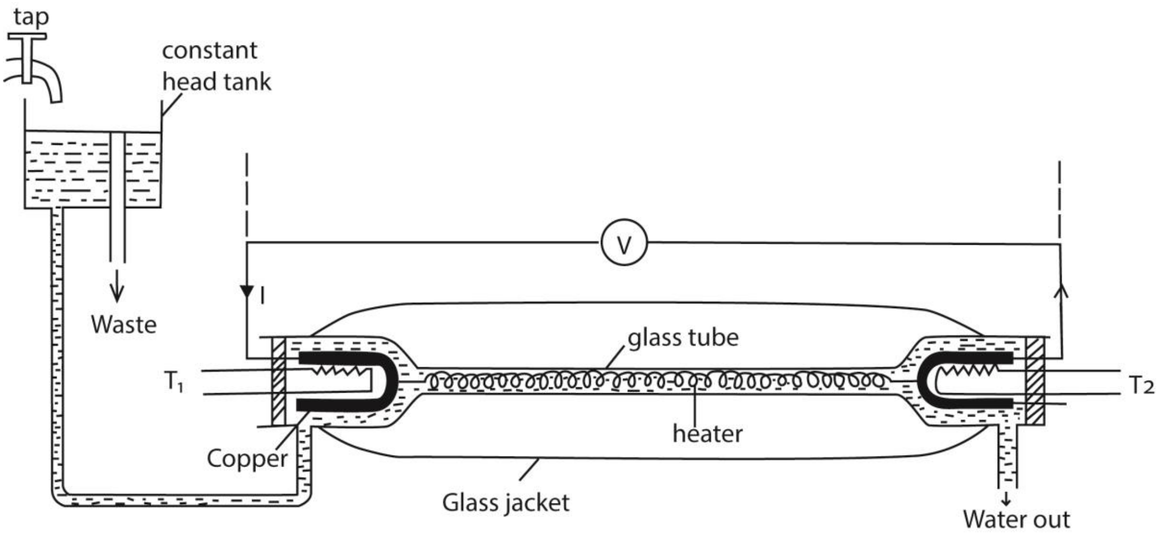
(ii) State effect of impurities on melting point (01mark)

Impurities lower the melting point.

(b) Explain why there is no change in temperature when a substance is melting (04marks)

Supply of heat to a melting solid reduces the forces of attraction between the molecules and increases the separation between them. This increases the potential energy (P.E) between the molecules while keeping kinetic energy (K.E) of the molecules the same. Further increase in separation between the molecules causes the regular pattern to collapse as the solid changes to liquid. Until this process is complete, the temperature does not change.

(c) With the aid of a labelled diagram, describe the continuous flow method of measuring the specific heat capacity of a liquid. (06marks)



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

(d) In an experiment to determine the specific latent heat of fusion of ice, heating coil is placed in a filter funnel and surrounded by lumps of ice. The following sets of reading were obtained.

V(V)	4.0	6.0
I(A)	2.0	3.0
Mass of water m (g) collected in 500s	14.9	29.8

Calculate

(i) Specific latent heat of fusion of ice (04marks)

Specific latent heat $c_l = \frac{(VI - V_1I_1)}{(m - m_1)} = \frac{4\,x 2 - 6\,x\,3}{\frac{14.9}{500\,x\,10^3} - \frac{29.8}{500\,x\,10^3}}$ = 3.36 x 10^5Jkg

(ii) Energy gained in the course of obtaining the first set of readings (03marks)

$I_1V_1 = m_1c_l + h$

4 x 2 = $\frac{14.9}{500\,x\,10^3}\ x\ 3.36\ x\ 10^5 + h$

h = -2W

Energy gained from surrounding = h x t = 2 x 500 = 1000J

(e) Why are two sets of reading necessary n (d) above. (01mark)

To account for heat gained from surrounding

6. (a) (i) State Dalton's law of partial pressures. (01marks)

Dalton's law of partial pressures states that the total pressure of a mixture of gases that do not react chemically is equal to the sum of partial pressures

(ii) Using the expression p = $\frac{1}{3}\rho\overline{c^2}$, where ρ is the pressure of a gas of density ρ and mean square speed c^2, derive Daltons law of partial pressures for two gases. (05marks)

P = $\frac{1}{3}N\frac{m}{V}\overline{c^2} = \frac{2}{3}N\left(\frac{1}{2}m\overline{c^2}\right)$

For gas 1, $P_1V_1 = \frac{2}{3}N_1\left(\frac{1}{2}m_1\overline{c_1^2}\right)$

=> $N_1 = \frac{3}{2}P_1V_1.\frac{1}{K_1}$

Similarly for gas 2

$N_2 = \frac{3}{2}P_2V_2.\frac{1}{K_2}$

For a mixture of gases, N = $\frac{3}{2}PV.\frac{1}{K}$; but N = $N_1 + N_2$

$\frac{3}{2}PV.\frac{1}{K} = \frac{3}{2}P_1V_1.\frac{1}{K_1} + \frac{3}{2}P_2V_2.\frac{1}{K_2}$

Since temperature is constant, $K_1 = K_2 = K$

- $PV = P_1V_1 + P_2V_2$
- But $V = V_1 = V_2$
- $\therefore P = P_1 + P_2$

(b) (i) What is meant by isothermal process and adiabatic process. (02marks)

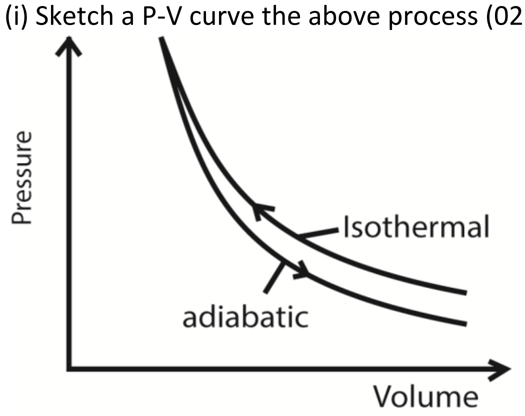
Isothermal process is the expansion or compression of a gas at constant temperature.
Adiabatic process is the expansion or compression of a gas where there is no heat loss or gain into the gas.

(ii) Explain why adiabatic expansion of a gas causes cooling (03marks)

During an adiabatic expansion of a gas, no heat is supplied to the gas. Molecules strike the receding piston and bounce off with reduced velocities and hence lower kinetic energy. Since kinetic energy is proportional to temperature, the gas cools during the expansion

(c) A gas at a temperature of 17^0C and pressure 1.0×10^5Pa compressed isothermally to half its original volume. It is then allowed to expand adiabatically to its original volume

(i) Sketch a P-V curve the above process (02marks)



(ii) If the specific heat capacity at constant pressure is 2100Jmol^{-1}K^{-1} and at constant volume is 1500Jmol^{-1}K^{-1}, find the final temperature of the gas (04marks)

$\gamma = \frac{2100}{1500} = 1.4$

$T_2 V_2^{\gamma - 1} = T_3 V_3^{\gamma-1}$

$290\left(\frac{V}{2}\right)^{0.4} = T_3 V^{0.4}$

$T_3 = 219.8K$

(d) (i) What is meant by saturated vapour? (01mark)

A saturated vapour is a vapour in dynamic equilibrium with its own liquid.

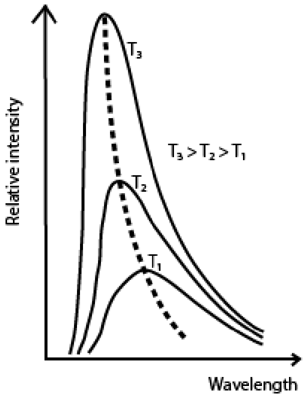
(ii) Explain briefly the effect of altitude on the boiling point of a liquid (02marks)

A liquid boils when its saturated vapour pressure is equal to the external vapour pressure. Atmospheric pressure decreases with increasing altitude, hence the boiling point of a liquid reduces as the altitude increases.

7. (a)(i) Define a black body. (01mark)

A black body is a body which absorbs all the radiations incident on it and does not reflect or transmit any.

(ii) Sketch and explain graphs of intensity versus wavelength for three different temperatures of a black body. (03marks)



- For every wave length, relative intensity increases as temperature is increased.
- The wavelength at which maximum intensity occur shifts to the shorter wavelength as temperature is increased.
- λ_{max} is the wavelength of radiation emitted at maximum intensity/emission of a black body at a particular temperature.

(b)Describe with the aid of a diagram how an optical radiation pyrometer is used to measure temperature. (06marks)

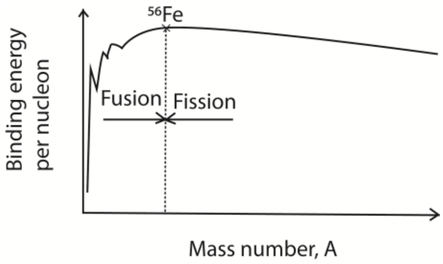
SECTION C

8. (a) (i) Distinguish between mass defect and binding energy of an atomic nucleus (01mark)

Mass defect s the difference between the mass of nucleons that make up a nucleus and the mass of a nucleus.

Binding energy of an atomic nucleus is the minimum energy to break up a nucleus into its constituent nucleons.

(ii) Sketch a graph of nuclear binding energy per nucleon versus mass number for naturally occurring isotopes and use it to distinguish between nuclear fission and fusion. (04marks)

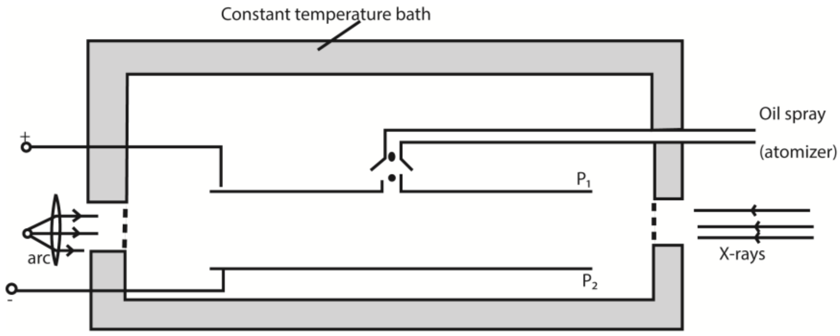


- Two Small nuclei with atomic mass less than 56 each fuse to give a heavier nuclei with smaller mass by higher binding energy to increase stability of nucleon
- A nucleus with atomic mass higher than 56 split to form lighter nuclei of higher binding energy per nuclei.

(b) Describe with the aid of a diagram, Millikan's oil drop experiment to determine charge on oil drop. (07marks)

Millikan's Oil drop experiment

This is used to determine electronic charge e



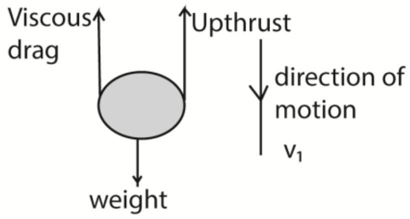
Procedure

- Set up of the apparatus is as shown above
- Oil drops are introduced between the plates P_1 and P_2 by spraying using the atomizer.
- These oil drops are charged in the process of spraying by friction but the charge may be increased further ionization due to X-rays.
- The oil drops are strongly illuminated by an intense light from the arc lamp so that they appear as bright spots when observed through a low power microscope.
- With no electric field between the plates, record the time t_1 taken for drop to fall from P_1 to P_2.
- The electric field between the plates is turned on and adjusted so that the drop becomes stationary.

Case 1

With no electric field, the oil drop falls with a uniform velocity v_1 called terminal velocity

Forces of falling oil drop



Weight = Upthrust + viscous drag ……………………………… (i)

= volume of the oil drop x density x gravity

= $\frac{4}{3}\pi r^3\rho g$ (ρ = density of oil, r = radius of oil drop)

Upthrust = weight of air displaced by oil drop

= volume of the air displaced by oil drop x density x gravity

= $\frac{4}{3}\pi r^3\sigma g$ (σ = density of air)

Viscous drag = $6\pi r\eta v_1$ (From strokes' law)

From 1

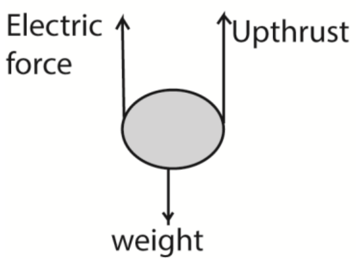
$\frac{4}{3}\pi r^3\rho g = \frac{4}{3}\pi r^3\sigma g + 6\pi r\eta v_1$ …………………… (ii)

$r = \left[\frac{9\eta v_1}{2g(\rho-\sigma)}\right]^{\frac{1}{2}}$

Case 2

When the electric field is applied so that the drop is stationary, the drop has no velocity and no acceleration.

Forces of stationary oil drop



Weight = Upthrust + electric force

$\frac{4}{3}\pi r^3\rho g = \frac{4}{3}\pi r^3\sigma g + qE$ …………………… (iii)

From (ii) and (iii)

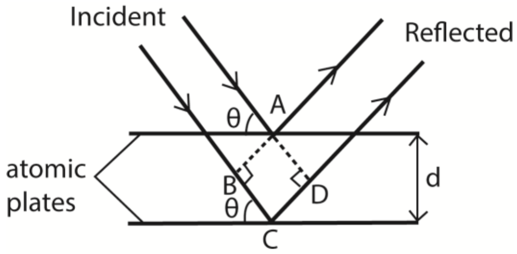
q = $\frac{6\pi r\eta v_1}{E}$ but E = $\frac{V}{d}$

Substituting for r

q = $\frac{6\pi\eta d v_1}{V}\left[\frac{9\eta v_1}{2g(\rho-\sigma)}\right]^{\frac{1}{2}}$

(c) (i) Explain briefly diffraction of X-rays by crystals and derive Bragg's law. (06marks)

- A parallel beam of monochromatic X-rays incident on a crystal is reflected from successive atomic planes and super-imposed, forming an interference pattern.



For constructive interference to occur, the path difference is equal to the whole number of wavelength

Thus BC + CD = nλ

⇨ dsinθ + dsinθ = nλ

or 2dsinθ = nλ where n = 1, 2, 3, 4 …

(ii) A second order diffraction image by reflection of X-rays at atomic plates of crystal for glancing angle of $11^0 24'$. Calculate the atomic spacing of the plates if the wavelength of X-ray is 4.0 x 10^{-11}m. (02marks)

From 2dsinθ = nλ

d = $\frac{2 \, x \, 4 \, x \, 10^{-11}}{2 \, x \sin 11^0 24\prime}$ = 2.02 x 10^{-1}0m

9. (a) state Bohr's postulates of an atom (03marks)
Bohr's model state that electrons move in allowed orbits round the nucleus and while in orbits, they do not radiate any energy

(b) An electron of mass m and charge –e, is considered to move in circular orbit about a proton.

(i) Write down the expression for the electric force on the electron. (02marks)

Force = $\frac{e^2}{4\pi\varepsilon_0 r^2}$ where e = electronic charge, r = orbit radius

(ii) Derive an expression for total energy given that the angular momentum for the electron is equal to $\frac{nh}{2\pi}$ where n is an integer and h is Plank's constant. (06marks)

In the orbit, $\frac{mv^2}{r} = \frac{e^2}{4\pi\varepsilon_0 r^2}$

=> Kinetic energy = $\frac{e^2}{8\pi\varepsilon_0 r}$ ………… (i)

Potential energy = $\int_{\infty}^{r} \frac{-e^2}{4\pi\varepsilon_0 r^2} dr = -\frac{e^2}{4\pi\varepsilon_0 r}$

Total energy, E_t = P.E + K.e

$$= -\frac{e^2}{4\pi\varepsilon_0 r} + \frac{e^2}{8\pi\varepsilon_0 r} = -\frac{e^2}{8\pi\varepsilon_0 r} \text{ ………. (ii)}$$

Angular momentum = mvr

mvr = $\frac{nh}{2\pi}$

$\therefore m^2v^2r^2 = \frac{n^2h^2}{4\pi^2}$

$\frac{1}{2}mv^2 = \frac{n^2h^2}{8\pi^2mr^2}$

From (i) $\frac{e^2}{8\pi\varepsilon_0 r} = \frac{n^2h^2}{8\pi^2mr^2}$

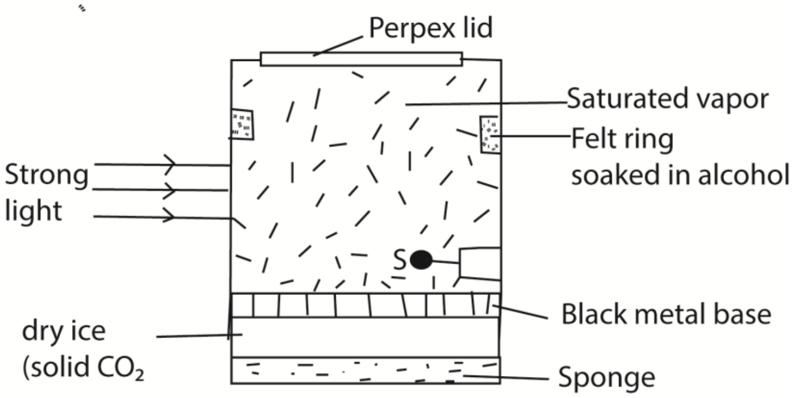
$r = \frac{n^2h^2\varepsilon_0}{\pi me^2}$

Substituting for r in equation (ii)

$E_t = -\frac{e^2}{8\pi\varepsilon_0} x \frac{\pi me^2}{n^2h^2\varepsilon_0}$

$= \frac{-me^4}{8n^2h^2\varepsilon_0^2}$

(c) With the aid of a labelled diagram, describe the operation of a diffusion type cloud chamber. (06marks)



- The base of the chamber is maintained at low temperature, about -80^{0}c 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 vapor from the felt ring. This vapor continuously diffuse downwards into the cooler regions so that the air at the chamber is super saturated with alcohol vapor.
- Radiations from the radioactive source S cause the ionization of the vapor.
- The ionizations from the radioactive source S cause condensation of the vapor 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 vapor.

(d) The energy levels of an atom have values

E_1 = - 21.4eV

E_2= -4.87 eV

E_3 = -2.77 eV

E4 = -0.81eV

E_∞ = 0.00eV

(i) Calculate the wavelength of radiation emitted when an electron makes a transition from E_3 to E_2 (03marks)

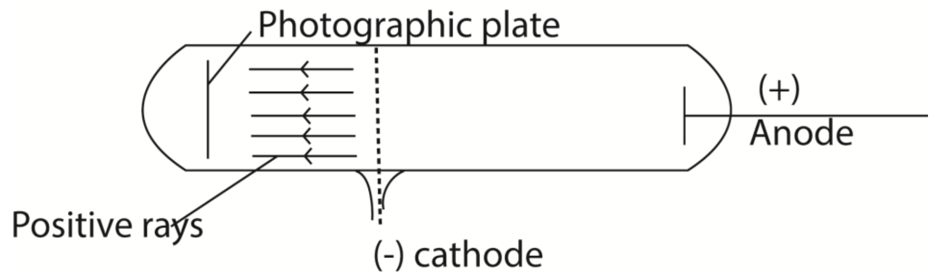
$E_3 - E_2 = hf = \frac{hc}{\lambda}$

$\lambda = \frac{6.6 \, x \, 10^{-34} \; x \; 3 \, x \, 10^{8}}{(-2.77-(-4.87) \, x \, 10^{-19}}$ = 5.97 x 10^{-7}m

(ii) State the region of the electromagnetic spectrum where the radiation lies (01mark)

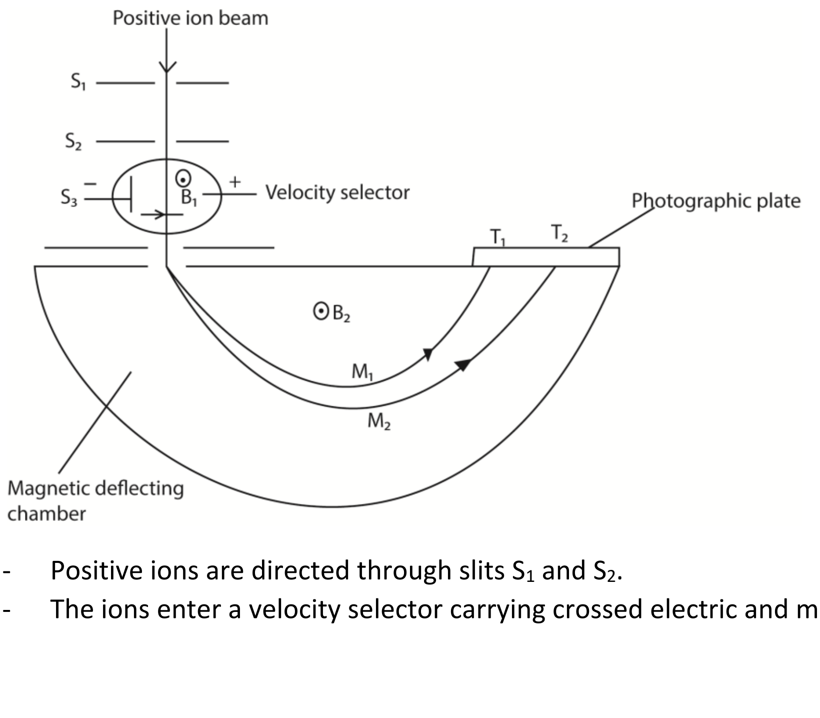
Visible spectrum

10. (a) Describe how positive rays are produced. (03marks)



Positive rays are produced when a stream of electrons is passed through a vapor (gas) in discharge tube. The electrons dislodge electrons from the atoms producing positively charged ions. The positive ions are accelerated towards perforated cathode. The ions pass through the slits and are further accelerated. These ions constitute a stream of positive rays.

(b) Describe how a Bainbridge spectrometer can be used to detect isotopes. (05marks)



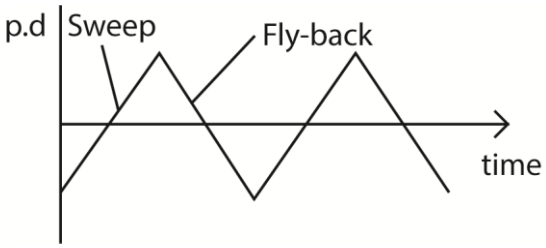
- Positive ions are directed through slits S_1 and S_2.
- The ions enter a velocity selector carrying crossed electric and magnetic field.

- Selected ions enter a region of uniform magnetic field in circular paths and strike the photographic plate at different points

(c) (i) What is time base as applied to a Cathode Ray Oscilloscope? (01mark)

Is a circuit connected to the x-plate of cathode ray oscilloscope to sweep the electron beam across a screen of a C.R.O

(iii) Draw a sketch graph showing the variation of time base voltage with time (01mark)



(d) An alternating p.d applied to the Y-plate of an oscilloscope produces five complete waves on a 10cm length of the screen when the time base setting is 10mscm^{-1}. Find the frequency of the alternating voltage. (03marks)

Period, T = $\frac{10 \ x \ 10 \ x \ 10^{-3}}{5}$ = 0.02s

Frequency = $\frac{1}{T} = \frac{1}{0.02}$ =50Hz

(e) (i) Explain the motion of an electron projected perpendicularly into a uniform magnetic field. (03marks)

By Fleming's left hand rule, the electrons experience a force which is always at right angles to the magnetic field and the direction of motion. The speed of electrons remain unaltered but the electrons is deflected by from its original path by this force. The motion of electrons in a magnetic field is a circular path.

(ii) An electron accelerated from rest by a p.d of 100V, enters perpendicularly into a uniform electric field intensity 105Vm-1. Find the magnetic field density, B, which must be applied perpendicularly to the electric field so that the electron passes undeflected through the fields. (04marks)

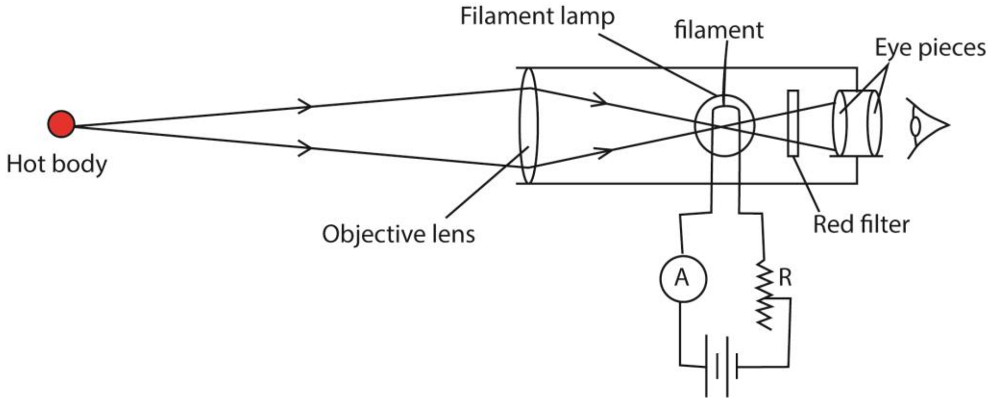
$\frac{1}{2}mu^2 = eV$

u = $\sqrt{\frac{2eV}{m}} = \sqrt{\frac{2 \ x \ 1.6 \ x \ 10^{-19} \ x \ 100}{9.11 \ x \ 10^{-31}}}$ = 5.93 x 10^{6}ms^{-1}

when the electron passes through crossed field undeflected

Beu = eE

B = $\frac{E}{u} = \frac{10^6}{5.93 \ x \ 10^6}$ = 0.0169T



- the filament is focused on the eye piece and the objective focuses the object so that the image of the object lies in the same plane as the filament
- Light from the hot object and the filament is passed through the red filter and viewed by the eyepiece.
- Current is adjusted by the rheostat R until the filament and the object are equally bright.
- The temperature of the hot body is then read from the calibrated ammeter, A.

(c) (i) State Prevost's theory of heat exchanges (01marks)

When a body is in thermal equilibrium with its surrounding, its rate of emission of radiation to surrounding is equal to the rate of absorption of the radiation from the surrounding.

(ii) Metal sphere of radius 1.5cm is suspended within an evacuated enclosure whose walls are at 320K. The emissivity of the metal is 0.40. Find the power input required to maintain the sphere at a temperature of 320K, if heat conduction long the support is negligible. (04mrks)

P =εAσ(T_4 - T_0^4)

= 0.4 x 4π (1.5 x 10^{-2})2 x 5.67 x 10^{-8}(320^4 – 320^4) = 0

(d) A metal boiler is 1.5cm thick. Find the difference in temperature between the inner and outer surfaces if 40kg of water evaporate from the boiler per meter squared per hour. [Latent heat of vaporization of water = 2268kJkg^{-1}, Thermal conductivity of the metal of the boiler = 63Wm^{-1}K^{-1}] (05marks)

$\frac{dQ}{dt} = \frac{40}{3600}\ x\ 2268000$ = 22500

From $\frac{dQ}{dt} = \frac{kA(\theta_2 - \theta_1)}{l}$

22500 = $\frac{63\ x\ 1\ x\ \Delta Q}{1.5\ x\ 10^{-2}}$

ΔQ = 6.0K

Compiled by Dr. Bbosa Science