Q. No. 2 Part (i) **MAGNETIC FLUX** :- The scalar product of magnetic induction and area is called magnetic flux or the no. of magnetic field lines that pass through an area is magnetic flux.

***UNITS** :- Weber (W), Tesla·metre sq (Tm^2)

$$1W = 1\frac{Nm}{A}$$

$$\therefore \phi_B = B \cdot A = BA\cos\theta.$$

MAGNETIC FLUX DENSITY :- The magnetic flux per unit area is known as magnetic flux density. It is also called magnetic induction (B).

***UNITS** :- Tesla (T), Weber per metre sq ($Wb\,m^{-2}$)

$$1T = 1\frac{N}{mA}, \quad 1\,Gauss = 10^{-4}\,Tesla$$

$$1G = 10^{-4}\,T$$

$$\therefore B = \frac{\phi_B}{A}$$

Q. No. 2 Part (ii) WEIN'S DISPLACEMENT LAW :-

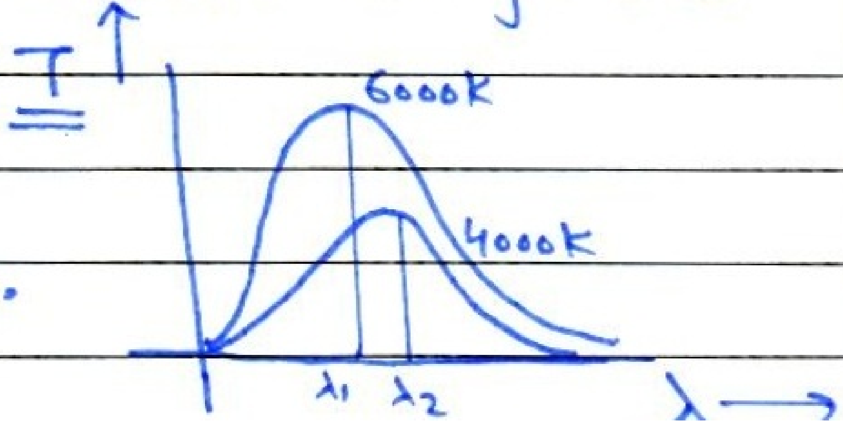
With the increase of temperature, peak of the distribution shifts toward shorter wavelength. If λ_{max} is wavelength when curve peak and T is absolute temperature then:-

$$\lambda_{max} \propto \frac{1}{T}$$

$$\lambda_{max} = \frac{constant}{T}$$

$$\lambda_{max} \times T = constant$$

constant is called wein's constant having value 2.9×10^{-3} mK.



when Temp increases, λ_{max} will decrease and viceversa.

Q. No. 2 Part (iii) **BASE OF TRANSISTOR** :- In transistor, EB junction is forward biased to emit large amount of charges. The base is lightly doped so that recombination of charges in base is less and transit time of charge is low. The base is made thin so that it cannot accomodate such large amount of charges, and all charge move to collector.

∴ Since CB junction is reverse bias, so the large potential gradient attracts all the charges towards itself and due to its size, it can accomodate these charges too. So base current is very small, due to thin and lightly doped characteristics.

Q. No. 2 Part (iv) GIVEN :- Lyman series

REQUIRED :- longest wavelength of radiation = ?

FORMULA :- $\frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{n^2}\right)$.

SOLUTION :-

since minimum energy is released when electron jumps from n = 2 to n = 1, so wavelength will be longest.

$$\frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{2^2}\right)$$

$$\frac{1}{\lambda} = 1.0967 \times 10^7 \left(\frac{3}{4}\right)$$

$$\frac{1}{\lambda} = 8227500\ m^{-1}$$

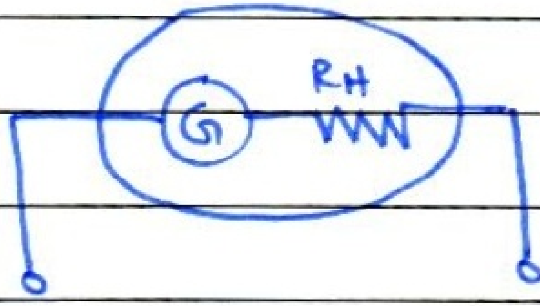
$$\lambda = 121.5\ nm$$

RESULT :- longest wavelength of radiation is 121.5 nm

Q. No. 2 Part (v)

CURIE TEMPERATURE	CRITICAL TEMPERATURE
"Temperature at which ferromagnetism changes into paramagnetism is known as curie temperature."	"Temperature at which resistance of superconductor drops to zero is called critical temperature."
* Must be high temperature to break bonds and domains.	* Must/usually is low temperature.
* By increasing temp, bonds break and paramagnetic substance produced	* By decreasing temp, atom K.E decreases, so collisions decrease and R = 0.
* curie temp of iron is 450°C	* Critical temp of $YtBaO_3$ is 163K

Q. No. 2 Part (vi) **VOLTMETER** :- Voltmeter is a device used to measure potential difference. It is formed by galvanometer by connecting a **high resistance** in **series** with it.



As in series, current is same so I_g is current through G and R_H.
The voltage is sum of potential drop across R_H and G.

$$V = V_R + V_G = I_g R_H + I_g R_g$$

$$\frac{V}{I_g} = R_H + R_g$$

$$R_H = \frac{V}{I_g} - R_g$$ ∴ it is resistance of voltmeter

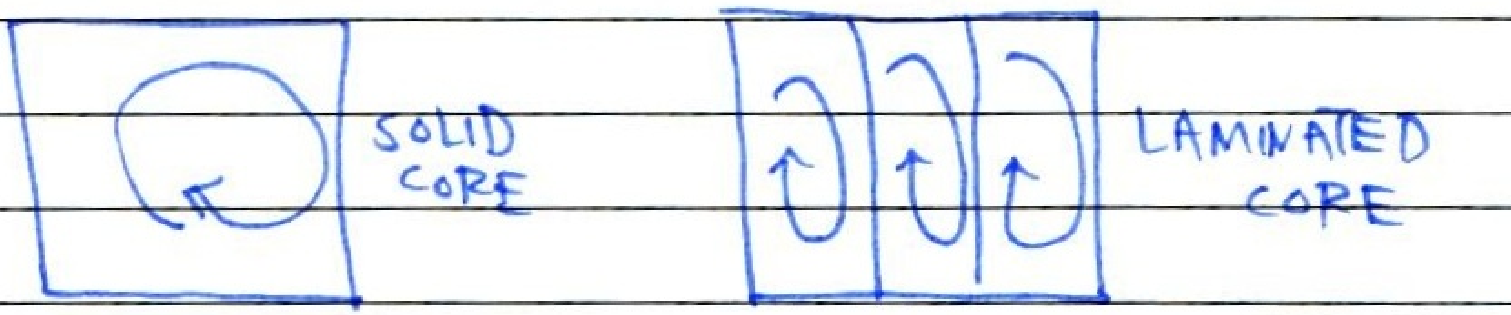
Ideally, voltmeter should have infinite resistance
∴ voltmeter is connected in parallel with circuit.

Q. No. 2 Part (vii) GEIGER-MULLER COUNTER

Principle:- Detects radiations due to their interaction with matter (ionization by radiation).

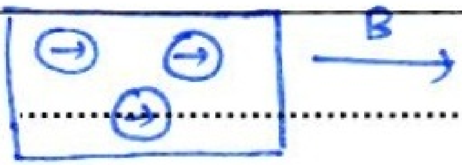
Construction and working:- It consists of long tube made of metal at low temperature, filled with a gas. There is a long wire along the axis of the tube. Wire is maintained at a relatively positive potential. When photons enter through window at one end of tube, they ionize the gas molecule into ions. The electrons released start moving toward the positive wire and ionize other gas molecules in their path. Thus large no. of electrons result in an electric pulse that is detected and counts through the counter and amplifier.

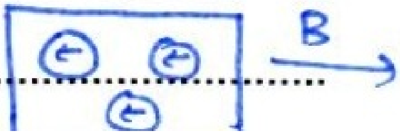
Q. No. 2 Part (viii) **TRANSFORMER** :- Transformer cores consist of soft iron core sheets that are pressed together but are seperated by an insulating layer. This arrangement is called laminated iron core. The advantage of laminated iron core is that circulation of eddy current is limited and it reduced to thickness of 1 lamina rather than the whole core. In this way, by reducing eddy current, heat losses are reduced and efficiency of transformer increases.



Q. No. 2 Part (ix)

PARAMAGNETIC MATERIAL	DIAMAGNETIC MATERIAL
① The spin and orbital axis of atoms are so oriented that they support each other. They behave like tiny magnets.	① The spin and orbital axis of atom cancel fields and net magnetic moment is zero
② In presence of B, the magnetic moments of atom align in direction of B weakly, so they are weakly attracted to B	② In presence of B, magnetic moments allign in direction opposite to B weakly, so are weakly repelled by B.
③ E.g. - Aluminium, Antimony	③ E.g :- Copper, Zinc
④ $u_o > 1$	④ $u_o < 1$



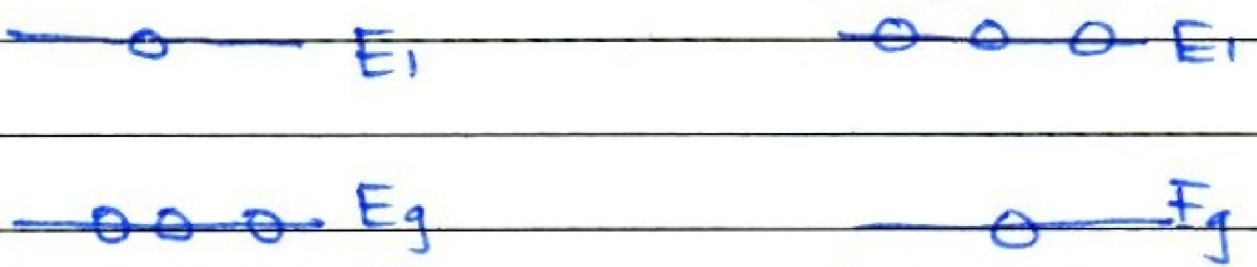


Q. No. 2 Part (x) **METASTABLE STATE:-** The excited state in which atom/electron stays for slightly longer period of time Before undergoing spontaneous emission is called metastable state.

Duration of excited state 10^{-8} s, Duration of metastable state 10^{-3} s.

POPULATION INVERSION:- The state/OR condition when more electrons are present in excited state than the normal state is called population inversion.

It is achieved by laser pumping.



NORMAL POPULATION   POPULATION INVERSION

Q. No. 2 Part (xi) GIVEN :- $K \cdot e = 1200 keV = 1200 \times 10^{3} \times 1.6 \times 10^{-19} = 1.92 \times 10^{-13} J$

REQUIRED :- $\lambda = ?$

FORMULA :- $\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{h}{\sqrt{2mK \cdot E}}$

SOLUTION

$$\lambda = \frac{h}{\sqrt{2mk \cdot e}}$$

$$= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 9.11 \times 10^{-31} \times 1.92 \times 10^{-13}}}$$

$$= 1.12 \times 10^{-12} \text{ m}$$

RESULT :- Wavelength of electron is 1.12×10^{-12} m.

....

Q. No. 2 Part (xii) GIVEN :- $m = 0.5\,kg = 500g$, $E = 208\,MeV$

REQUIRED :- energy for 0.5 kg U-235 = ?

FORMULA :- No. of moles = $\frac{m}{M}$; No. of particles = $N_A \times$ moles

SOLUTION :-

$$\text{No. of moles} = \frac{\text{mass}}{\text{Molar mass}} = \frac{500}{235} = 2.12 \text{ moles}$$

$$\text{No. of atoms} = N_A \times \text{moles} = 2.12 \times 6.02 \times 10^{23} = 1.28 \times 10^{24}$$

$$\text{Energy for 0.5 kg U-235} = E(\text{per event}) \times \text{No. of atoms}$$

$$= 208\,MeV \times 1.28 \times 10^{24}$$

$$= 2.66 \times 10^{26}\,MeV$$

RESULT :- Energy released by 0.5 kg $_{235}U$ is 2.66×10^{26} MeV.

Q. No. 2 Part (xiii) ELECTRON VOLT :- Amount of energy lost or acquired by an electron when it is displaced between two points between which potential different is 1V is equal to 1 electron volt.

$$W = q\Delta V$$

For electron;

$$E = W = e\Delta V \quad \because e = 1.6 \times 10^{-19} C$$

$$1eV = 1e \cdot 1V$$

$$= 1.6 \times 10^{-19} C \times 1V$$

$$= 1.6 \times 10^{-19} J$$

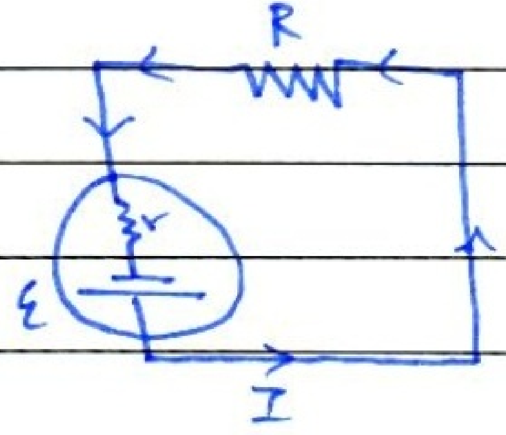
Thus eV is related to Joules by relation

$$1eV = 1.6 \times 10^{-19} J.$$

Q. No. 2 Part (xiv) **MAXIMUM POWER TRANSFER:-**

"Maximum power is delivered to load resistance if value of source resistance is equal to the value of load resistance."

i.e $\boxed{r = R}$



Power $= VI = I^2 R$

where $I = \varepsilon / r+R$, so

$$P = \frac{\varepsilon^2 R}{(R+r)^2} = \frac{\varepsilon^2 R}{(R-r)^2 + 4rR}$$

when $r = R$, then :-

$$P = \frac{\varepsilon^2 R}{\cancel{(R-R)^2} + 4R \cdot R} = \frac{\varepsilon^2 R}{4R^2} = \frac{\varepsilon^2}{4R}$$

hence max power is delivered when $r = R$.

BOHR'S ATOMIC MODEL

POSTULATES

Following are the postulates of Bohr's atomic model:-

① Electrons revolve around the nucleus in circular orbits. The centripetal force required to keep the electron moving in a circle is given by the electrostatic force of attraction between positively charged nucleus and electron.

$$F_c = F_e$$

$$\frac{mv^2}{r} = \frac{ke^2}{r^2}$$

② Electrons donot revolve around nucleus in any arbitrary orbits. Only those orbits are possible in which angular momentum is an integral multiple of $\frac{h}{2\pi}$.

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

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

③ Electron doesnot radiate energy continuosly. Energy is emitted only when electron moves from high energy orbit to low energy orbit.

$$hf = E_n - E_p.$$

ENERGY OF ELECTRON IN H ATOM

The kinetic energy and potential energy of electron in H atom depends on how far the electron is from the nucleus. The total energy

Q. No. 3 (Page 2) is the sum of kinetic and potential energies of electron.

$$E = K.E + P.E \rightarrow (1)$$

As kinetic energy is given by:-

$$K.E = \frac{1}{2} mv^2$$

$$= \frac{1}{2} \frac{ke^2}{r_n} \qquad \because mv^2 = \frac{ke^2}{r_n}$$

And potential energy is given by workdone as:-

$$P.E = -\frac{ke^2}{r_n}$$

putting values in (1), we get

$$E = \frac{1}{2} \frac{ke^2}{r_n} - \frac{ke^2}{r_n}$$

$$E = -\frac{1}{2} \frac{ke^2}{r_n} \rightarrow (2)$$

By Bohr radii, $r_n = \frac{n^2 h^2}{4\pi^2 m k e^2}$, put this value in (2)

$$E = -\frac{1}{2} ke^2 \times \frac{4\pi^2 m k e^2}{n^2 h^2}$$

$$E = -\frac{1}{2} \frac{4\pi^2 m k^2 e^4}{n^2 h^2}$$

$$E = -\frac{2\pi^2 m k^2 e^4}{n^2 h^2} \rightarrow (3)$$

As $\frac{2\pi^2 m k^2 e^4}{h^2}$ is constant and is equal to E_o.

E_o can be calculated by putting values

$\pi = 3.14$, $m = 9.11 \times 10^{-31}$ kg, $k = 9 \times 10^9\ Nm^2 C^{-2}$, $e = 1.6 \times 10^{-19}$ C, $h = 6.63 \times 10^{-34}$ Js.

$$E_o = \frac{2\pi^2 m k^2 e^4}{h^2} = 13.6\,eV$$

put in (3):-

Q. No. 3 (Page 3)

$$E_n = \frac{-E_o}{n^2}$$

$$E_n = \frac{-13.6 eV}{n^2} = -\frac{2.18 \times 10^{-18} J}{n^2}$$

E_o is the energy of first orbit of H atom and is called **ground state energy.** The other members have energy that can be calculated by E_o.

$$E_2 = \frac{-13.6 eV}{(2)^2} = -3.4 eV$$

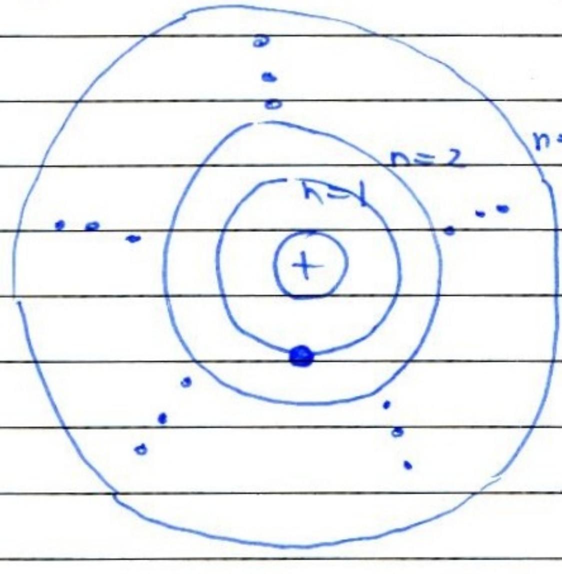
$$E_3 = -\frac{13.6 eV}{(3)^2} = -1.51 eV$$

⋮ ⋮

$$E_n = -\frac{13.6 eV}{(n)^2}$$

QUANTIZATION

Thus energy of electron in H atom is quantized and can be calculated using ground state energy E_o (lowest possible energy).



POTENTIOMETER

DEFINITION

"Potentiometer is a null type resistance network that is used for the measurement of potential difference."

PRINCIPLE

Accurate measurement of potential difference, current, resistance can be done through this device. Its principle is to measure an unknown emf by balancing it wholly or in parts with a source of known emf.

CONSTRUCTION AND WORKING

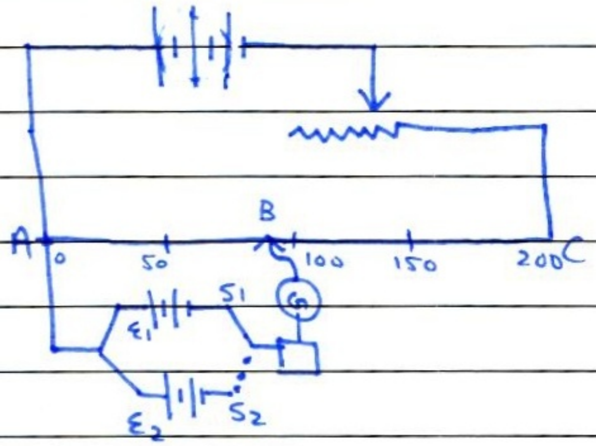
Potentiometer consist of a long wire AC of crossectional area A connected to a battery through rheostat. The battery through rheostat and wire provides the working current. The working current may be changed by adjusting setting of rheostat. A source of known emf is connected between A and terminal switch S_1 of the two way switch. The pointer B is pressed momentarily against the wire AC and its position is adjusted till galvanometer shows

Q. No. 4 (Page 2) no deflection. The length of wire AB is denoted as l_1. The fall in potential over l_1 is the emf $\mathcal{E}_1$ of the source. Now the second source is connected between A and terminal switch S_2 of the two way switch. The emf of this source is to be determined. The pointer B is again pressed on wire AC till galvanometer shows no deflection. This length is denoted l_2. Emf $\mathcal{E}_2$ of unknown source can be calculated as:-

$$\frac{\mathcal{E}_2}{\mathcal{E}_1} = \frac{l_2}{l_1}$$

$$\mathcal{E}_2 = \frac{l_2}{l_1} \times \mathcal{E}_1$$

FIGURE



USES

Potentiometer has following uses:-

1. It is used to measure small emf(2V) and largeemf(250V).
2. It is used in comparison of emf of two cells.
3. It is used to measure current and resistance.
4. It is used in calibration of ammeter and voltmeter.

Q. No. 4 (Page 3)

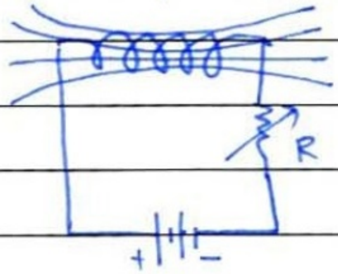
SELF INDUCTANCE

DEFINITION

"The emf induced in a coil due to change in its own flux linking with it is called self inductance."

CONSIDERATION

Consider a coil connected to battery of voltage V through the rheostat. The current is provided by battery to coil. By adjusting setting of rheostat, current in coil can be changed. This in turn changes the flux that results in production of self induced emf.



DERIVATION

The induced emf can be calculated through electromagnetic induction law of Faraday. let the coil have N no. of turns, then by Faraday's law, emf is given by:-

$$\mathcal{E} = N\frac{\Delta\phi}{\Delta t}$$

$$\mathcal{E} = \frac{\Delta N\phi}{\Delta t} \rightarrow (1)$$

where $N\phi$ is the flux linkage. The flux linkage is found proportional to current.

$$N\phi \propto I$$

so (1) becomes :-

$$\mathcal{E} \propto \frac{\Delta I}{\Delta t}$$

$$\mathcal{E} = L\frac{\Delta I}{\Delta t}$$

where L is proportionality constant called self inductance.

UNIT

Unit of self inductance is Henry.

$$1H = 1\,V s A^{-1}.$$

1 Henry is the self inductance when ratio of induced emf to rate of change of current is 1.

$$1H = \frac{\mathcal{E}}{\Delta I/\Delta t} = \frac{1V}{1As^{-1}} = 1\,Vs A^{-1}.$$

As $\mathcal{E} = N\frac{\Delta\phi}{\Delta t}$ and $\mathcal{E} = L\frac{\Delta I}{\Delta t}$, combining these equations, we get :-

$$LI = N\phi$$

$$L = \frac{N\phi}{I}$$

Q. No. 5 (Page 3) FACTORS AFFECTING INDUCTANCE

Inductance(L) depends on:-
i) material of core
ii) No. of turns and shape of coil/core
iii) Area and length of coil/core.

By using a material of high permeability, self inductance increases i.e. By replacing air with iron, L will increase.

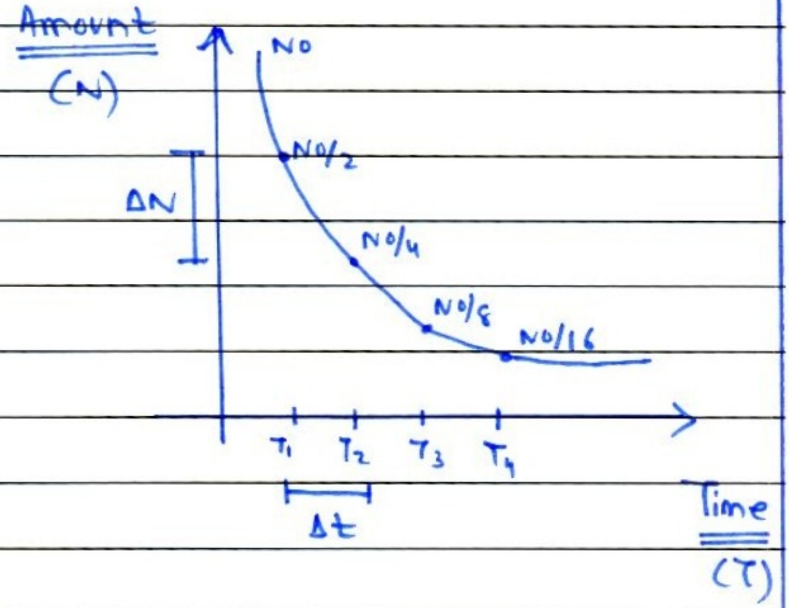
Q. No. 6 (Page 1)

HALF LIFE

DEFINITION

"The time during which half of radioactive nuclei in sample decays is known as half life."

Radioactive decay is random process. After one half life, amount of sample left becomes half. After 2nd half life, the amount left becomes 1/4 and so on.



DERIVATION

According to law of radioactive decay, the amount left behind is directly proportional to initial amount N. Radioactive decay rate or activity of sample is no. of disintegrations per second. Rate of decay is proportional to amount of sample.

Q. No. 6 (Page 2) By law of radioactive decay; we know:-

$$\frac{\Delta N}{\Delta t} \propto -N$$

$$\frac{\Delta N}{\Delta t} = -\lambda N$$

∴ negative sign indicate decrease in amount of sample

where λ is proportionality constant, that is called decay constant.

As $\frac{\Delta N}{\Delta t} = -\lambda N$

$$\frac{\Delta N}{N} = -\lambda \Delta t$$

integrating both sides:-

$$\int_{N_0}^{N} \frac{1}{N} \cdot \Delta N = -\lambda \int_{0}^{t} \Delta t$$

$$\left| \ln N \right|_{N_0}^{N} = -\lambda (t)_0^t$$

$$\ln \frac{N}{N_0} = -\lambda t$$

$$\frac{N}{N_0} = e^{-\lambda t}$$

$$\boxed{N = N_0 e^{-\lambda t}}$$

After first half life, mass/amount of sample left behind is $\frac{N_0}{2}$.

$$\frac{N_0}{2} = N_0 e^{-\lambda t_{1/2}}$$

Q. No. 6 (Page 3)

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

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

$$-\ln 2 = -\lambda t_{1/2}$$

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

As $\ln 2 = 0.693$, so:-

$$\lambda T_{1/2} = 0.693$$

$$\boxed{T_{1/2} = \frac{0.693}{\lambda}}$$

Decay constant is the time during which only 36.8% of sample is left behind. Units are per second.

ACTIVITY

"Rate of decay or activity of sample is no. of disintegrations per unit time."

$$A = \lambda N = \frac{\Delta N}{\Delta t}$$

UNITS:-

Becqueral, is the SI unit. Other unit is Curie that 3.7×10^{10} decay per second.

$$1\ Cu = 3.7 \times 10^{10}\ Bq$$

and $1\ Bq = 1$ decay per second

$\frac{h}{\sqrt{m\sqrt{v \times v}}}$ $\frac{h}{\sqrt{2 \times \frac{m^2 v^2}{2}}}$ $\frac{5(n)}{2}$

$\frac{h}{\sqrt{2mk \cdot e}}$

$\frac{q}{m} = \frac{2V}{B^2 r^2}$

$C = 1$

$Q = CV$

$= 1 \times 20$

$\Delta N \propto N$

$\Delta N \propto \frac{1}{\Delta t}$

~~$\Delta N \propto -\frac{N}{\Delta t}$~~

$N \propto \frac{\Delta N}{\Delta t}$

$V = \frac{kQ}{r}$ $V \propto \frac{1}{r}$ $V = \frac{kQ}{r}$

$r \uparrow V \downarrow$

$V = \frac{kQ}{r}$

$E = hf = \frac{hc}{\lambda}$

$C = 1$

$Q = CV$

$= 1 \times 20V$

$= 20VC$

$\Delta N \cdot$

$E = \frac{\Delta d}{\Delta r}$

$\frac{C \downarrow Q \uparrow}{NAB}$

$V \propto \frac{kQ}{r}$

$\Delta N \propto -N$

$\theta = 0°$ $E \propto V$

$\cos\theta = 1$

$\cos 0$

$P = \frac{W}{t}$

$Pt = W$

$\frac{N_S}{N_P} = 1$

$\lambda = \frac{h}{m_2 v} = \frac{h}{m}$

$\frac{I_C}{I_E - I_C}$

$\frac{\alpha}{1-\alpha}$

$\lambda = \frac{h}{mv}$

$\frac{2l - l}{l} = 1$

Δl

$2l - l$

$\frac{l}{l}$