Revision Booster WORKSHOP for NEET & JEE Main

Modern Physics

Notes of Revision Booster Workshop for JEE Main & NEET

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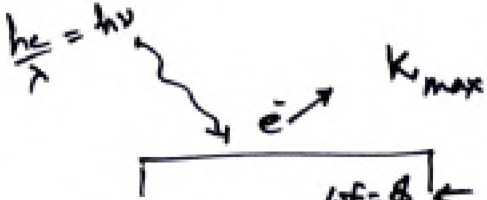
QUESTIONS BASED ON

CHANGE IN KE OF PHOTOELECTRONS



$h\nu > \phi$

$\lambda < \lambda_{th}$

$K_{max_1} = \frac{hc}{\lambda} - \phi$

$K_{max_2} = \frac{hc}{\lambda} - \phi'$

$K_{max_3} = \frac{hc}{2\lambda} - \phi'$

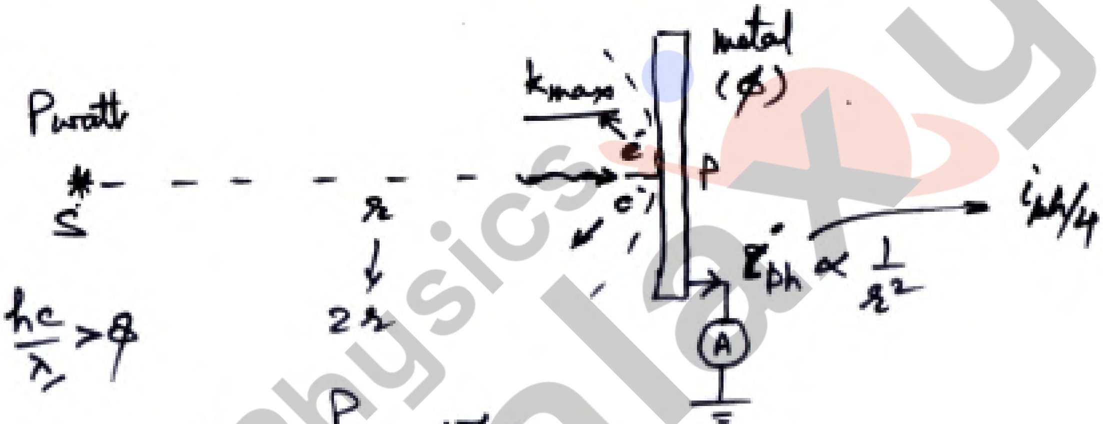
$\Delta K = |K_{m_1} - K_{m_2}|$

NOTE: if $\lambda \rightarrow 2\lambda$ ⇒ $\nu \rightarrow \nu/2$ ⇒ $K_f < \frac{K_i}{2}$

$\lambda \rightarrow \lambda/2$ or $\nu \rightarrow 2\nu$ ⇒ $K_f > 2K_i$

Questions Based on

Change in Photocurrent by Position of Source



$\frac{hc}{\lambda} > \phi$

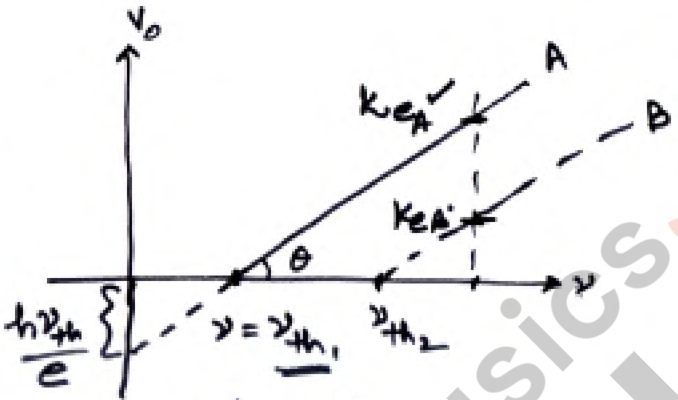
$I_P = \frac{P}{4\pi r^2}$ W/m²

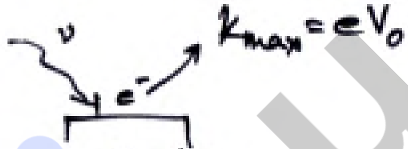
photon flux $\phi_p = \frac{I_P \lambda}{hc}$ no of photons/s-m²

$\Rightarrow \phi_p \propto \frac{1}{r^2}$

QUESTIONS BASED ON

STOPPING POTENTIAL VARIATION WITH FREQUENCY





$$\phi = h\nu_{th}$$

$$h\nu = h\nu_{th} + eV_0$$

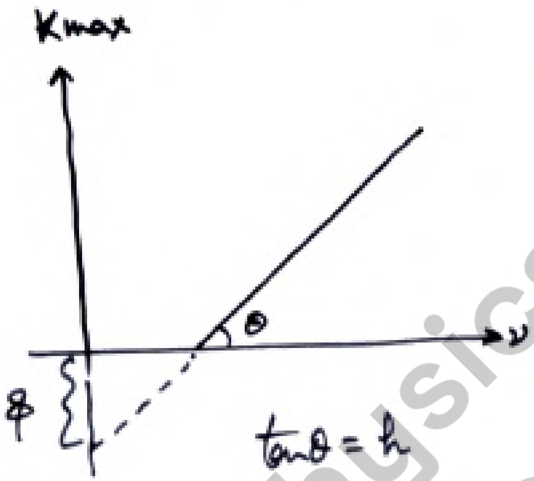
$$V_0 = \frac{h\nu}{e} - \frac{h\nu_{th}}{e}$$

$$\left(\tan\theta = \frac{h}{e}\right)$$

$$\phi_B > \phi_A$$

Questions Based on

Variation Curve of Maximum Kinetic Energy and Frequency



eV_0

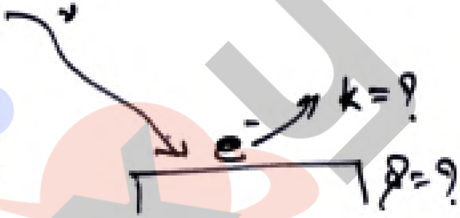
$K_{max} = h\nu - \phi$

QUESTIONS BASED ON

PHOTOELECTRIC ERRECT BY EQUATION OF EMW

$y = A \sin(\omega t - kx)$

$B = B_0 \sin[(3.14 \times 10^7 ct) - (\ldots)x]$



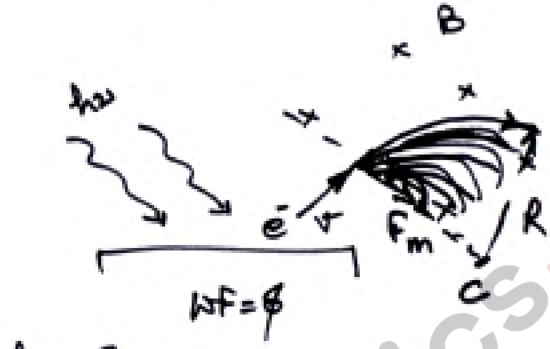
$2\pi f = \omega = 3.14 \times 10^7 c$

$\nu = f = \frac{10^7 \times 3 \times 10^8}{2} = 1.5 \times 10^{15}$ Hz

$K_{max} = h\nu - \phi$

Questions Based on

Photoelectrons Insertion in a Magnetic Field



$$R = \frac{mv}{qB}$$

$$R_{max} = \frac{\sqrt{2mK_{max}}}{qB} = \frac{\sqrt{2m(h\nu - \phi)}}{qB}$$

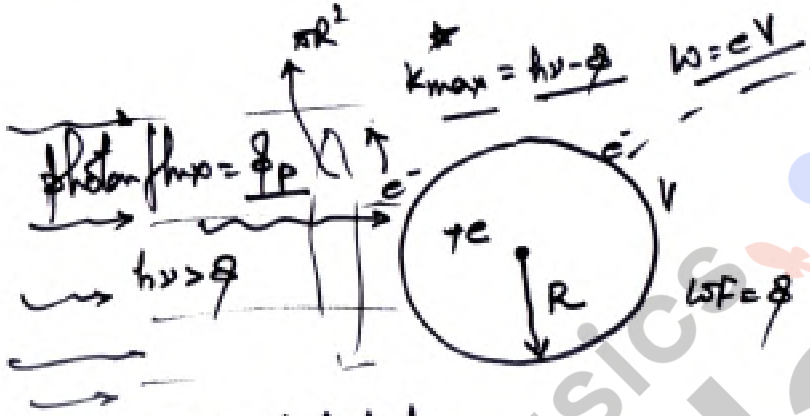
$$h\nu > \phi$$

$$h\nu - \phi = K_{max}$$

$$0 \le v \le v_{max}$$

Questions Based on

Stopping of Photoelectric Effect in an Isolated Sphere



★ $K_{max} = h\nu - \phi$ $\quad W = eV$

→ No of ph incident on sphere/sec

$N = \phi_p \pi R^2$

if quantum efficiency $= \eta$

$N_e = \phi_p \pi R^2 \eta$ e's/s.

charge/sec $= N_e e$.

after time t $\quad q = N_e e t$.

all ejected photoelectrons to be instantly removed from sphere surrounding!

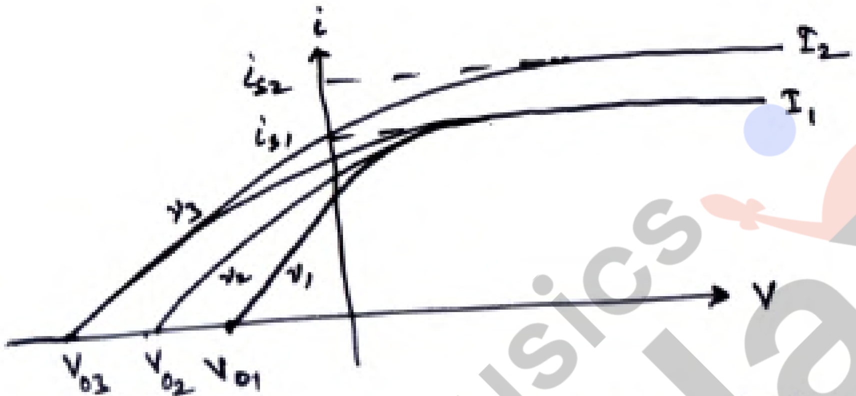
Pot^n of sphere at time t $\quad V_t = \frac{kq}{R} = \frac{1}{4\pi\epsilon_0} \cdot \frac{q}{R}$

To stop PEE $\quad$ ★ $K_{max} = eV_t$

$t = ----$ [at this time PEE will stop]

QUESTIONS BASED ON

EXPERIMENTAL ANALYSIS OF PHOTOCURRENT VARIATION

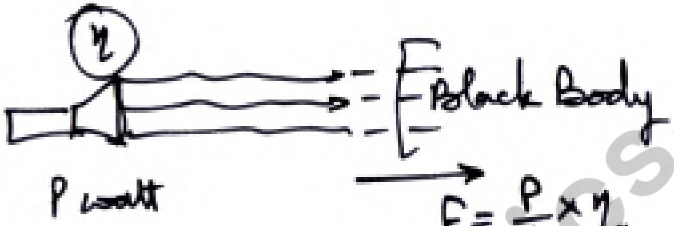


for diff freq → V_0 will be diff & i_s will be same if I → remains same (photon flux)

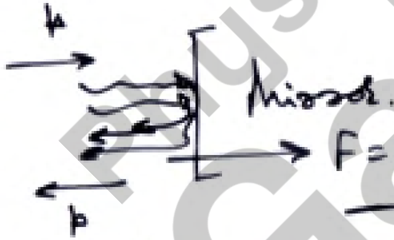
for diff I → i_s will be diff & V_0 will remain same if ν → constant

Questions Based on

Radiation Force by Light on a Surface



$$F = \frac{P}{c} \times \eta$$



$$F = \frac{\Delta p}{\Delta t} = \frac{2P}{c}$$

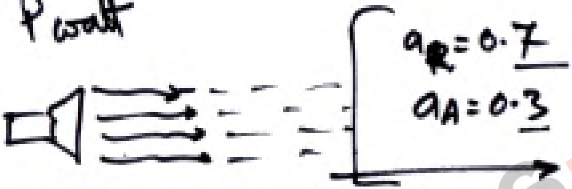
if Mirror is free to move ⇒ Some momentum will be gained by Mirror

$$F < \frac{2P}{c}$$

Questions Based on

Radiation Force on a Partly Reflecting Surface

P watt



$$F = \frac{0.3P}{c} + \frac{1.4P}{c} = \frac{1.7P}{c}$$

No of photons $= \frac{P\lambda}{hc}$ ph/s $\times \frac{h}{\lambda}$

QUESTIONS BASED ON

MATTER WAVES OF ACCELERATED ELECTRONS

p.d = V

e^- ———→ $K = eV$

de Broglie WL $\lambda = \frac{h}{\sqrt{2mK}} = \frac{h}{\sqrt{2meV}}$

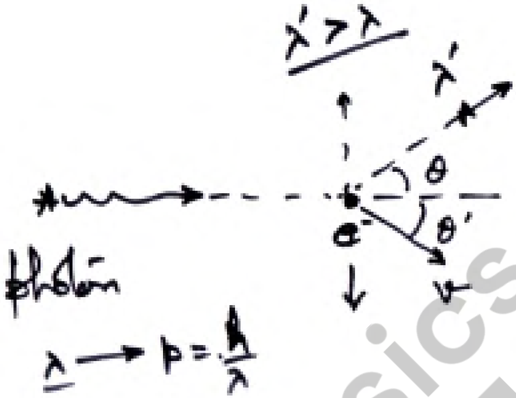
$\left\{ \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{V_2}{V_1}} \right\}$

* → YDSE

→ Diffraction by single slit

Questions Based on

Scattering of a Photon by an Electron



by Cons of energy

$$\frac{hc}{\lambda} = \frac{hc}{\lambda'} + \frac{1}{2}mv^2 \quad -(1)$$

by Cons of momentum

x dir → $\frac{h}{\lambda} = \frac{h}{\lambda'}\cos\theta + mv\cos\theta' \quad -(2)$

y dir → $\frac{h}{\lambda'}\sin\theta = mv\sin\theta' \quad -(3)$

Questions Based on

de Broglie Wavelength of Thermal Motion

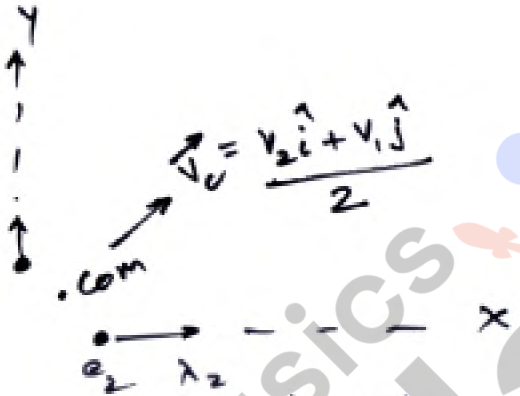
• In thermal motion $K = \frac{3}{2}kT$ (Translational KE)

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m(3/2\,kT)}} = \frac{h}{\sqrt{3mkT}}$$

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{T_2}{T_1}}$$

QUESTIONS BASED ON

de BROGLIE WAVELENGTH IN DIFFERENT REFERENCE FRAME



$\frac{h}{mv_1} = \lambda_1$

$v_1 = \frac{h}{m\lambda_1}$ ✓

$\vec{V}_c = \frac{v_2\hat{i} + v_1\hat{j}}{2}$

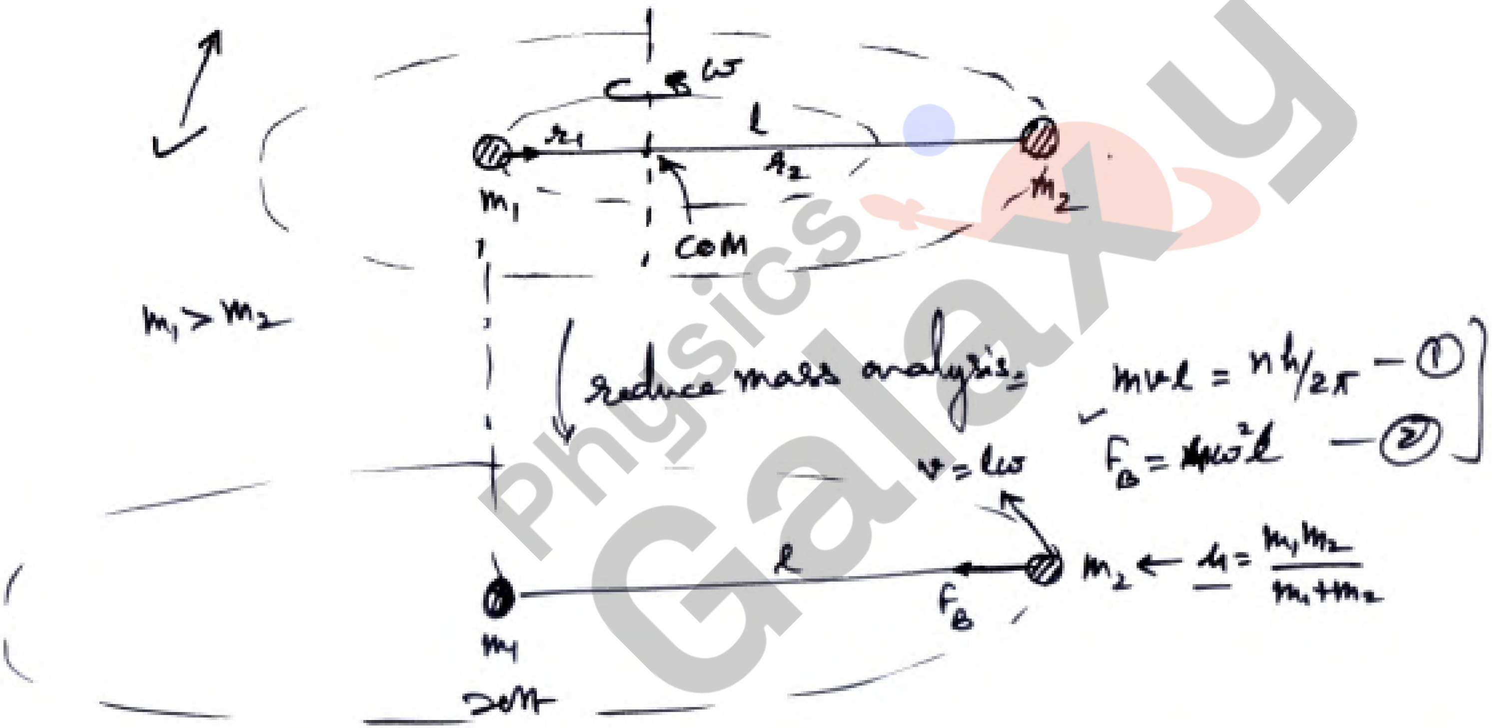
$v_2 = \frac{h}{m\lambda_2}$ ✓

$\vec{V}_{e,c} = \vec{V}_1 - \vec{V}_c = v_1\hat{j} - \left(\frac{v_2\hat{i} + v_1\hat{j}}{2}\right) = \frac{v_1\hat{j} - v_2\hat{i}}{2} = \frac{\sqrt{v_1^2 + v_2^2}}{2}$

dB WL of e_1 in frame of COM $\quad \lambda_{1c} = \frac{h}{mV_{1c}} = \frac{2h}{m\sqrt{v_1^2 + v_2^2}} = \_\_\_\_$

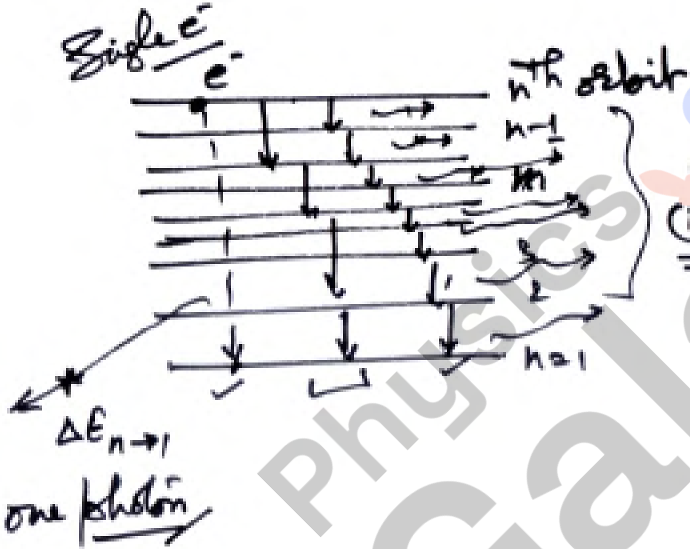
QUESTIONS BASED ON

BOHR'S II POSTULATE IN DIATOMIC MOLECULE



Questions Based on

Emission of Spectral Lines by Excited H-atom



upto (n−1) photons

"spectral lines"

↓

we talk about "gas" → system of multiple atoms

⇒ from $n^{th} \rightarrow 1^{st}$ orbit

Spectral lines $N = {}^nC_2 = \frac{n(n-1)}{2}$

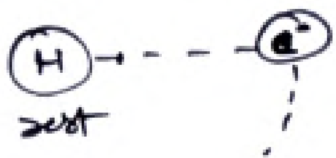
Questions Based on

Ionization Energy Difference of H and D

$$IP = \frac{13.6 Z^2}{(Z=1)} = 13.6\,eV. \quad (\text{Same for H \& D})$$

As H and D nuclear masses are diff $\Rightarrow$ IP expression will be given as

$$\mu = \frac{m_e m_H}{m_e + m_H}$$



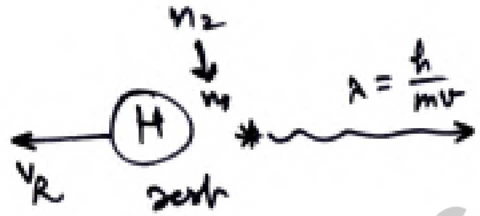
$$IP_n = \frac{2\pi^2 k^2 Z^2 e^4 m_e}{n^2 h^2} \longrightarrow \mu_e = \frac{m_e m_H}{m_e + m_H}$$

$$IP_H = 13.6 \times \frac{m_H}{m_e + m_H}\,eV$$

$$IP_D = 13.6 \times \frac{m_D}{m_e + m_D}\,eV$$

Questions Based on

Recoiling of an Atom During Transition



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

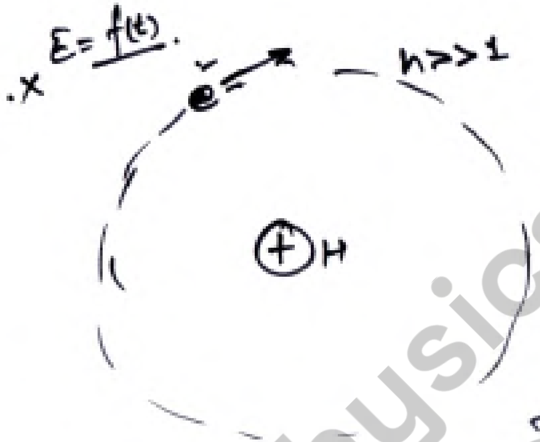
$v_R = \text{----}$ [considering total energy goes into photon]

$$\Delta E_{n_2 \to n_1} = \frac{hc}{\lambda} + \frac{1}{2} m v_R^2 + \Delta E_{n_1 \to n_{1s}}$$

This v_R is slightly more than actual recoil speed!

QUESTIONS BASED ON

REVOLUTION FREQUENCY OF e^- IN HIGHER ORBITS



$$f_n = \frac{v_n}{2\pi r_n}\bigg|_{n>>1} = \_\_\_\_$$

This freq is equal to the rad freq emitted for transition of e^- from

$n \longrightarrow (n-1)$

adjoining orbit transition

Questions Based on

Energy Levels of Hypothetical Bohr's Model

$\downarrow$

$U_n / E_n = f(n)$

$F(r) = \frac{d}{dr}(f(r)) = \frac{mv^2}{r}$ — (1) $\Rightarrow v = $ —

using Bohr's quantization postulate

$mvr = n\left(\frac{h}{2\pi}\right)$ — (2)

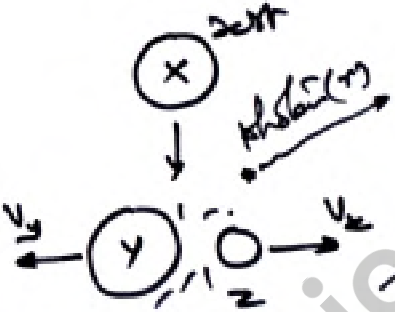
$v_n = $ —

$r_n = $ —

$E_n = U_n + K_n = $ —

Questions Based on

Nuclear Disintegration in Two Elements



Nuclear radii

$$R \propto A^{1/3}$$

$$\frac{R_y}{R_z} = \left(\frac{m_y}{m_z}\right)^{1/3} = \left(\frac{v_z}{v_y}\right)^{1/3}$$

$$m_y v_y = m_z v_z$$

$$\left[Q = E_{released} = \frac{1}{2} m_y v_y^2 + \frac{1}{2} m_z v_z^2 + E_r \right]$$

Questions Based on

Simulataneous Decay of Two Radioactive Elements

(A)

$N_A = N_{0A}(2)^{-t/T_A}$

(B)

$N_B = N_{0B}(2)^{-t/T_B}$

$N_A = N_{0A}e^{-\lambda_A t}$; $N_B = N_{0B}e^{-\lambda_B t}$

after $t = t_1$

$N_A = N_B$

$t_1 =$ ______

$$\frac{N_A}{N_B} = \left(\frac{N_{0A}}{N_{0B}}\right) 2^{-t\left[\frac{1}{T_A} - \frac{1}{T_B}\right]}$$

Questions Based on

Simulataneous Decay Modes of One Radioactive Elements

at $t=0$: N_0

at $t=t \rightarrow N_x$

$X \xrightarrow{\lambda_1} Y$, Prob $= p_1$

$X \xrightarrow{\lambda_2} Z$, Prob $= p_2$

$A_{cy} = \lambda_1 N_x \leftarrow$ production rate of Y.

$A_{cz} = \lambda_2 N_x \leftarrow$ production rate of Z.

$\lambda_{eqX} = \lambda_1 + \lambda_2$

$\lambda_1 = p_1 \lambda_{eqX}$ & $\lambda_2 = p_2 \lambda_{eqX}$

$N_x = N_0 e^{-\lambda_{eqX} t}$

$X \xrightarrow{\lambda_1} Y + \Delta E_1$

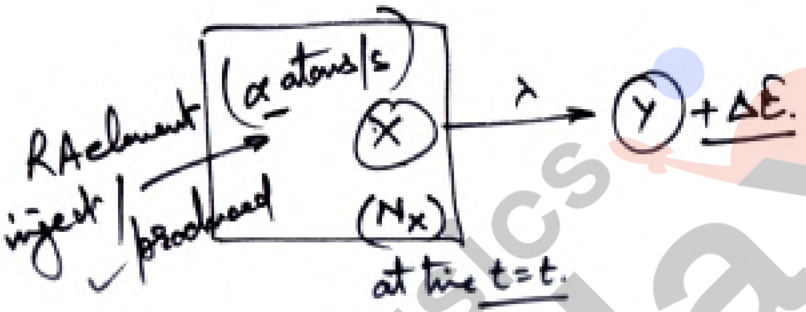
$X \xrightarrow{\lambda_2} Z + \Delta E_2$

Nuclear power production by X at any time t -

$P = (\lambda_1 N_x \Delta E_1 + \lambda_2 N_x \Delta E_2) \eta \times \frac{1}{100}$ (η ← efficiency)

Questions Based on

Production of a Radioactive Element



$$Power_t = \lambda N_x \Delta E$$

Y production rate $= \lambda N_x$ dis/sec

Accumulation rate of X $\quad \dfrac{dN_x}{dt} = \alpha - \lambda N_x$

$$\int_0^{N_x} \frac{dN_x}{\alpha - \lambda N_x} = \int_0^t dt \longrightarrow N_x = f(t)$$

QUESTIONS BASED ON

PROCESS OF CARBON DATING

↓

used to calculate age of any old substance (RA)

Present Sample $A_c(t)$

original Activity A_0.

→ $A_c(t) = A_0 (2)^{-t/T}$

$t =$ —— Age of substance