Long Answer ① Q

1) Explain The J.J Thomson experiment to determine the specific charge of electron

pg:144

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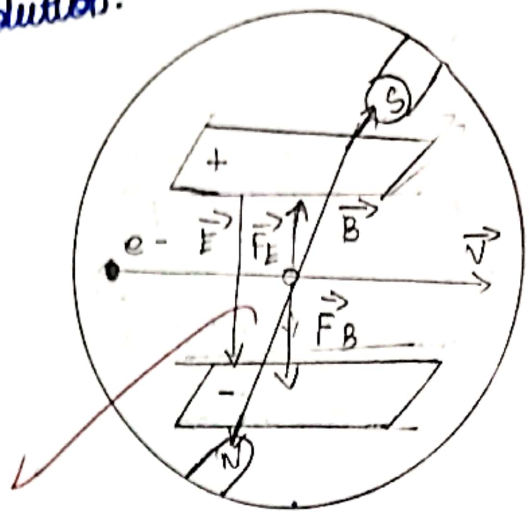
5 mark

Solution:



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1887

J.J Thomson

Discharge Tubes

electric field

Magnetic field

cathode ray reflected

variation electric and magnetic field

cathode ray Measured

electron beam

A → Anode beam

parallel Metal Plate

high voltage

both electric and magnetic field perpendicular each other

v → velocity

B → magnetic field

E → Electric field

F_E → electric field force

F_M → Magnetic field force

e → electron

cathode the charge (e/m)

i) $eE = eBV$ ii) $eE = \frac{1}{2}mv^2$

$V \to$ Potential difference

$v \to$ velocity

$e \to$ electron

$m \to$ mass

$= \frac{1}{2}mv^2 = KE$

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

$\left(\frac{e}{m}\right) V = \frac{1}{2}v^2$

$\frac{e}{m} = \frac{1}{2}\frac{v^2}{V}$

$\frac{e}{m} = \frac{v^2}{2V}$

$v = E/B$

$\frac{e}{m} = \frac{1}{2V}\left(\frac{E}{B}\right)^2$

$\frac{e}{m} = \frac{1}{2V}\frac{E^2}{B^2}$

$\frac{e}{m} = 1.7 \times 10^{11}\, C\,kg^{-1}$

ii) velocity of cathode ray

$eE = eBv$

$E = Bv$

$\frac{E}{B} = v$

iv) Deflection of charges only due to uniform electric field

using kinematic equation

$s = ut + \frac{1}{2}at^2$ $\boxed{s = y'}$

$u = 0$

$t = \frac{l}{v}$

$a = \frac{eE}{m}$

$$F = ma$$

$$a = \frac{F}{m}$$

$$a = \frac{eE}{m}$$ $a \to$ electron, $E \to$ Electric field

$$s = ut + \frac{1}{2}at^2$$

$u = 0$

$s = y'$

$t = l/v$

$a = \frac{eE}{m}$

$v = E/B$

$$y' = 0(l/v) + \frac{1}{2}\left(\frac{eE}{m}\right)\left(\frac{l}{v}\right)^2$$

$$y' = 0 + \frac{1}{2}\left(\frac{eE}{m}\right)\left(\frac{l^2}{v^2}\right)$$

$$y' = \frac{1}{2}\left(\frac{eE}{m}\right)\left(\frac{l^2}{(E/B)^2}\right)$$

$$y' = \frac{1}{2}\left(\frac{eE}{m}\right)\left(\frac{l^2}{\frac{E^2}{B^2}}\right)$$

$$y' = \frac{1}{2}\left(\frac{eE}{m}\right)\left(\frac{l^2 B^2}{E^2}\right)$$

$$y' = \frac{1}{2}\left(\frac{e}{m}\right)\left(\frac{l^2 B^2}{E}\right)$$

$$y = cy'$$

$$y = c\frac{1}{2}\left(\frac{e}{m}\right)\left(\frac{l^2 B^2}{E}\right)$$

$$2y = c\left(\frac{e}{m}\right)\left(\frac{l^2 B^2}{E}\right)$$

$$2yE = c\left(\frac{e}{m}\right)(l^2 B^2)$$

$$\frac{2yE}{l^2 B^2} = c\left(\frac{e}{m}\right)$$

$$\frac{2yE}{cl^2 B^2} = \frac{e}{m}$$

$$\frac{e}{m} = 1.7 \times 10^{11}\ C\,kg^{-1}$$

4 7th long answer

Discuss the spectral series of hydrogen atom

Hydrogen atom

Lyman series	Balmer series	Paschen series	Brackett series	Pfund series
n=1	n=2	n=3	n=4	n=5
m=2,3,4...	m=3,4,5...	m=4,5,6...	m=5,6,7..	m=6,7,8....
ultra violet	visible	near IR	middle IR	IR far

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

R → Rydberg constant

$R = 1.09737 \times 10^7 m$

m > n.

m and n → positive integer

λ → wavelength

$\bar{\nu}$ → frequency

i) Lyman series

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

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

ii) Balmer series

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

$$\frac{1}{\lambda} = R\left(1/4 - \frac{1}{m^2}\right) = \bar{\nu}$$

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iii) Paschen series

$$\frac{1}{\lambda} = R\left(\frac{1}{3^2} - \frac{1}{m^2}\right) = \bar{V}$$

$$\frac{1}{\lambda} = R\left(\frac{1}{9} - \frac{1}{m^2}\right) = \bar{V}$$

iv) Brackett series

$$\frac{1}{\lambda} = R\left(\frac{1}{4^2} - \frac{1}{m^2}\right) = \bar{V}$$

$$\frac{1}{\lambda} = R\left(\frac{1}{16} - \frac{1}{m^2}\right) = \bar{V}$$

v) Pfund series

$$\frac{1}{\lambda} = R\left(\frac{1}{5^2} - \frac{1}{m^2}\right) = \bar{V}$$

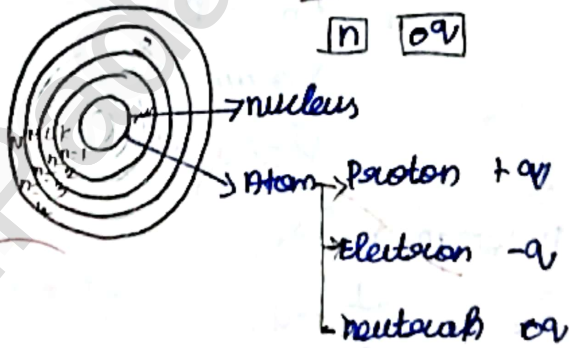
$$\frac{1}{\lambda} = R\left(\frac{1}{25} - \frac{1}{m^2}\right) = \bar{V}$$

1) Nucleus :

pg: 180

P +q

n 0q



$2n^2$

$n = 1$

$2(n)^2 = 2(1)^2$
$= 2(1)$
$= 2$

$n = 2$

$2(n)^2 = 2(2)^2$
$= 2(4)$
$= 8$

$n = 3$

$2(n)^2 = 2(3)^2$
$= 2(9)$
$= 18$

$n = 4$

$2(n)^2 = 2(4)^2$
$= 2(16)$
$= 32$

2^{xn} → element

Z → atomic number

A → mass number

$_6C^{12}$ → mass number
$A = 12 \quad Z = 6 \quad N = ?$

N → number of neutron

atomic number / proton number: $N = A - Z$

$= 12 - 6$

$N = 6$

Proton number $P = 6$

pg:163

Final Mass number

$6C^{12} \quad A = ? \quad A = Z + N \quad \boxed{Z = 6}$

$N = A - Z$

$= 12 - 6$

$\boxed{N = 6}$

$A = 6 + 6$

$\boxed{A = 12}$

A → mass number

Z → proton number (atomic number)

N → Neutron number

Example

$_7N^{15}$

$A = 15$

$Z = 7$

$N = 8$) same

$P = 7$

$N = A - Z = 15 - 7$

$N = 8$

660 Nucleus classification

mark

Isotopes | Isobars | Isotons

Isotopes: same element, Same Z, Difference A

$(_1H^1, {}_1H^2, {}_1H^3)$ hydrogen, deuterium, tritium

Isobars: Different element, Same A, Different Z

$(_{16}S^{40}, {}_{17}Cl^{40}, {}_{18}Ar^{40}, {}_{19}K^{40}, {}_{20}Ca^{40})$

Isotons: Different element, Same number of neutron

$(_5B^{12}, {}_6C^{13})$

$_5B^{12}$

$N = A - Z$

$= 12 - 5$

$N = 7$

$6C^{13} \quad N = A - Z$

$N = 13 - 6$

$N = 7$

pg: 165 Example 9.7

Solution:

Au - Gold

$_{79}Au^{197}$ nucleus

radius = ?

$R = R_0 (A)^{1/3}$

$R_0 = 1.2 \times 10^{-15} m = 1.2 F$

$10^{-15} m$ = ~~Fa~~ Fermi (F)

$R = 1.2 \times 10^{-5} \times (197)^{1/3}$

$R = 1.2 \times 10^{-15} \times ((5.82)^{1/3})^{1/3}$

$R = 1.2 \times 5.82 \times 10^{-15} m$

$R = 6.984 \times 10^{-15} m$

$R = 6.984 F$

$5.82 \times 5.82 \times 5.82$

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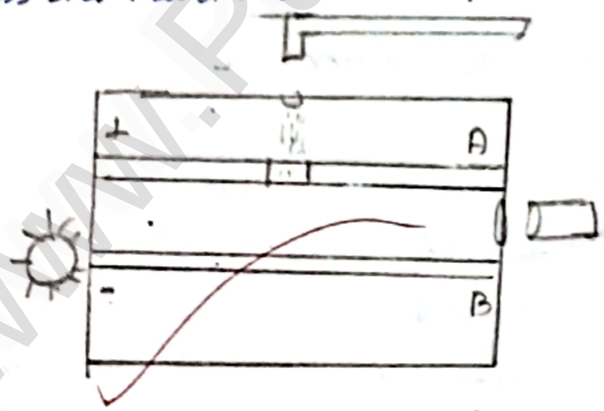
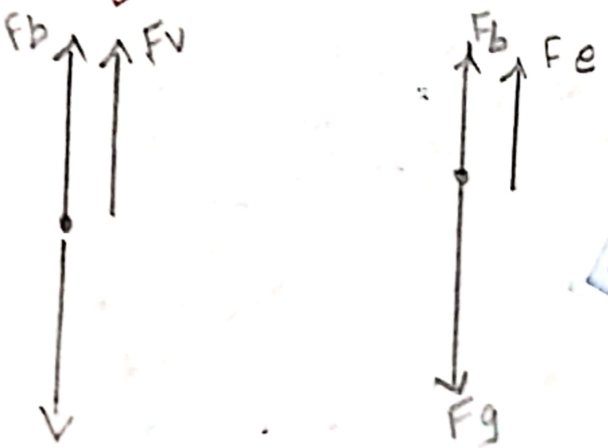
10/10/24 Thursday unit-9

1) Discuss the Millikan's oil drop experiment

pg: 146





charge of a electron adjusting electric field
Motion of oil drop
Inside champer on controlled two horizontal
metal surface A and B

A, B → diameter 20 cm → 2×10^{-2} m
small distance 5 cm → 1.5×10^{-2} m
glass water
A B high potential difference (10V)
Electric field act vertically downward
highly viscous liquid glycerine
Electric charge (negative charge)
x-ray is between the parallel place
clearly using microscope
perpendicular light beam

oil drops

Radius of the droplet

electric charge

gravitational force $F_g = mg$
electric force $F_e = qE$
buoyant force F_b
viscous force F_v

a) Determination of radius of the droplet
ρ → oil density
σ → air density

$F_g = F_b + F_v$
$F_g = \rho(\frac{4}{3}\pi r^3)g$
$F_b = \sigma(\frac{4}{3}\pi r^3)g$

ρ → density of oil drop
σ → density of air
η → coefficient of viscosity

$F_V = 6\pi\eta r v$

$F_g = F_b + F_V$

$\rho\left(\frac{4}{3}\pi r^3\right)g = \sigma\left(\frac{4}{3}\pi r^3\right)g + (6\pi\eta r v)$

$\rho\left(\frac{4}{3}\pi r^3\right)g - \sigma\left(\frac{4}{3}\pi r^3\right)g = 6\pi\eta r v$

$\frac{4}{3}\pi r^3(\rho-\sigma)g = 6\pi\eta r v$

$\frac{4}{3} r^3(\rho-\sigma)g = 6\eta r v$

$\frac{2}{3} r^3(\rho-\sigma)g = 3\eta r v$

$\frac{2}{3} r^3(\rho-\sigma)g = 3\eta v$

$2r^2(\rho-\sigma)g = 9\eta v$

$r^2 = \frac{9\eta v}{2(\rho-\sigma)g}$ $\quad r = \left(\frac{9\eta v}{2(\rho-\sigma)}\right)^{1/2}$

ii) Determine the electric charge

$F_e + F_b = F_g$

$F_e = qE$ $\quad q \to$ charge $\quad E \to$ Electric field

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

$qE = \frac{4}{3}\pi r^3\rho g - \frac{4}{3}\pi r^3\sigma g$

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

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

$qE = \frac{4}{3}\pi\left(\frac{9\eta v}{2(\rho-\sigma)g}\right)^{3/2}(\rho-\sigma)g$

$qE = \frac{4}{3}\pi\left[\frac{9^{3/2}\eta^{3/2}v^{3/2}}{2^{3/2}[(\rho-\sigma)g]^{3/2}}\right](\rho-\sigma)g$

$9^{3/2} = 9^{1/2}\,9^{1/2}\,9^{1/2}$ $\quad 2^{3/2} = 2^{1/2}\,2^{1/2}\,2^{1/2}$

$= \sqrt{9}\sqrt{9}\sqrt{9} = 9\times3 = 27$ $\quad = \sqrt{2}\sqrt{2}\sqrt{2}$

$9^{3/2} = 27$ $\quad = 2\sqrt{2}$

$\frac{(\rho-\sigma)g}{[(\rho-\sigma)g]^{3/2}} = \frac{x}{x^{3/2}}$ $\quad x^1 = x^{-3/2}$

$x^{1-3/2} = x^{\frac{2-3}{2}} = x^{-1/2}$

$= 1/2$

$= \frac{1}{(\rho-\sigma)g}$

$$q_E = \frac{4}{3}\pi\left[\frac{2\pi\eta^{3/2} v^{3/2}}{2\sqrt{2}(\rho-\sigma)g}\right]$$

$$q_E = 2\pi\left[\frac{9\eta^{3/2} v^{3/2}}{\sqrt{2}(\rho-\sigma)g}\right]$$

$$q_E = 18\pi\left[\frac{\eta^{3/2} v^{3/2}}{(2)^{1/2}(\rho-\sigma)g}\right]$$

$$q_E = \frac{18\pi}{E}\left[\frac{\eta^3 v^3}{2(\rho-\sigma)g}\right]^{1/2}$$

unit-9

pg:192 Exercise Problem

b) Half life of two radioactive element

Half life A, $T_A = 20$ minutes

Half life B, $T_B = 40$ minutes

$N_{01} = N_{02} = N$

$$\frac{N_1}{N_0} = (1/2)^{T/T_A} = (1/2)^{\frac{80}{20}}$$

$$= \left(\frac{1}{2}\right)^{8/2}$$

$$= (1/2)^4 = \frac{(1)^4}{(4)^4} = \frac{1}{16} \rightarrow (1)$$

A sample decayed

$$= 1 - \frac{N_1}{N_0}$$

$$= 1 - \frac{1}{16}$$

$$= \frac{16-1}{16} = \frac{15}{16} \rightarrow (2)$$

'B" $\frac{N_2}{N_0} = (1/2)^{T/T_B}$

$$= (1/2)^{(80/40)}$$

$$= (1/2)^2 = \frac{1^2}{2^2} = \frac{1}{4} \rightarrow (3)$$

B sample decayed

$$= 1 - \frac{N_2}{N_0}$$

$$= 1 - \frac{1}{4} = \frac{4-1}{4}$$

$$= \frac{3}{4} \rightarrow (4)$$

Ratio = $\frac{\text{A sample decayed}}{\text{B sample decayed}}$

$= \frac{15/16}{3/4} = \frac{15}{16} \times \frac{4}{3} = \frac{5}{4}$

A:B = 5:4

13) Question

Example 8.2

Solution: $\lambda = 300nm$ $\lambda = 300 \times 10^{-9} m$

silver surface (Ag)

workfunction silver = 4.7eV → electron voltage

$E = h\nu$ → ① $\nu = \frac{c}{\lambda}$

$E = h\left(\frac{c}{\lambda}\right)$ → ②

From equation 2

$E = \frac{hc}{\lambda}$ (Joule)

$E = \frac{hc}{\lambda e}$ (eV)

h → Planks constant 6.62×10^{-34} Js

c → velocity of light $3 \times 10^{8} ms^{-1}$

λ → wavelength $300 \times 10^{-9} m$

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

$E = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{300 \times 10^{-9} \times 1.6 \times 10^{-19}}$

$E = \frac{6.626 \times 3 \times 10^{-34} \times 10^{8}}{300 \times 1.6 \times 10^{-9-19}}$

$E = \frac{6.626 \times 3 \times 10^{-34} \times 10^{8}}{300 \times 1.6 \times 10^{-28}}$

$E = \frac{6.626 \times 3 \times 10^{-34} \times 10^{8} \times 10^{+28}}{300 \times 1.6}$

$E = 19.878 \times 10^{-34} \times 10^{+36}$

$E = 0.04\,14125 \times 10^{+2}$

$E = 0.0414 \times 100$

$E = 4.14\,eV.$

Example 8.9

pg:132

Solution

$\lambda_0 = \frac{12400\,A^0}{V}$ $V = 201,000$

$\lambda = \frac{12400}{201000}\,A$

$\lambda = \frac{124}{200}$

$\lambda = \frac{124}{2 \times 10^2} = \frac{62}{10^2}$

$\lambda_0 = 62 \times 10^{-2}$

$\lambda_0 = 0.62\,A$

$\lambda_0 = 0.62 \times 10^{-10}\,m$

$\gamma_0 = \frac{c}{\lambda_0}$

$\gamma_0 = \frac{3 \times 10^8}{0.62 \times 10^{-10}}$

$\gamma_0 = \frac{3}{0.62} \times 10^8 \times 10^{10}$

$\gamma_0 = \frac{3}{0.62} \times 10^{18}$

$\gamma_0 = 4.84 \times 10^{18}$ Hz (Hertz)

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