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## PAPER-1

Q.1 $\lambda_0$ is the threshold wavelength of a metal for photoelectric emission. If the metal is exposed to light of wavelength $\lambda$, then the velocity of ejected electron will be $\sqrt{\frac{2hk}{m}(\lambda_0-\lambda)}$. Value of $k$ is :

(A) speed of light (B) 1 (C) $\frac{c}{\lambda_0\lambda}$ (D) $\frac{1}{\lambda\lambda_0}$

$$\frac{1}{2}mv^2 = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$$

Q.3 The wave number corresponding to highest energy transition in Balmer series, in the emission spectra of hydrogen represented by: $\left(R_H = 109737\ \text{cm}^{-1}\right)$

(A) $4389.48\ \text{cm}^{-1}$

(B) $2194.74\ \text{cm}^{-1}$

(C) $5486.85\ \text{cm}^{-1}$

(D) $27434.25\ \text{cm}^{-1}$

$\infty \longrightarrow 2$

$\bar{\nu} = \frac{1}{\lambda} = R_H \left[\frac{1}{4}\right]$

Q.4 $NH_3$ can be liquefied at ordinary temperature without the application of pressure. But $O_2$ cannot, because

(A) its critical temp. is very high

(B) its critical temp. is low

(C) its critical temp. is moderate

(D) its critical temperature is higher than that of ammonia.

Q.5 Which of the following is correct? ( $r_n$ is radius of $n$th Bohr's Orbit)

(A) $r_n = \dfrac{n^2h}{4\pi^2 KZme^2}$

(B) $r_n = \dfrac{n^2h^2}{4\pi^2 KZme^2}$

(C) $r_n = \dfrac{nh}{4\pi^2 KZme^2}$

(D) $r_n = \dfrac{nh^2}{4\pi KZme^2}$

**Q.6** In the preparation of iron from haematite $(Fe_2O_3)$ by the reaction with carbon

$$Fe_2O_3 + C \longrightarrow Fe + CO_2$$

How much $80\%$ pure iron could be produced from $120$ kg of $90\%$ pure $Fe_2O_3$?

(A) $94.5$ kg

(B) $60.48$ kg

(C) $116.66$ kg

(D) $120$ kg

$$Fe_2O_3 + \frac{3}{2}C \rightarrow 2Fe + \frac{3}{2}CO_2$$

$$\frac{120 \times 0.9 \times 10^3}{160}$$

$$2 \times \frac{120 \times 0.9 \times 10^3}{160} \times 56 \times \frac{100}{80}$$

100 80 gm

Q.8 An aqueous solution of glucose $(C_6H_{12}O_6)$ is $0.01M$. To $200\ mL$ of this solution, which of the following should be carried out to make it $0.02M$?

I. Evaporate $50\ m\ell$ of solution

II. Add 0.180 gm of glucose

III. Add $50\ mL$ of water

The correct option is :

(a) I (b) II (c) I, II (d) I, II, III

$$\frac{200}{1000} \times 0.01 = 2 \times 10^{-3}$$

$$= 2 \times 180 \times 10^{-3}$$

$$= \underline{0.36}$$

**Q.9** Hydrogen atoms are excited to $n = 4$ energy state. In the spectrum of emitted radiation, ratio of number of lines in the U.V. and visible regions are respectively:

(A) $3:1$ (B) $1:3$ (C) $2:3$ (D) $3:2$

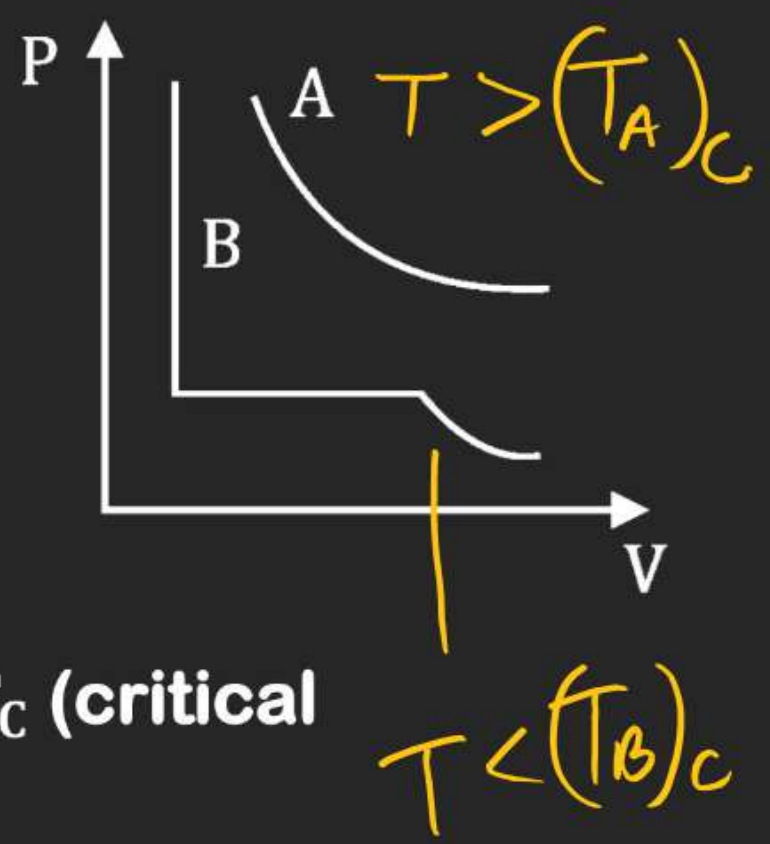
U.V $= 3$ Bal $= 2$

Q.11 Which Bohr's orbit of $Be^{3+}$ has the same orbit radius as that of the ground state of hydrogen atom?

(Atomic number of $Be = 4$ )

$$\frac{n^2}{Z}$$

Q.14 For two gases $A$ and $B$, $P$ v/s $V$ isotherms are drawn at $T$ Kelvin as shown. The number of correct statement(s) is/are:




(I) Pressure correction term will be more negligible for gas B at T K

(II) The curve for gas ' $B$ ' will be of same shape as for gas $A$ if $T > T_C$ (critical temperature of B)

(III) Gas ' $A$ ' will show same $P$ v/s $V$ curve as of gas ' $B$ ' if $T > T_C$ (critical temperature of $A$ )

(IV) Repulsive forces are dominating forces for gas B

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Q.15 A hydrogen atom in the ground state is hit by a photon exciting the electron to 3rd excited state. The electron then drops to 2nd Bohr orbit. What is the frequency of radiation emitted in the process ? (in 1014 hz)

Total Marks, objective PC, Numerical

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O-I 45-54

S I 41-53

O-I 47

$$\lambda = \frac{h}{\sqrt{2mKE}}$$

$$2mKE = \frac{h^2}{\lambda^2}$$

$$TE_{n_2} = -\frac{h^2}{2m\lambda_1^2}$$

$$TE_{n_1} = -\frac{h^2}{2m\lambda_2^2}$$

$$TE_{n_2} - TE_{n_1} = \frac{h^2}{2m}\left[\frac{1}{\lambda_2^2} - \frac{1}{\lambda_1^2}\right]$$

$$= \frac{\cancel{h}c}{\lambda}$$

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52) $dx \cdot dp = \frac{h}{4\pi}$

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

$dp = \left(\frac{h}{\lambda^2} d\lambda\right)$

$dx\left(\frac{\cancel{h}}{\lambda^2} d\lambda\right) = \frac{\cancel{h}}{4\pi}$

$dx = \frac{\lambda^2}{4\pi} \frac{1}{d\lambda}$

$\frac{\lambda^2}{4\cancel{\pi}} = \frac{1}{\cancel{\pi}}$

$\lambda = 2$

$\lambda = \sqrt{\frac{150}{V}} = 2$

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accurate = 0.001% of 300

$$= \frac{0.001}{100} \times 300$$

$$\Delta V = 10^{-5} \times 300$$

1 pm

(54)

$$dx\left(\frac{h}{\lambda^2}d\lambda\right) = \frac{h}{4\pi}$$

$$dx = \frac{7}{22}\ nm$$

$$\lambda = \sqrt{\frac{150}{6}}\ A^0 = 5\ A^0$$

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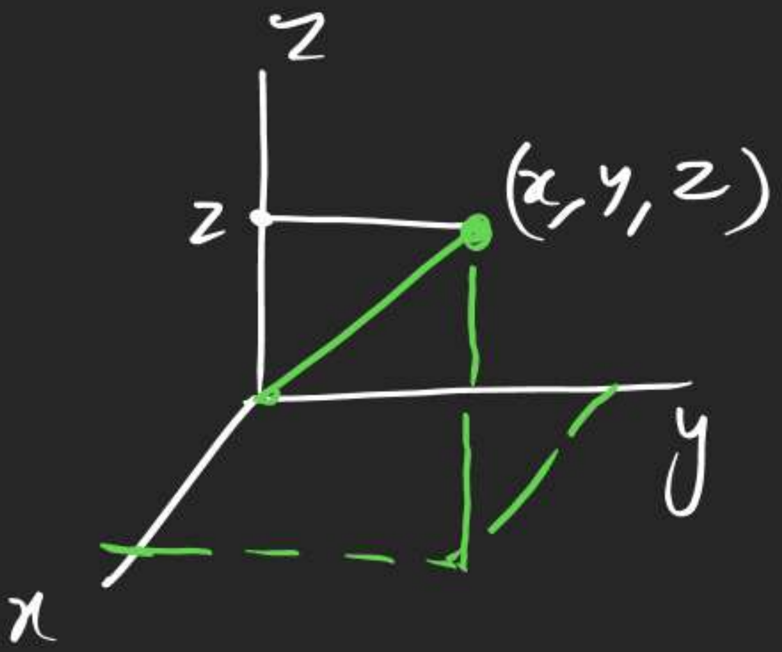
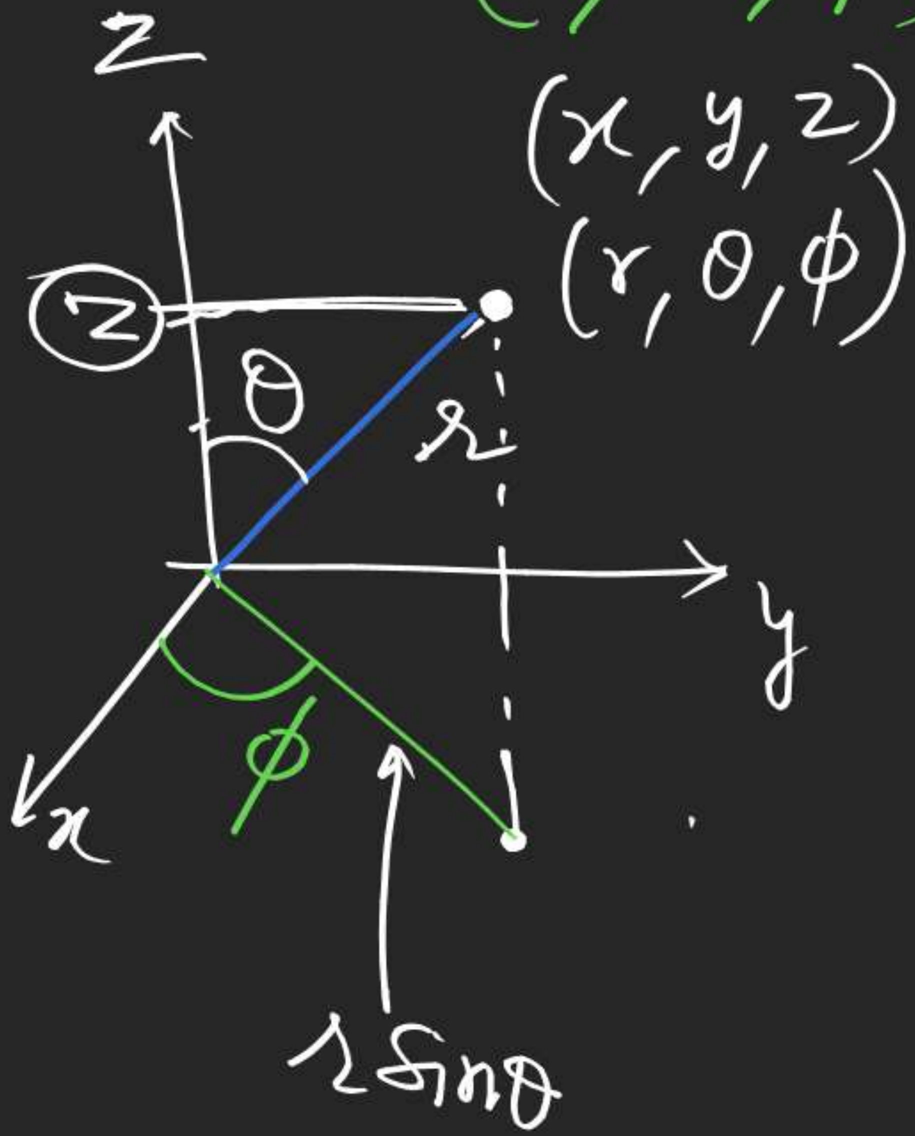
Cartesian coordinates $x, y, z$

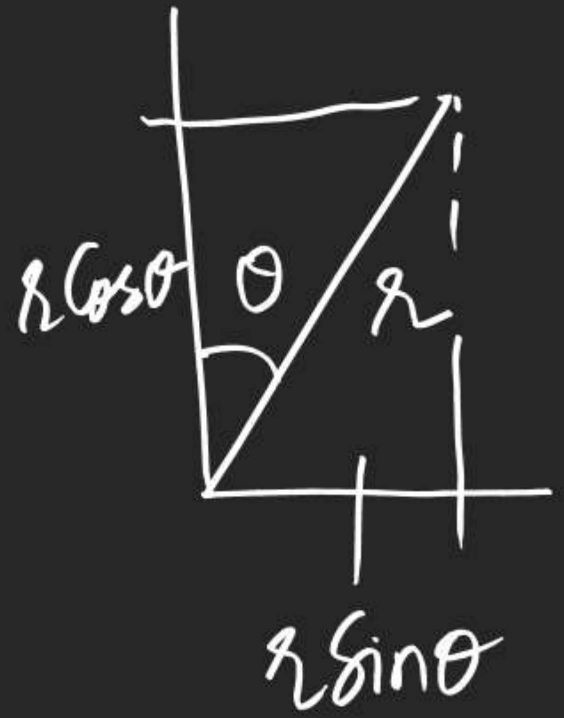



Spherical coordinate system

$(r, \theta, \phi)$




$$\boxed{\begin{aligned} z &= r\cos\theta \\ x &= r\sin\theta\cos\phi \\ y &= r\sin\theta\sin\phi \end{aligned}}$$



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$$\psi = f(r, \theta, \phi)$$

$(n, l, m) \leftarrow$ integration constant

$$\psi = f(r) \cdot f(\theta, \phi)$$

Wave function

Radial part of wave function

$(n, l)$

Angular part of wave function

$(l, m)$

$n = 1, 2, 3 \ldots\ldots$

$l = 0, 1 \ldots\ldots (n-1)$

$m = -l$ to $+l$ including zero

$(n, l, m) \rightarrow (1, 0, 0) \leftarrow$

$(2, 0, 0) \leftarrow$

$(2, 1, 0) \leftarrow$

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$(1, 0, 0)$

1S

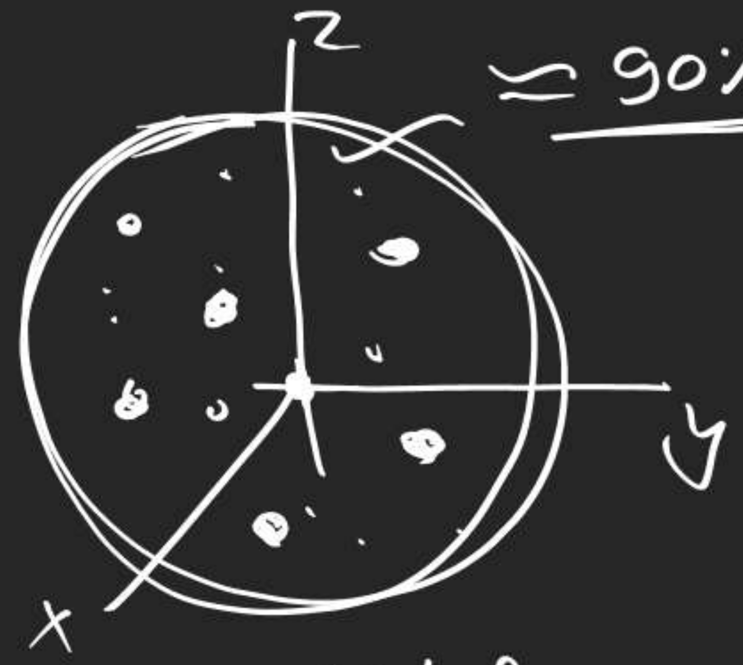
$$\boxed{\text{Probability} = \int \psi^2 dv}$$

for light: intensity $\propto$ (amplitude)$^2$

$\psi$ has no physical significance

$$\boxed{\text{Probability density} \propto \psi^2}$$

(Probability of finding an $\bar{e}$ per unit volume)




orbital

It is the volume in which probability of finding an $\bar{e}$ is nearly 90%

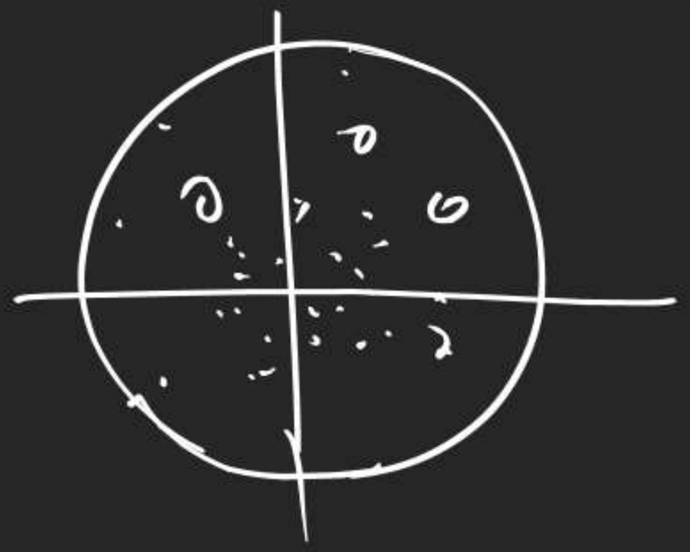
1s $\begin{pmatrix} n & l & m \\ 1 & 0 & 0 \end{pmatrix}$

$n \rightarrow$ size

$l \rightarrow$ Shape

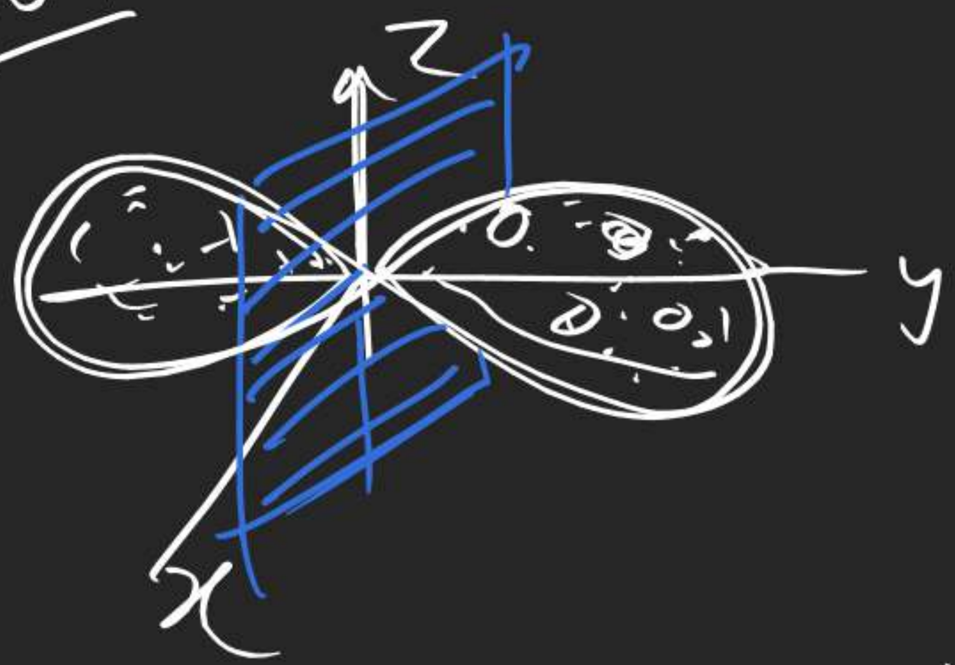
$m \rightarrow$ orientation

1s



dumbell

2p



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$$y = x + \sin(n\pi)$$

$$x = 0 \qquad n = 1, 2, 3, 4 \ldots$$

$$\frac{d^2 s}{dt^2} = 3t$$

$$\frac{ds}{dt} = \frac{3t^2}{2} + c$$

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

$$A \sin(2t - 3x)$$

$$A \sin(4t - 3x)$$