BOUNCE BACK 2.0

Unacademy Atoms

JEE MAINS & ADVANCED

ONE SHOT

ATOMIC STRUCTURE

SAKSHI VORA


Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions
Questions

jee main 2022

Consider the following pairs of electrons

(A) (a) $n = 3, l = 1, m_l = 1, m_s = +\frac{1}{2}$

(b) $n = 3, l = 2, m_l = 1, m_s = +\frac{1}{2}$

(B) (a) $n = 3, l = 2, m_l = -2, m_s = -\frac{1}{2}$

(b) $n = 3, l = 2, m_l = -1, m_s = -\frac{1}{2}$

(C) (a) $n = 4, l = 2, m_l = 2, m_s = +\frac{1}{2}$

(b) $n = 3, l = 2, m_l = 2, m_s = +\frac{1}{2}$

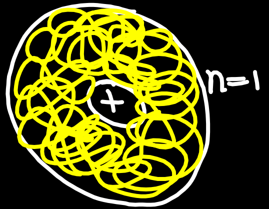
The pairs of electron present in degenerate orbitals is/are

A. Only A

B. Only B

C. Only C

D. (B) and (C)



Q The energy of one mole of photons of radiation of wavelength 300 nm is
(given : h = 6.63 x 10^{-34} Js, N_A = 6.02 x 10^{23} mol^{-1}, c = 3 x 10^8 ms^{-1})

Jee main 2022

A. 235 kJ mol^{-1}
B. 325 kJ mol^{-1}
C. 399 kJ mol^{-1}
D. 435 kJ mol^{-1}

$n = 6.022 \times 10^{23}$

$\lambda = 300 nm$

$c = \nu\lambda$

$E = nh\nu$

$= \frac{nhc}{\lambda} = \frac{6.02 \times 10^{23} mol^{-1} \times 6.63 \times 10^{-34} Js \times 3 \times 10^{8} ms^{-1}}{300 \times 10^{-9} m}$

_______ $J mol^{-1}$

The pair, in which ions are isoelectronic with Al^{3+} is :-

$12-3 = 10e^-$

Same e^-

A. Br^- and Be^{2+}

B. Cl^- and Li^+

C. S^{2-} and K^+

D. O^{2-} and Mg^{2+}

JEE main 2022

$12-2 = 10e^-$

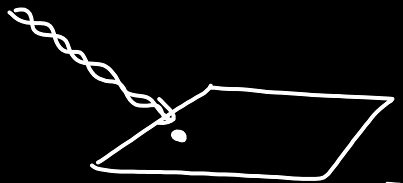
$8+2 = 10$

The minimum energy that must be possessed by photons in order to produce the photoelectric effect with platinum metal is:
[Given: The threshold frequency of platinum is 1.3 x 10^{15} s^{-1} and h = 6.6 x 10^{-34} J s.]

JEE main P.Y.Q.

6.6×10^{-34} J s $\times 1.3 \times 10^{15}$ s^{-1}

A. 3.21 x 10^{-14} J
B. 6.24 x 10^{-16} J
C. 8.58 x 10^{-19} J
D. 9.76 x 10^{-20} J



$\nu_0 = 1.3 \times 10^{15}$ s^{-1} = Hz

$E = h\nu_0$

If the radius of the 3rd Bohr's orbit of hydrogen atom is r_3 and the radius of 4th Bohr's orbit is r_4. Then :

JEE 2022

(A) $r_4 = \frac{9}{16} r_3$

(B) $r_4 = \frac{16}{9} r_3$

(C) $r_4 = \frac{3}{4} r_3$

(D) $r_4 = \frac{4}{3} r_3$

$$\frac{r_3 = \frac{0.529 \times 3^2}{1}}{r_4 = \frac{0.529 \times 4^2}{1}}$$

$$\frac{r_3}{r_4} = \frac{9}{16}$$

$$r_4 = \frac{16}{9} r_3$$

Which of the following is the energy of a possible excited state of hydrogen

jee main 2015

a) −3.4 eV

b) +6.8 eV

c) +13.6 eV

d) −6.8 eV

−13.6

−3.4

−1.51

−0.85

The number of radial and angular nodes in 4d orbital are respectively

A. 1 and 2
B. 3 and 2
C. 1 and 0
D. 2 and 1

jee main 2022

4d

$n = 4$
$l = 2$

$l = 0 \quad 1 \quad 2 \quad 3$
$\quad s \quad p \quad d \quad f$

Total = $n-1$
angle = l → 2
Radial = $n-l-1 = 4-2-1$
$= 4-3$
$= 1$

If the uncertainty in velocity and position of a minute particle in space are, 2.4×10^{-26} (ms^{-1}) and 10^{-7} (m) respectively. The mass of the particle of g is_ (nearest integer)
(given : $h = 6.626 \times 10^{-34}$ Js)

jee main 2022

$\Delta v = 2.4 \times 10^{-26}\ ms^{-1}$

$\Delta x = 10^{-7}\ m$

$\Delta x\, \Delta p \geq \frac{h}{4\pi}$

$\Delta x\, \Delta p = \frac{h}{4\pi}$

$(10^{-7} m)(M)(2.4 \times 10^{-26} ms^{-1}) = \frac{h}{4\pi}$

$24\, M = \frac{66}{3 \times 4} \times 10^{-1}$

$48\, M = 10^{-1}$

$M = \frac{1 \times 11}{10 \times 48}$

22

Consider the following set of quantum numbers

jee main 2022

	n	l	m_l
A.	3	3	-3
B.	3	2	-2
C.	2	1	+1
D.	2	2	+2

b, c

$n = 3 \quad l = 0, 1, 2$

$n = 3, \quad l = 0, 1, 2$

$m = 0 \quad -1, 0, 1 \quad -2, -1, 0, 1, 2$

$n = 2 \quad l = 0, 1$

$m = 0 \quad -1, 0, 1$

$n = 2 \quad l = 0, 1$

If the work function of a metal is 6.63×10^{-19} J, the maximum wavelength of the photon required to remove a photoelectron from the metal is_ nm . (Nearest integer)
[given : h = 6.63×10^{-34} J s, and c = 3×10^{8} m s^{-1}]

H.W

jee main 2022

Consider the following statements:

A. The principal quantum number 'n' is a positive integer with values 'n' = 1, 2, 3, ...

B. The azimuthal quantum number 'l' for a given 'n' (principal quantum number) can have values as l' = 0, 1, 2, ... n

C. Magnetic orbital quantum number 'mi' for a particular 'l' (azimuthal quantum number) has (2l + 1) values.

D. ±1/2 are the two possible orientations of electron spin.

E. For l = 5, there will be a total of 9 orbital.

l = 5

m = -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5

Which of the above statements are correct ?

A. (A), (B) and (C)

B. (A), (C), (D) and (E)

C. (A), (C) and (D)

D. (A), (B), (C) and (D)

Which of the following statements are correct ?

A. The electronic configuration of Cr is [Ar] $3d^5\ 4s^1$.
B. The magnetic quantum number may have a negative value
C. In the ground state of an atom, the orbitals are filled in order of their increasing energies.
D. The total number of nodes are given by n-2.

Choose the most appropriate answer from the options given below :

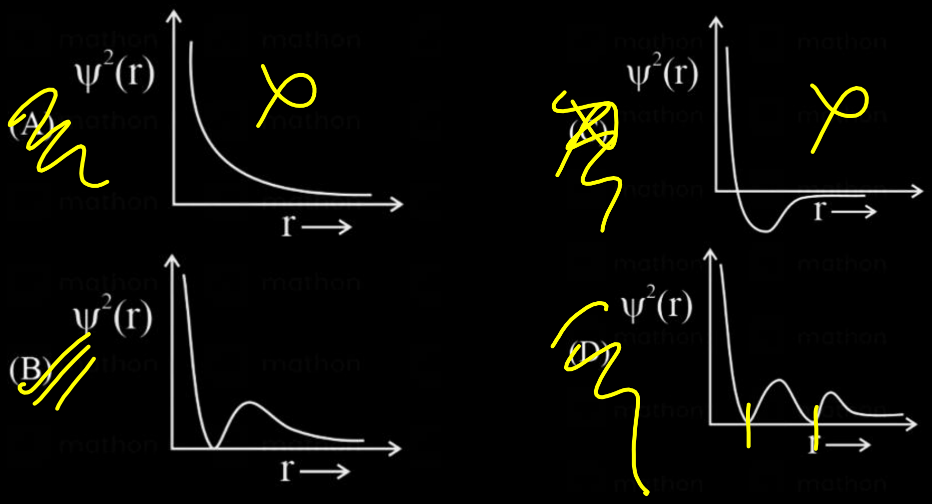
A. (A), (C) and (D) only
B. (A) and (B) only
C. (A) and (C) only
D. (A) , (B) and (C) only.

The electronic configuration of Pt (atomic number 78) is :

A. [xe] $4f^{14}\ 5d^{9}\ 6s^{1}$
B. [Kr] $4f^{14}\ 5d^{10}$
C. [Xe] $4f^{14}\ 5d^{10}$
D. [Xe] $4f^{14}\ 5d^{8}\ 6s^{2}$

Which of the following is the correct plot for the probability density ψ^2 (r) as a function of distance 'r' of the electron from the nucleus for 2s orbital ?

jee main 2022



2s

n = 2
l = 0

n - l - 1

2 - 0 - 1 = 1

Which of the following sets of quantum is not allowed ?

jee main 2022

A. $n = 3, l = 2, m_l = 0, s = +1/2$

B. $n = 3, l = 2, m_l = -2, s = +1/2$

C. $n = 3, l = 3, m_l = 3, s = -1/2$

D. $n = 3, l = 0, m_l = 0, s = -1/2$

$n = 3 \quad l = 0, 1, 2$

When the excited electron of a H atom from n = 5 drops to the ground state, the maximum number of emission lines observed are_

The wavelength of an electron and a neutron will become equal when the velocity of the electron is x times the velocity of neutron. The value of x is_. (nearest integer) (mass of electron is 9.1 x 10^{-31} kg and mass of neutron is 1.6 x 10^{-27} kg) (jee main 2022)

$x = 1758$

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

$\lambda_e = \lambda_N$

$v_e = x v_N$

$\frac{h}{m_e v_e} = \frac{h}{m_N v_N}$

$m_N v_N = m_e v_e$

$16 \times 10^{-27}\, kg \times v_N = 91 \times 10^{-31}\, kg \times x v_N$

$\frac{1.6 \times 10^{-27}}{9.1 \times 10^{-31}}$

Consider an imaginary ion $^{48}_{22}X^{3-}$. The nucleus contains 'a' % more neutrons than the number of electrons in the ion. The value of 'a' is_ [nearest integer]

JEE Main 2022

$^{48}_{22}X^{3-}$

no of p = 22

no of e^- = 22 + 3 = 25

p + n = 48

p = 22

n = 26

% extra neutrons $\Rightarrow \frac{26-25}{25}$

$\frac{1}{25} \times 100$

4

Given below are two statements. One is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : Energy of 2s orbital of hydrogen atom is greater than that of 2s orbital of lithium.

Reason R : Energies of the orbitals in the same subshell decrease with increase in the atomic number.

In the light of the above statements choose the correct answer from the options given below.

A. Both A and R are true and R is the correct explanation of A.
B. Both A and R are true but R is not the correct explanation of A.
C. A is true but R is false.
D. A is false but R is true.

The correct decreasing order of energy, for the orbitals having, following set of quantum numbers :

(A) $n = 3, l = 0, m = 0$

(B) $n = 4, l = 0, m = 0$

(C) $n = 3, l = 1, m = 0$

(D) $n = 3, l = 2, m = 1$

A. (D) > (B) > (C) > (A)

B. (B) > (D) > (C) > (A)

C. (C) > (B) > (D) > (A)

D. (B) > (C) > (D) > (A)

Identify the incorrect statement from the following.

jee main 2022

A. A circular path around the nucleus in which an electron moves is proposed as Bohr's orbit. Yes

B. An orbital is the one electron wave function (Ψ) in an atom Yes

C. The existence of Bohr's orbits is supported by hydrogen spectrum. Yes

D. Atomic orbital is characterised by the quantum numbers n and l only

n
l
m

If the wavelength for an electron emitted from H- atom is 3.3×10^{-10} m, then energy absorbed by the electron in its ground state compared to minimum energy required for its escape from the atom, is _ times. [given : h = 6.626×10^{-34} Js,

Mass of electron = 9.1×10^{-31}]

The minimum uncertainty in the speed of an electron in an one dimensional region of length $2a_o$ (where a_0 = Bohr radius 52.9 pm) is _ km s^{-1}.
(Given : Mass of electron = 9.1×10^{-31} kg, Planck's constant h = 6.63×10^{-34} Js

HW

Consider the Bohr's model of a one – electron atom where the electron moves around the nucleus. In the following List–I contains some quantities for the n^{th} orbit of the atom and List–II contains options showing how they depend on n

[Adv. 2019]

	List–I		**List–II**
(I)	Radius of the n^{th} orbit	(P)	$\propto n^{-2}$
(II)	Angular momentum of the electron in the n^{th} orbit	(Q)	$\propto n^{-1}$
(III)	Kinetic energy of the electron in the n^{th} orbit	(R)	$\propto n^{0}$
(IV)	Potential energy of the electron in the n^{th} orbit	(S)	$\propto n^{1}$
		(T)	$\propto n^{2}$
		(U)	$\propto n^{1/2}$

(I) → T, (II) → S

$$r_n = 0.529 \frac{n^2}{Z}$$

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

$\propto n$

Which of the following options has the correct combination considering List–I and List–II?

A. (III), (S)

B. (IV), (Q)

C. (III), (P)

D. (IV), (U)

[Adv. 2019]

$$TE = -KE = \frac{PE}{2}$$

$$TE = -13\ 6 \times \frac{Z^2}{n^2}\ eV|atom$$

$$KE = 13\ 6 \times \frac{Z^2}{n^2}\ eV|atom$$

$$KE \propto n^{-2}$$

$$PE = 2\left(-13\ 6 \times \frac{Z^2}{n^2}\ eV|atom\right) \qquad PE \propto n^{-2}$$

atomic structure

1
2
3.
4
5
6
7
8
9
10
11
12.
13.
14
15
16
17
18.
19
20
21
22
23.
24
25
26
27
28
29
30

Atomic Structure

#1 Dalton's atomic theory

1. matter ⟶ smallest particle ⟶ Atom
2. atom ⟶̸ created / destroyed in a chemical rxn
3. atom ⟶ smallest particle ⟶ take part in a chem rxn

4. atoms of the same element are similar in shape & mass

Hydrogen ⟶ H H H H

5. atom of different elements differ in shape & mass

#2 Thomson's model of an atom / Plum-Pudding / Water-melon.

1 atom — spherical

2 atom's mass (total) → Uniformly distributed

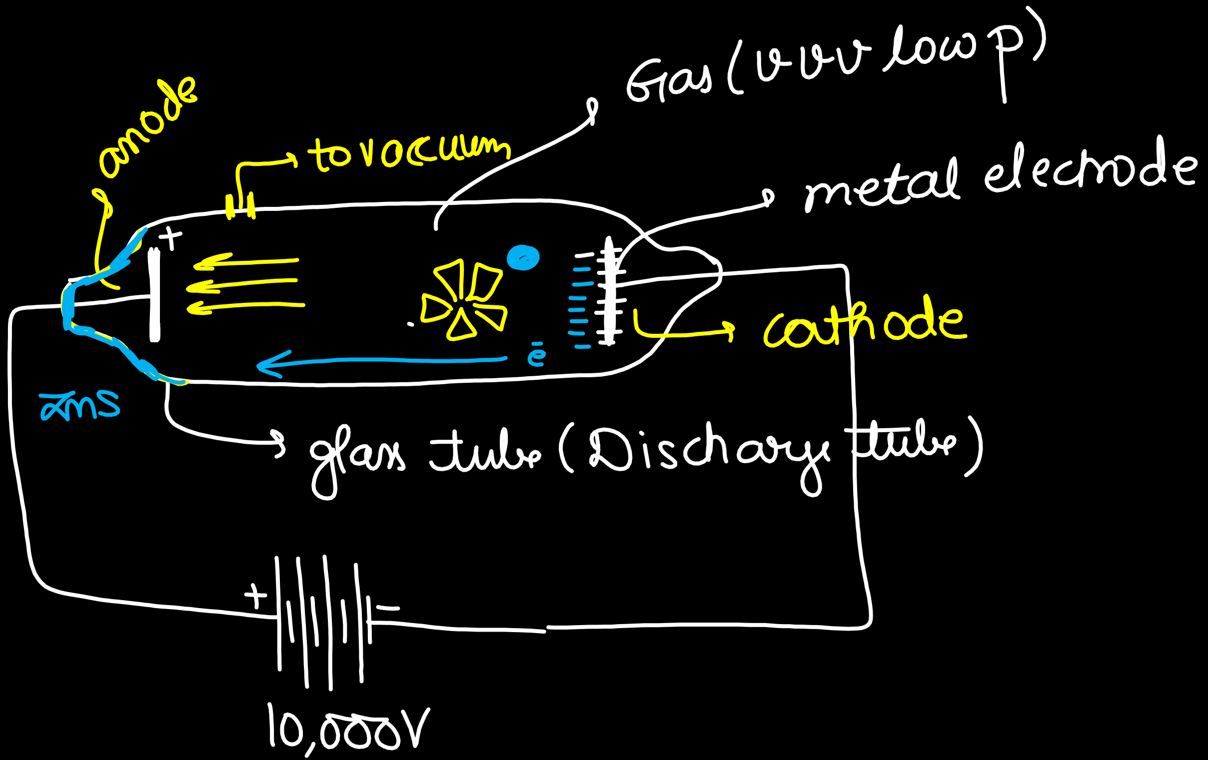
3 atom's total (+ve) → "

4 e^- → -vely → stable

#3 Discovery of electron

1. CRT experiment
2. Cathode ray tube exp
3. Cathode rays ⟶ St line
4. mechanical effect
5. −vely charged
6. high speed

They don't depend on the gas used



Gas (v v v low P)
anode
to vacuum
metal electrode
+
cathode
ē
glass tube (Discharge tube)
+
−
10,000V

$(Gas) \longrightarrow e^- + (Gas)^+$

e^- ↓ Cathode Ray

4 Specific charge

$$\text{Specific charge} = \frac{|\text{charge on 1-particle}|}{\text{mass of 1-particle}}$$

$$e^- = \frac{|-1.6 \times 10^{-19} C|}{9.1 \times 10^{-31} kg}$$

$$= \checkmark \text{cal}$$

$$C/kg$$

#5: Discovery of proton

Goldstein

Same CRT exp

Cathode → Perforated → छेद

Rays → +ve rays / Canal rays → Protons

Canal rays → 1 St line
2 high speed
3 mechanical effect
4 depend on the Gas

$He \longrightarrow e^- + He^+ \longrightarrow$ +ve Ray

canal ray

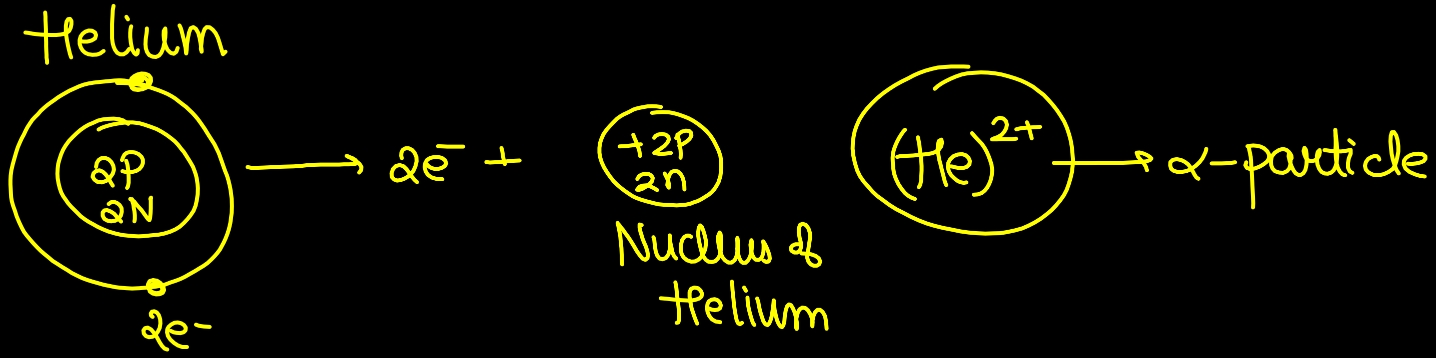
e^- → cathode Ray

$CO_2 \longrightarrow e^- + (CO_2)^+$

atomic H

$H \longrightarrow e^- + H^+$ Canal rays → Proton

#6. α-particle



Q

α-particle $\left(\frac{q}{m}\right) = ?$

↓

Specific charge $= \frac{|q|}{m} = \frac{|2 \times 1.6 \times 10^{-19} C|}{2m_p + 2m_N}$ $\quad m_p \simeq m_N$

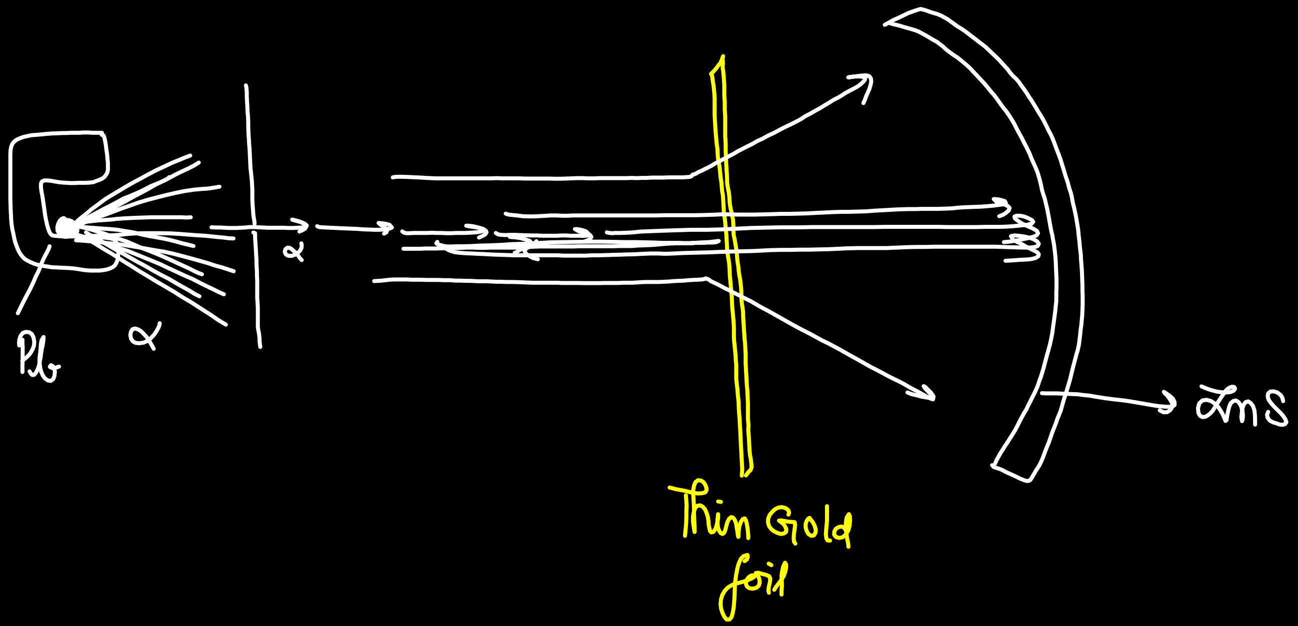
$He^{2+} = \begin{pmatrix} 2P \\ 2N \end{pmatrix}$ $\quad = \frac{2 \times 1.6 \times 10^{-19} C}{4\, m_p}$ $\quad \boxed{m_p \simeq 1\,amu}$

$= \frac{2 \times 1.6 \times 10^{-19} C}{4 \times 1\,amu}$

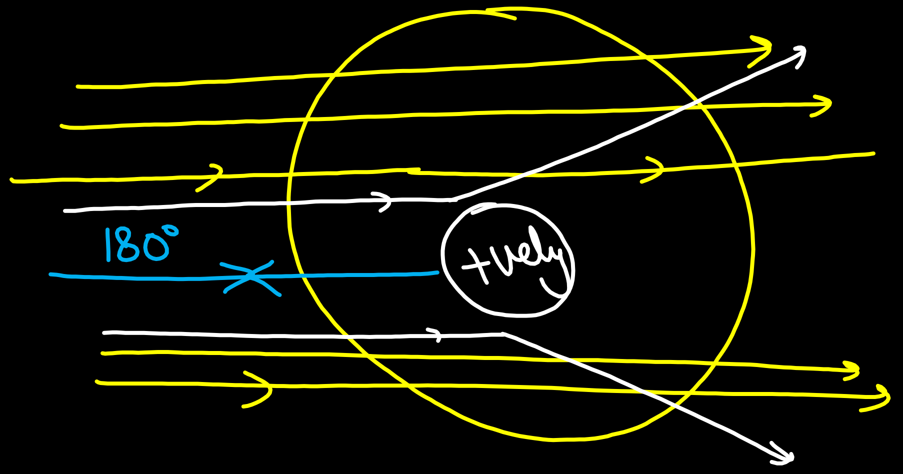
#7

Rutherford's model of an atom

α- scattering exp



1. 9999 / $\alpha \rightarrow$ continue $\rightarrow$ st path
2. Some $\alpha \rightarrow$ small angle से deflected
3. 1 in 20,000 α – $\longleftrightarrow$ 180°

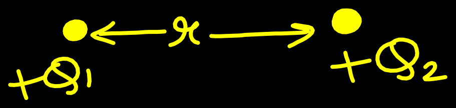

180°
+vely

#8 Rutherford.

1. centre → nucleus
2. nucleus around → e^- → revolve
3. e^- ⟷ nucleus (electrostatic forces of att)
4. $r_{atom} \simeq 10^5 r_{Nucleus}$
5. $V_{atom} \simeq 10^{15} V_{nucleus}$ ☆

#9

Columb's law

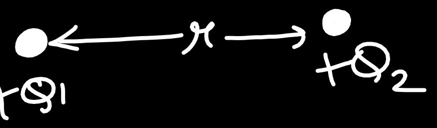


Repulsive force

~~Sign~~

$$|F| = \left| k \frac{Q_1 Q_2}{r^2} \right|$$

$$k = 9 \times 10^9 \ Nm^2/C^2$$

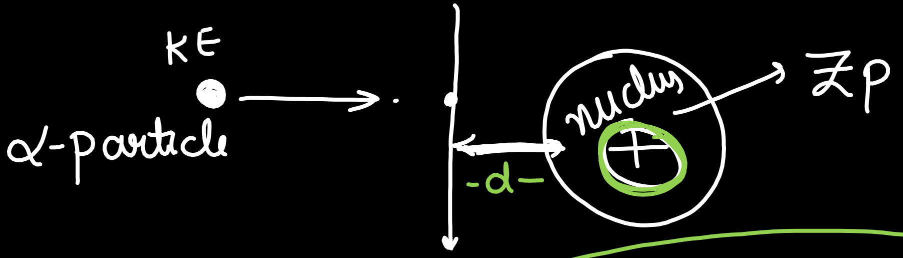


$$P.E = \frac{k \overset{\pm}{Q_1} \, \overset{\pm}{Q_2}}{r}$$

$P.E = \oplus \Rightarrow$ Repulsive

$P.E = \ominus \Rightarrow$ att.

10 distance of closest approach



KE of α-particle (m) (v)

$$\frac{1}{2} \cdot m v^2$$

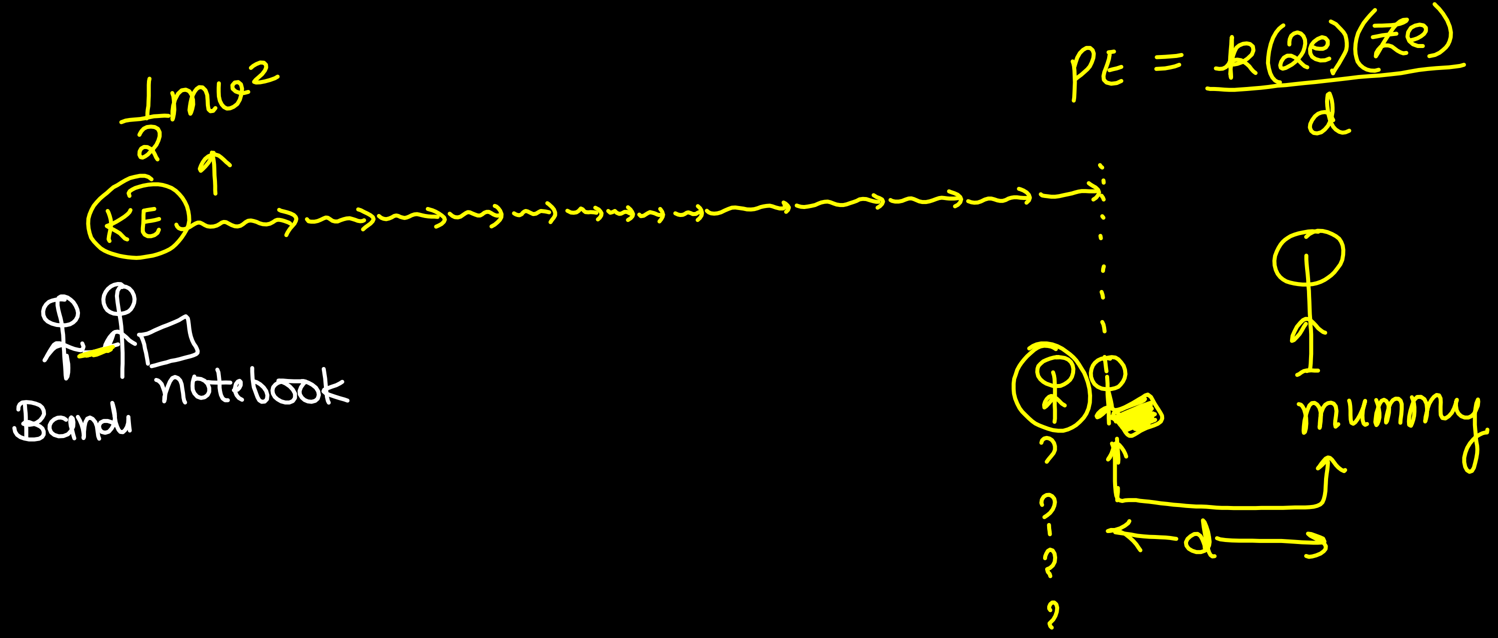
$$PE = \frac{k Q_1 Q_2}{r} \qquad \frac{k(2 \times 1.6 \times 10^{-19}) Z (1.6 \times 10^{-19} C)}{d}$$

$$\frac{1}{2}mv^2 = \frac{k(2e)(Ze)}{d}$$

jee adv

jee main

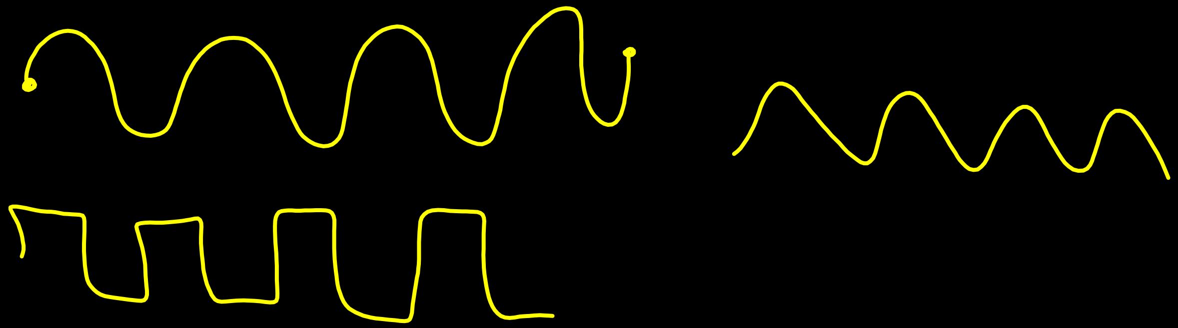
$$d = \frac{k(2e)Ze}{\frac{1}{2}mv^2}$$

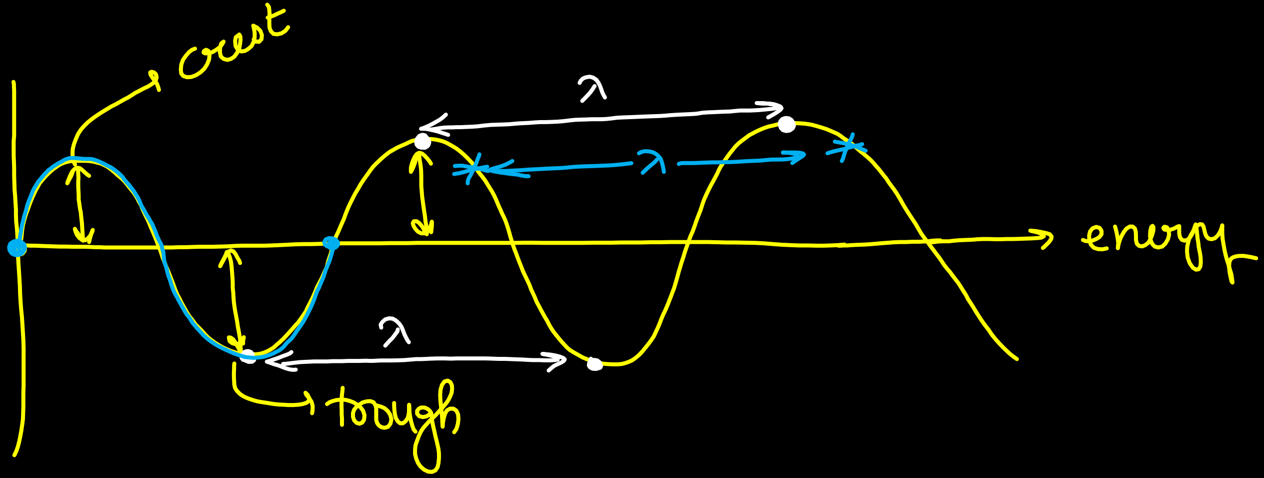


$\frac{1}{2}mv^2$
KE
Bandi
notebook
$PE = \frac{k(2e)(Ze)}{d}$
mummy
d

#11 Wave

means of transferring energy from one pt to another without actual transport of matter





1. Wavelength (λ) · length of 1 complete wave

2. **frequency** no of waves passing through a fixed pt in 1 sec

1s

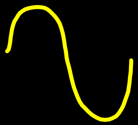
$$\text{speed} = \frac{\text{dis.}}{\text{Time}}$$

$$c = \frac{\lambda}{T}$$

T → Time period

time req to complete 1 oscillation

λ / T



$$c = \nu\lambda$$

$$c = \frac{\lambda}{T}$$

Wave number. $\bar{\nu}$ no of wavelengths per unit length

$$\bar{\nu} = \frac{1}{\lambda}$$

no of waves in 1m

12 EM wave / electromagnetic wave

[electric ⊥ mag] ⊥ direction of propagation

SV shortcut.

C G X U V I M R

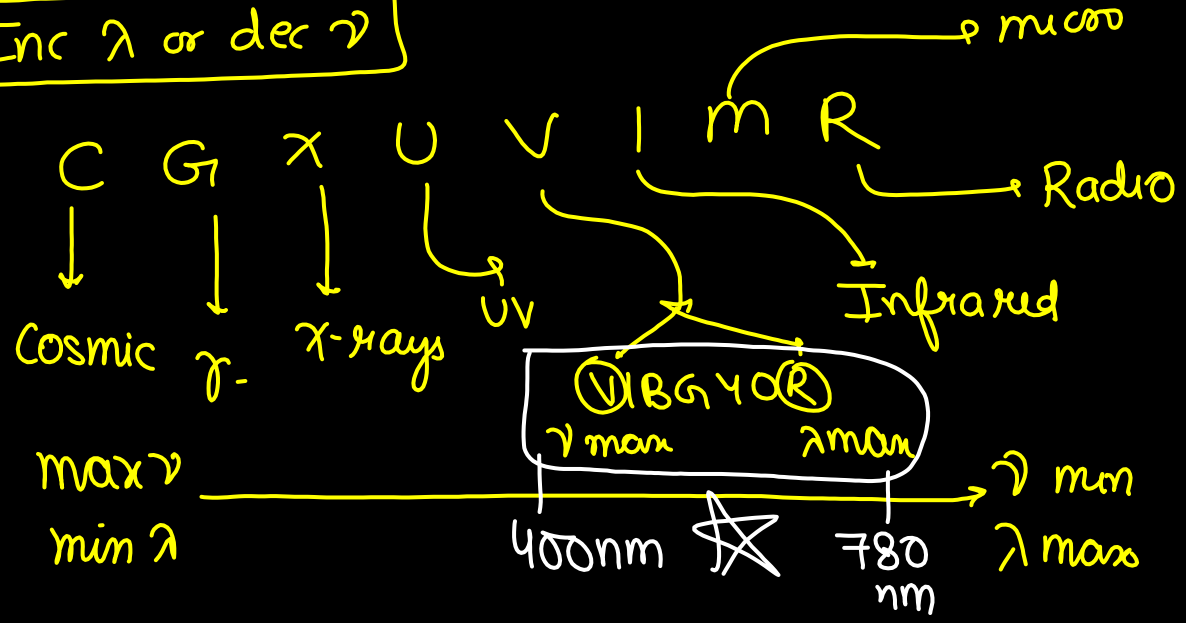
↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓

1 don't need any medium to travel

2 EM → ©

#13 Electromagnetic Spectrum.

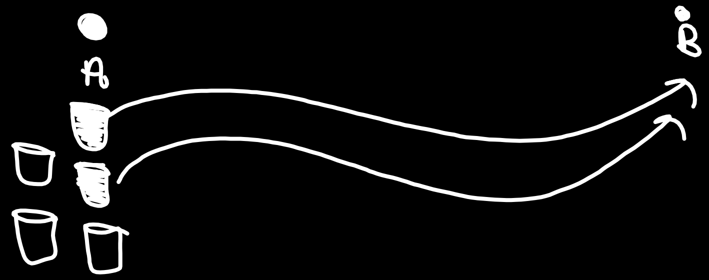
Inc λ or dec ν



14. Planck's Quantum Theory

atom → energy emit
energy absorb

discrete Quantity / small packet → Quantum



energy of a quantum $\propto \nu$

$$E_{Quantum} = h\nu$$

h → Planck's cons

$6\,626 \times 10^{-34}$ Js

Light → Quantum → (घर का नाम) Photon = ?

$E = 1 \cdot h\nu$

$2 h\nu$

$3 h\nu$

$4 h\nu$

$10000 h\nu$

$10^5 h\nu$

$\frac{1}{2} h\nu$

$35 h\nu$

$$E = nh\nu$$

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

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

n → no of photons / Quanta

1 single Quantum

eV

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

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

15:

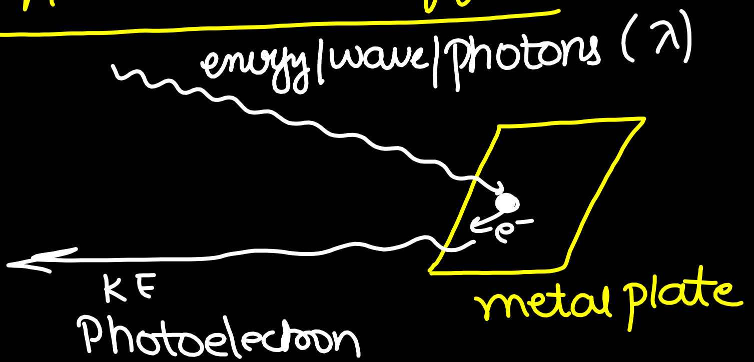
$$E = h\nu = \frac{hc}{\lambda}$$

$$\frac{6.626 \times 10^{-34}\,Js \times 3 \times 10^{8}\,ms^{-1}}{\lambda}$$

? ? ? ev ?

$$E(eV) = \frac{1240}{\lambda(nm)} \qquad \frac{12400}{\lambda(\text{Å})}$$

#16. Photoelectric effect



$$E = h\nu = \frac{hc}{\lambda}$$

W_0 = Threshold energy or work function

$$E_0 = W_0 = h\nu_0 = \frac{hc}{\lambda_0}$$

$$h\nu - h\nu_0 = (K.E)_{max}$$

$$E_{incident} - W_0 = (KE)_{max}$$

↳ work function

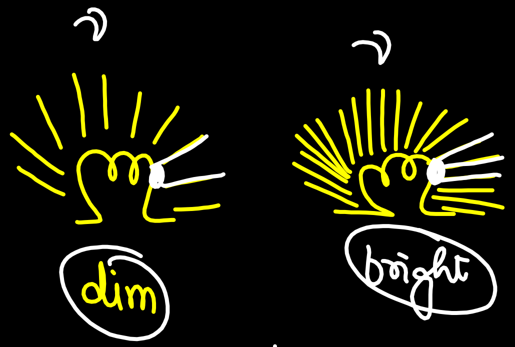
$$h\nu - h\nu_0 = (KE)_{max} = \frac{1}{2}mv^2$$

↳ Threshold freq

$$\frac{hc}{\lambda} - \frac{hc}{\lambda_0} = (KE)_{max} = \frac{1}{2}mv^2$$

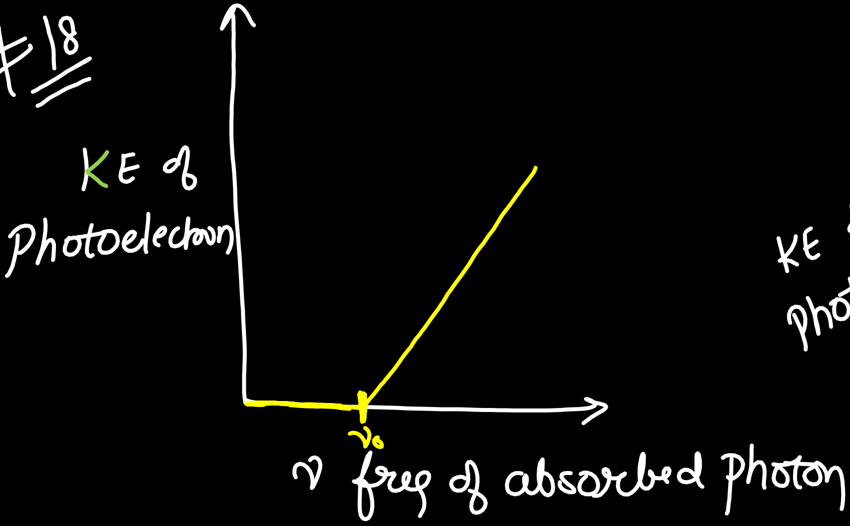
#17 Intensity.

$$I = \frac{\text{energy of Radiation}}{\text{time} \times \text{surface area}} = \frac{nh\nu}{t \times a}$$

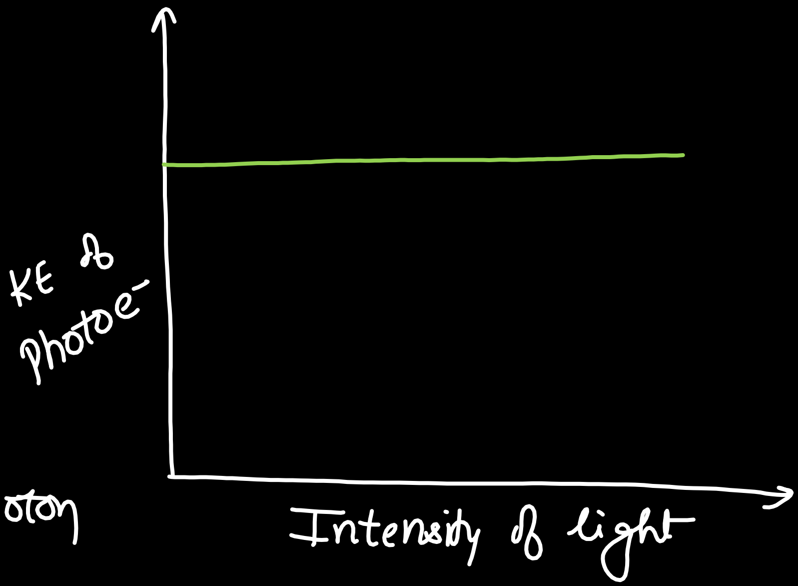


t = 1 sec -

18



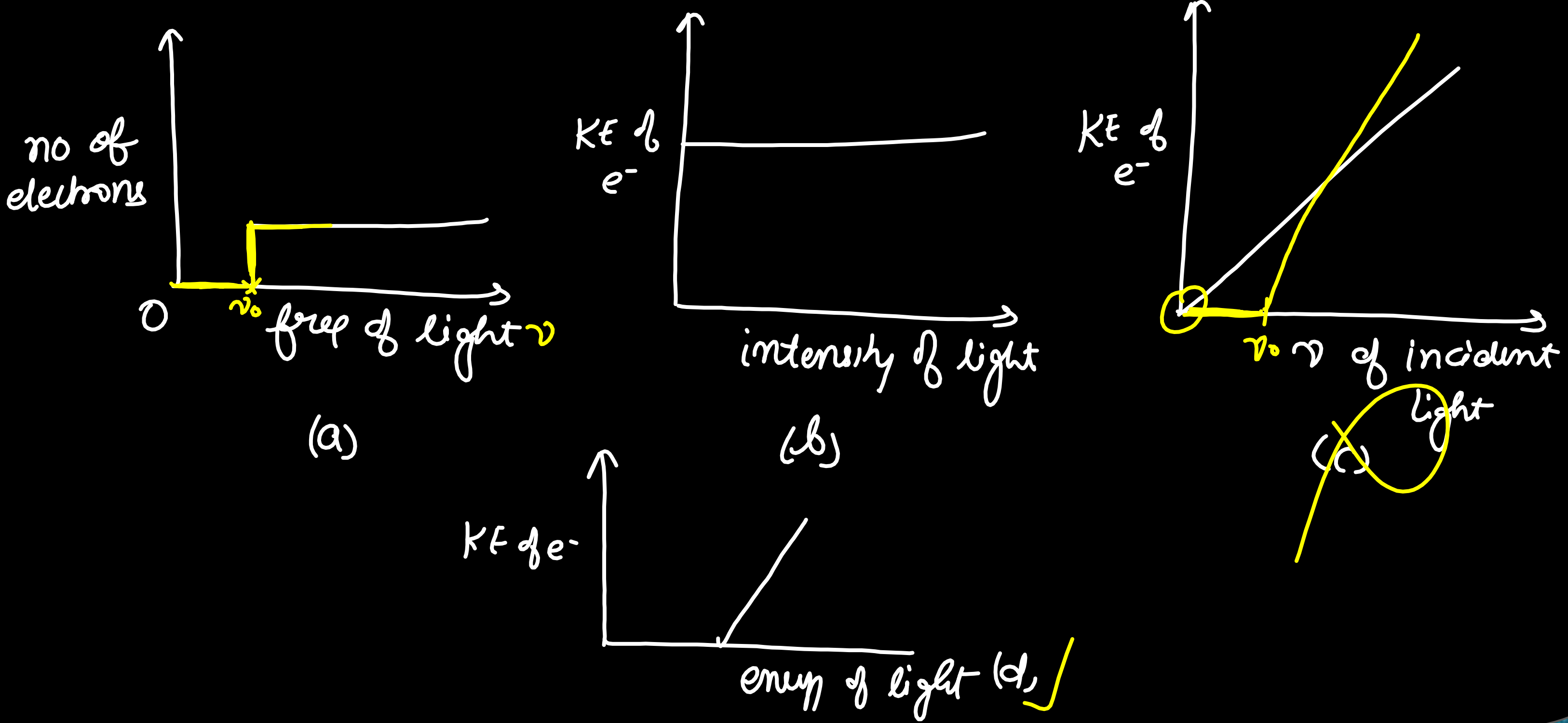
$h\nu - h\nu_0 = (KE)$



$h\nu - h\nu_0$

jee main 2019.

doesn't represent



jee main 2014.

$\lambda_0 \rightarrow$ threshold wavelength

$\lambda \rightarrow$ incident λ

the vel of photoelectron

a) $\sqrt{\frac{2h}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$

b) $\sqrt{\frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$

c) $\sqrt{\frac{2h}{m}}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)$

d) $\sqrt{\frac{2h}{m}\left(\frac{1}{\lambda_0} - \frac{1}{\lambda}\right)}$

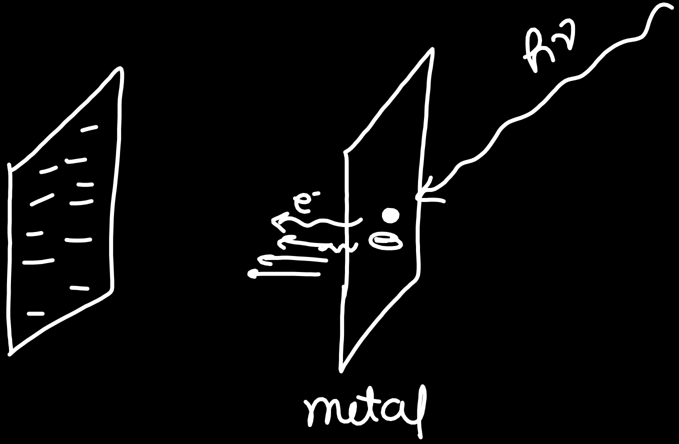
$$h\nu - h\nu_0 = \frac{1}{2}mv^2$$

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

$$\sqrt{\frac{2hc}{m}\left[\frac{1}{\lambda} - \frac{1}{\lambda_0}\right]} = v$$

$$\sqrt{\frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$$

#19 Stopping Potential



To stop a photoelectron

$$(KE)_{max} = PE$$

$$\frac{1}{2}mv^2 = q \times V_0$$

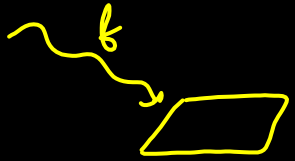
$$\boxed{\frac{\frac{1}{2}mv^2}{q} = V_0}$$

PYQ jee main

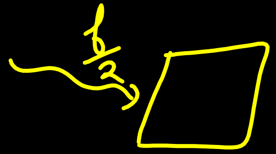
Q: When a certain surface is illuminated with a light of frequency f, the stopping pot for photoelectric current is $-\frac{V_0}{2}$; when the same surface is illuminated by a light of $\nu \to \frac{f}{2}$, the stopping pot is $-V_0$

Cal The Threshold freq

a) $\frac{4f}{3}$ b) $\frac{3f}{2}$ c) $\frac{5f}{3}$ d) $\frac{4f}{2}$



$SP = -\frac{V_0}{2}$



$SP = -V_0$

$$hf - \phi = -\frac{V_0}{2} \quad \text{——} \ (1) \quad \Rightarrow \quad hf = -\frac{V_0}{2} + \phi \ \text{—} \ A$$

$$\frac{hf}{2} - \phi = -V_0 \quad \text{——} \ (2) \qquad \frac{hf}{2} = -V_0 + \phi \ \text{—} \ B$$

$$\frac{A}{B}$$

$$\frac{2\cancel{hf}}{\cancel{hf}} = \frac{-\frac{V_0}{2} + \phi}{-V_0 + \phi}$$

$$-2V_0 + 2\phi = -\frac{V_0}{2} + \phi$$

$$\phi = -\frac{V_0}{2} + 2\frac{2V_0}{2}$$

$$\phi = \frac{3V_0}{2}$$

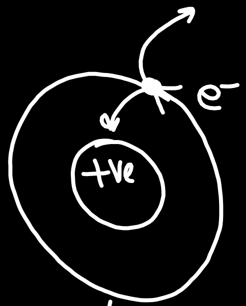
$$h[\nu_0] = \boxed{\frac{3V_0}{2}}$$

#20 Bohr's Atomic Theory

1. mono electronic species

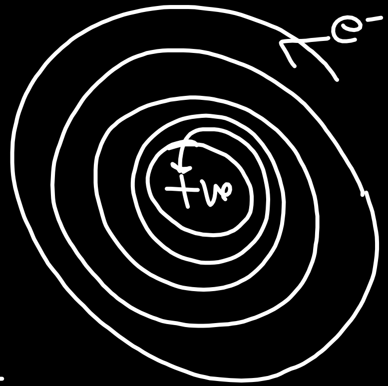
↳ H, He^{+}, Li^{2+} etc

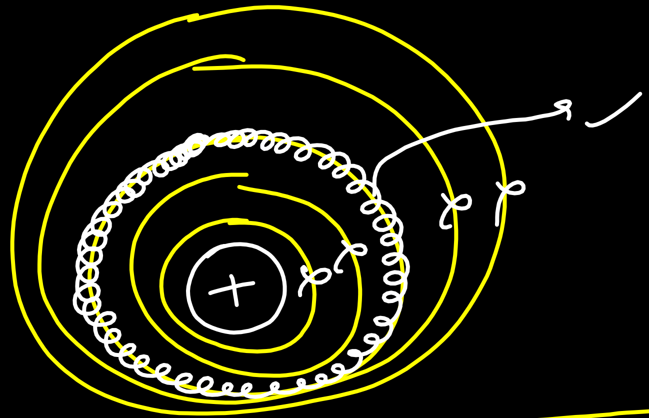
2



↳ non-Radiating orbits

Stationary orbits

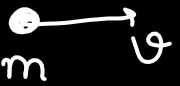




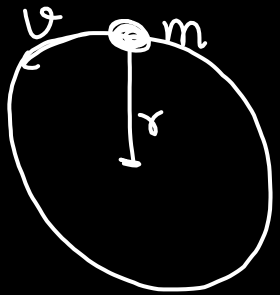
angular momentum = integral multiple of $\frac{h}{2\pi}$

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

$n = 1, 2, 3, 4, \ldots$



linear momentum = mv



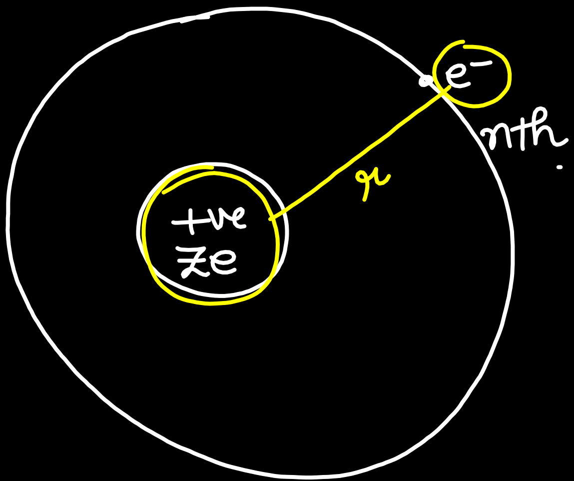
Angular momentum

$= mv \times r$

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

$n = 1, 2, 3, 4, \ldots$

K L M N



$$F_{att} = F_{centr}$$

$$F_{att} = \frac{kQ_1Q_2}{r^2}$$

$$= \frac{k(e)Ze}{r^2}$$

$$f_{centr} = \frac{mv^2}{r}$$

$$f_{att} = f_{centr}$$

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

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

$$mv^2 = \frac{kZe^2}{r} \quad \text{--- (1)}$$

$$mvr = \frac{nh}{2\pi} \quad \text{(Bohr' postulate)}$$

$$v = \frac{nh}{2\pi mr} \quad \text{--- (2)}$$

eq (2) in (1)

$$m\left[\frac{n^2h^2}{4\pi^2 m^2 r^2}\right] = \frac{kZe^2}{r}$$

$$\frac{n^2h^2}{4\pi^2 mkZe^2} = r$$

$$r_n = \frac{n^2}{Z}\left(\frac{h^2}{4\pi^2 m k e^2}\right)$$

21. radius of nth orbit

$$r_n = 0.529 \frac{n^2}{Z} \text{Å}$$

$$mvr = \frac{nh}{2\pi} \quad \text{—— (1)}$$

$$v = \frac{nh}{2\pi m r} \quad \text{—— (2)}$$

$$r = \frac{n^2 h^2}{4\pi^2 m k Z e^2} \quad \text{—— (3)}$$

Put eq 3 in eq 2

$$v = \frac{nh}{2\pi m r}$$

$$v = \frac{nh \, 4\pi^2 m k Z e^2}{2\pi m \, n^2 h^2}$$

\# 22. Vel of e^- in nth orbit

$$v_n = 2.18 \times 10^6 \times \frac{Z}{n} \ m/s$$

#23 energy of e^- in nth orbit

$$TE = KE + PE$$

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

$$= \frac{1}{2}\left(\frac{kZe^2}{r}\right)$$

$$KE = \frac{kZe^2}{2r}$$

$$PE = \frac{kQ_1Q_2}{r}$$

$$= \frac{k(-e)(Ze)}{r}$$

$$P.E = -\frac{kZe^2}{r}$$

$$TE = KE + PE$$

$$= \frac{kZe^2}{2r} - \frac{kZe^2}{r}$$

$$TE = \frac{-kZe^2}{2r}$$

→ r ....

24

$$TE = -KE = \frac{PE}{2}$$

$$E_n = -13.6\left(\frac{Z^2}{n^2}\right) \text{eV/atom}$$

$$E_n = -2.18 \times 10^{-19}\left(\frac{Z^2}{n^2}\right) \text{J/atom}$$

25: Hydrogen

$$E_n = -13.6 \times \frac{Z^2}{n^2} \text{ eV/atom}$$

$$Z = 1$$

$$E_n = -\frac{13.6}{n^2} \text{ eV/atom}$$

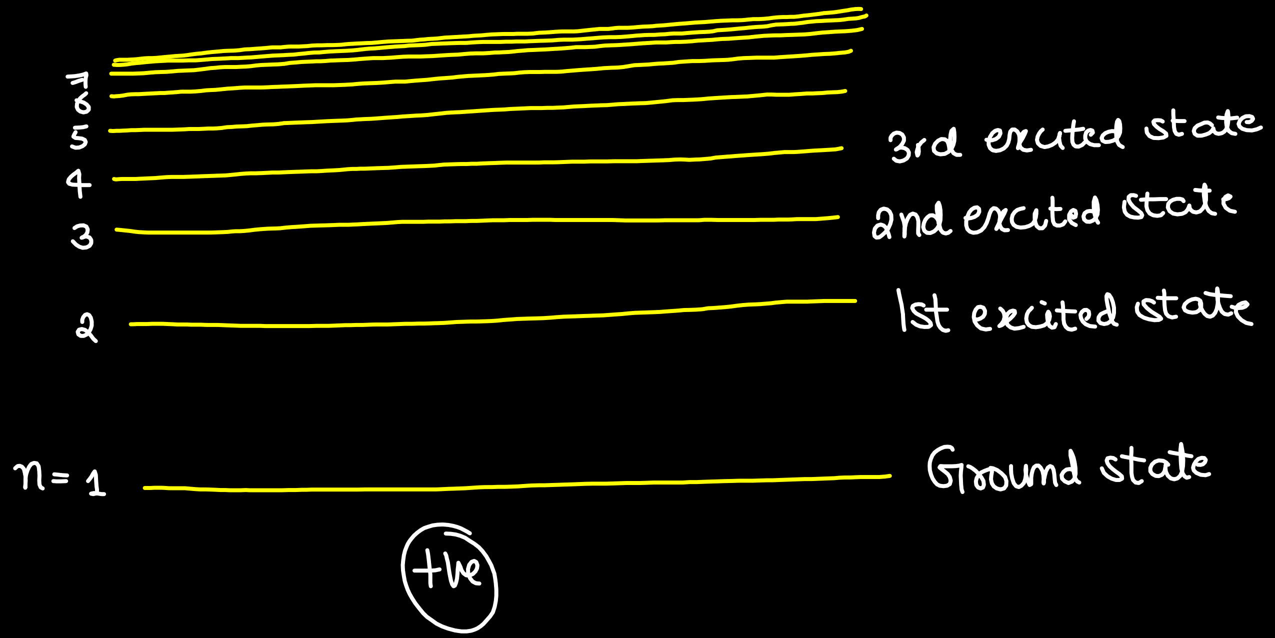
$n = 1$ $E_1 = -13.6$ eV/atom

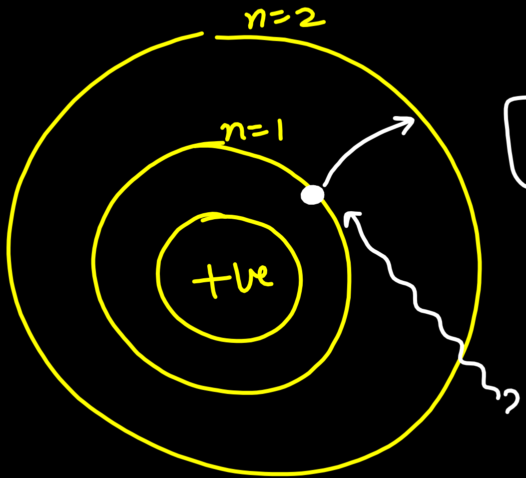
$n = 2$ $E_2 = -3.4$ eV/atom

$E_3 = -1.51$ eV/atom

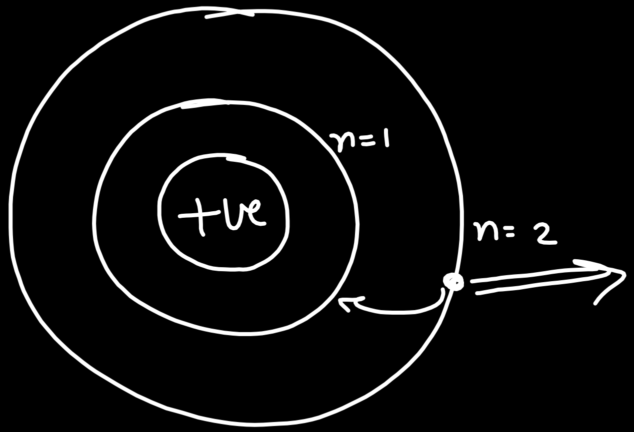
$E_4 = -0.85$ eV/atom

#26. Absorption & emission of energy





$$E_{ho} - E_{lo} = h\nu$$



+ve
n=1
n= 2

Jee main 2019

Q. The gnd state energy of H atom is −13.6 eV. The energy of 2nd excited state of He^{+} is

a) −54.4 eV

b) −3.4 eV

c) −6.04 eV

d) −27.2 eV

$$E = -13.6 \frac{Z^2}{n^2} \text{ eV}$$

$$= -\frac{13.6 \times 4}{9}$$

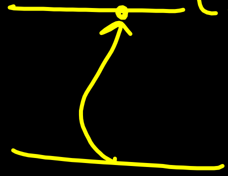
$$= \frac{-13.6}{9} \times 4$$

$$= -1.51 \times 4$$

#27

$$E_{ho} - E_{lo} = h\nu = \frac{hc}{\lambda}$$

$$\bar{\nu} = \frac{1}{\lambda} = R_H Z^2 \left(\frac{1}{n_{lo}^2} - \frac{1}{n_{ho}^2} \right)$$



R_H = Rydberg's const

$109677 \, cm^{-1}$

$$\frac{1}{\lambda} = R_H Z^2 \left(\frac{1}{n_{lo}^2} - \frac{1}{n_{ho}^2} \right)$$

$$\lambda = \frac{1}{R_H} Z^2 \left(\frac{1}{\left(\frac{1}{n_{lo}^2} - \frac{1}{n_{ho}^2} \right)} \right)$$

SV shortcut

$$\frac{1}{R_H} = 912 \text{ Å}$$

Q. Jee main 2019

The λ of radiation emitted, when in a H-atom, e^- falls from ∞ to stationary state

a) 91 nm

b) 192 nm

c) 406 nm

d) 91×10^{-8} nm

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

$$\frac{1}{\lambda} = R_H\left(\frac{1}{1} - \frac{0}{1}\right)$$

$$\lambda = \frac{1}{R_H} = 912\ \text{Å}$$

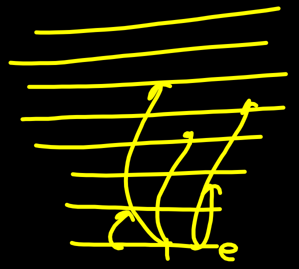
#28

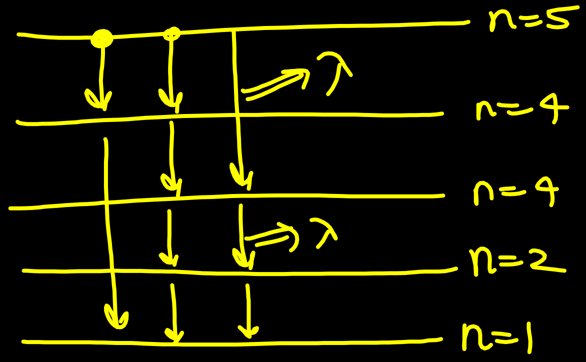
Line spectrum of hydrogen

$H_2(g)$ → low pressure

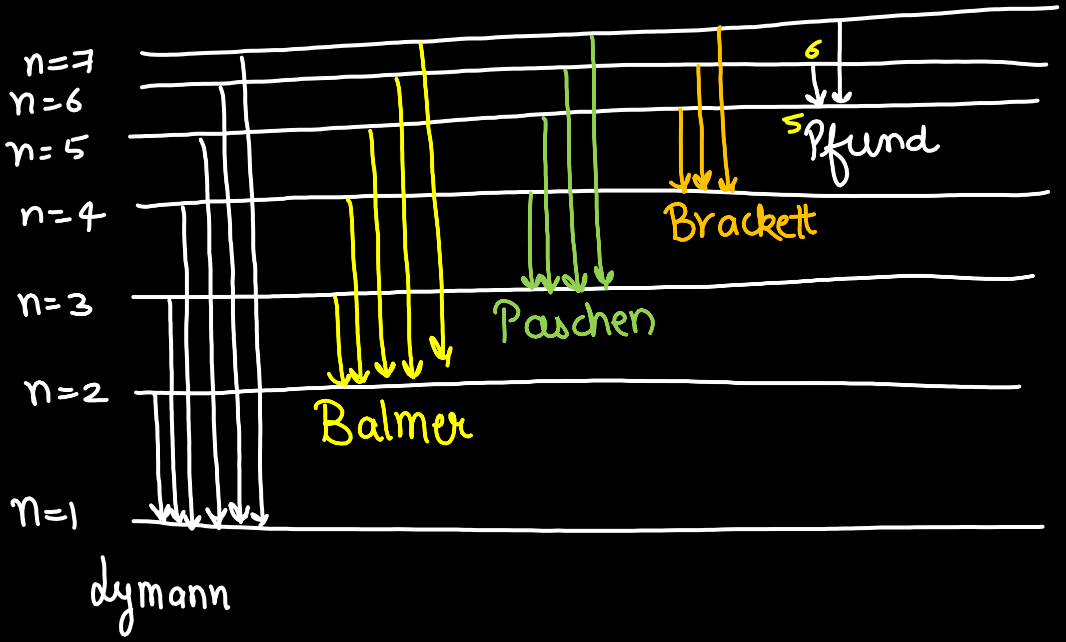
atomic H

↑ heat





#29.



#30

H-spectrum

$$\frac{1}{\lambda} = R_H\left(\frac{1}{n_{lo}^2} - \frac{1}{n_{ho}^2}\right)Z^2$$

Lymann

1st line (α-line)

$n_{lo} = 1 \quad n_{ho} = 2$

2nd line (β)

$n_{lo} = 1 \quad n_{ho} = 3$

#31 Line of max λ of Paschen series

max $\lambda \Rightarrow$ min energy

$n_{lo} = 3$ $n_{ho} = 4$

Line of min λ of Pfund series

min $\lambda \Rightarrow$ max energy

$n_{lo} = 5$ $n_{ho} = \infty$

#32 H- spectrum

1 Lymann

$n_{lo} = 1$

$n_{ho} = 2, 3, 4, 5 \ldots \infty$

$2 \longrightarrow 1$ 1st line

$3 \longrightarrow 1$ 2nd line

$\infty \longrightarrow 1$ last line

2 Balmer

$n_{lo} = 2$

$n_{ho} = 3, 4, 5, 6, \ldots \infty$

3 Paschen

$n_{lo} = 3$

$n_{ho} = 4, 5, 6, 7, 8 \ldots \infty$

#33 Sample of atomic H

no of unique spectral lines = $\frac{(n_{ho} - n_{lo})(n_{ho} - n_{lo} + 1)}{2}$

2022 ✓

2021 ✓

2022 ✓

Q. jee main 2019.

The Ratio of Shortest λ of 2 spectral lines of H-atom is $\simeq 9$. The lines are

$\frac{1}{\lambda} = R_H\left(\frac{1}{n_{lo}^2}\right)$

(a) Lymman Paschen
1 9

(b) Brackett Pfund
4^2 $\frac{1}{5^2}$

(c) Paschen Pfund
9 25

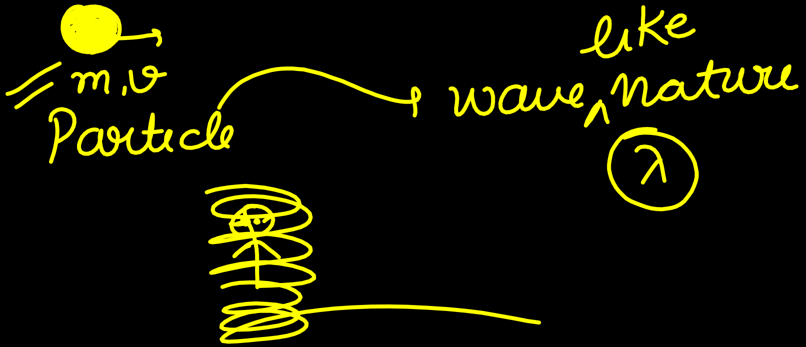
(d) Balmer Brackett

5 ⟶ 3 ⟶ 2 ⟶ 1

6 ⟶ 4 ⟶ 2 ⟶ 1

shortest λ
max energy
$n_{lo} = \infty$

#34. De-Broglie's Hypothesis.



m, v, λ

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

mv linear momentum

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

λ KE

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

÷ & × By m

$$KE = \frac{m^2 v^2}{2m}$$

$$2mKE = (mv)^2$$

$$\sqrt{2mKE} = mv$$

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

35

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

- m
  KE
  wave like
  (λ)

#26 e^- (rest) $\rightarrow$ (V)

$$\lambda = \frac{h}{\sqrt{2m(qV)}}$$

(qV) $\rightarrow$ KE

jee adv 2021

#37

Heinsberg's uncertainty principle

moving microscopic particle

↓ ✗

exact pos, exact momentum → Simultaneously

Δx error in pos

Δp error in momentum

$$\Delta x \cdot \Delta p \geq \frac{h}{4\pi}$$

$$\Delta x \, \Delta(mv) \geq \frac{h}{4\pi}$$

$$\Delta x \, \Delta v \geq \frac{h}{4\pi m}$$

38 error in KE

$\Delta(KE) = ?$

$KE = \frac{1}{2} m v^2$

$\frac{d(KE)}{dv} = \frac{1}{2} m\, 2 v$

$d(KE) = mv\, dv$

$\Delta(KE) = mv \cdot \Delta v$

$\frac{\Delta(KE)}{mv} = \Delta v$

$\Delta x\, \Delta p \geq \frac{h}{4\pi}$

$\Delta x\, \Delta v \geq \frac{h}{4\pi m}$

$\Delta x\, \frac{\Delta KE}{mv} \geq \frac{h}{4\pi m}$

$\Delta x \cdot \Delta KE \geq \frac{hv}{4\pi}$

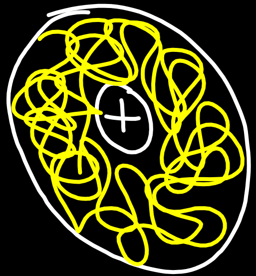
#39

Quantum Mechanical model of an atom

* In an atom, the exact pos of e^- can't be measured

* Prob to find the e^-

* e^- — 3D wave

* 

✓ e^- ⟶ wave ⟶ wave function ψ

✓ Schrodinger wave eq (e^- ⟶ motion)

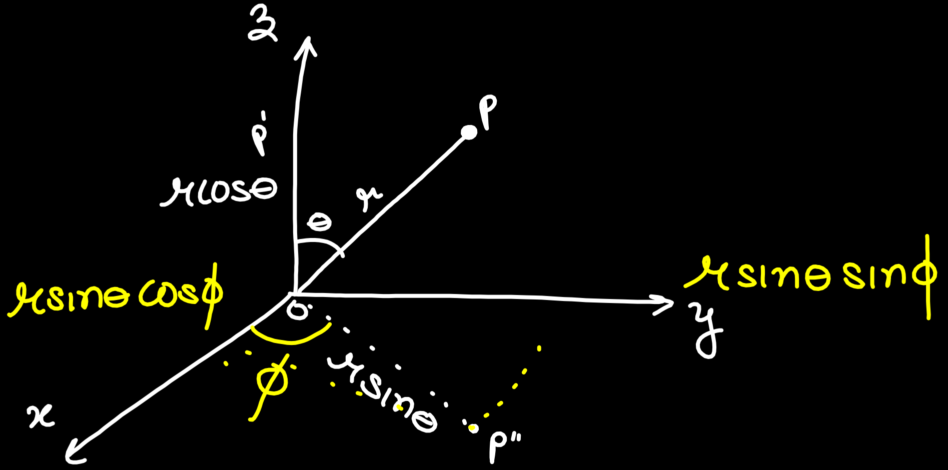
#40

$$\frac{\partial^2\psi}{\partial x^2} + \frac{\partial^2\psi}{\partial y^2} + \frac{\partial^2\psi}{\partial z^2} + \frac{8\pi^2 m}{h^2}(E-V)\psi = 0$$

$$\psi = f(x,y,z)$$

$e \longrightarrow$ wave Motion $\longrightarrow \psi(x,y,z)$

#41



✓ Polar cordinate system

r, θ, ϕ

Cartesian cor

x, y, z

#42

Cartesian ⟷ polar

$$z = r\cos\theta$$

$$x = r\sin\theta\cos\phi$$

$$y = r\sin\theta\sin\phi$$

$\psi(x,y,z) \longrightarrow \psi(r,\theta,\phi)$

$\downarrow$

$\psi(r)\,\underbrace{\psi(\theta,\phi)}$

$\psi = \underbrace{5\sin^2\theta\ 6\cos^3\phi}\ \underbrace{\frac{4}{3}r^3}$

$\psi(r,\theta,\phi) = \underbrace{R(r)}\ \underbrace{A(\theta,\phi)}$

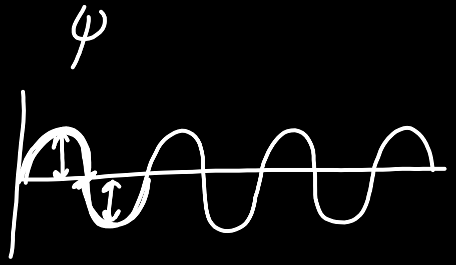
$A(\theta,\phi)$ → angular wave fn

$R(r)$ → Radial wave fn

#43: ψ wave function.

↳ Prob amplitude of e^-

→ ψ → +, −, 0



☆ ψ → no physical significance

#44:

ψ^2 Probability density

↳ $\frac{\text{Prob to find an } e^-}{\text{Volume}}$

$\frac{\text{Prob to find the } e^-}{\boxed{\psi^2 \, dV}}$

mass density = $\frac{\text{mass}}{\text{vol}}$

charge dens = $\frac{\text{charge}}{\text{vol}}$

Prob dens = $\frac{\text{Prob}}{\text{vol}}$ ✓

vol × Prob den = Prob

45

Nodes: The region of the space where prob to find e^- is 0 → node

$$\text{Prob} = 0$$

$$\boxed{\psi^2 dV = 0}$$

$$dV \neq 0$$

$$\psi^2 = 0$$

$$\Rightarrow \psi = 0$$

$$\psi = 0$$

$$R(r)\,A(\theta,\phi) = 0$$

$R(r) = 0$ → Radial node

$A(\theta,\phi) = 0$ → Angular node.

#46 ☆ jee main

nodes ($n-1$)

- **Radial** or **Spherical nodes**: $n-l-1$
- **Angular** or **nodal planes** or **nodal cones**: l

WA

Quantum Numbers

#47

Sch wave equation

↓

3 Solution

↓

Q NO

n, l, m

4th Q NO — theo derive

X

48 (n) · Principal Q.NO

(n) → Bohr·

n = 1, 2, 3, 4
K, L, M, N

→ shell / orbit / energy level

n· energy of e^- in an orbit

n. dis b/w the nucleus & e^-

49. Azimuthal Q No (l)

↳ subleve to which the e^- belongs

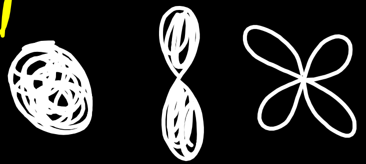
$l = 0$ to $n-1$

$n = 1, \quad l = 0$

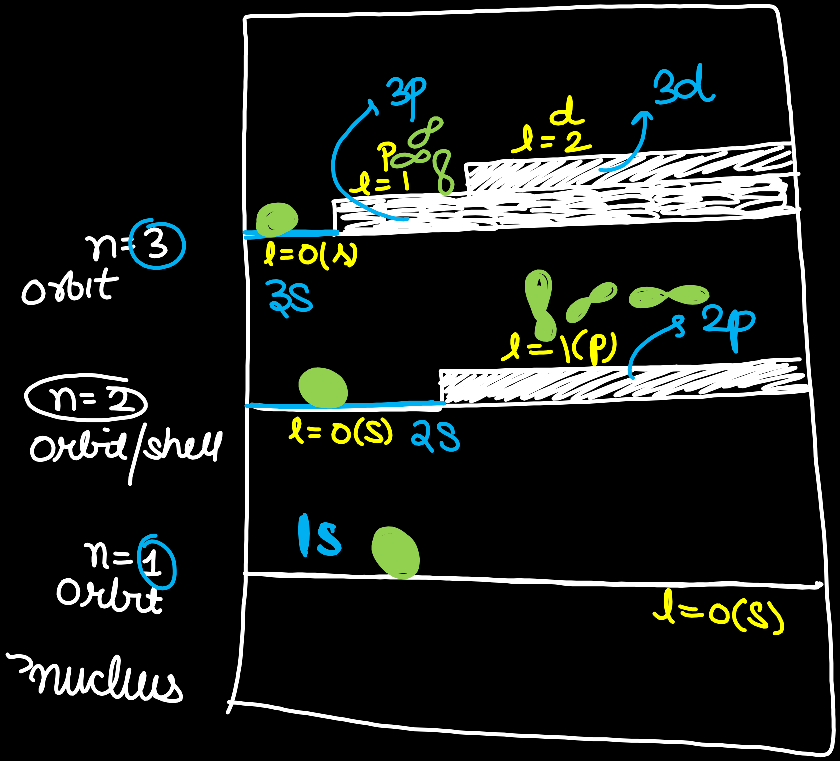
$n = 2, \quad l = 0, 1$

$n = 3, \quad l = 0, 1, 2$

$l =$	0	1	2	3
Name of Subshell	s	p	d	f



complex

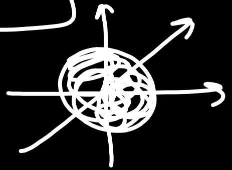


#50: magnetic Q No m or m_l

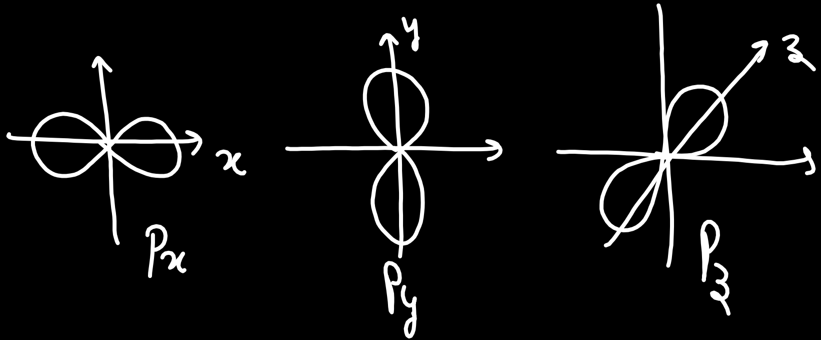
Possible orientations of a subshell

$$m = -l \text{ to } +l$$

(s) $l = 0$ $m = 0$

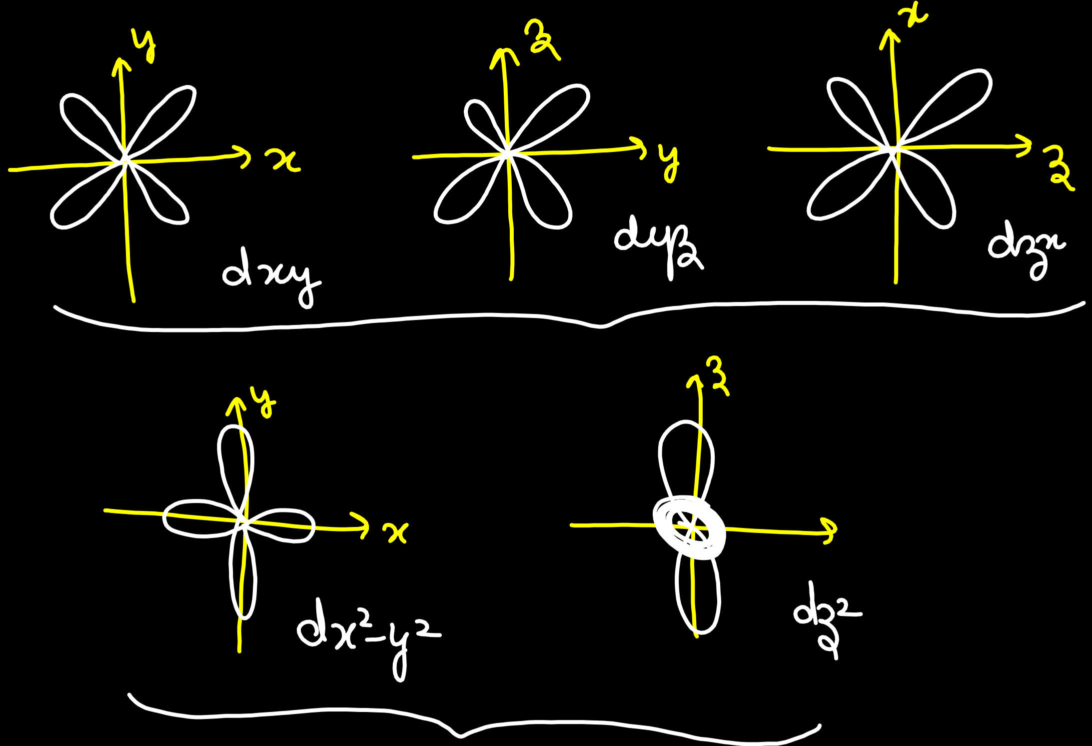


(p) $l = 1$ $m = -1, 0, 1$

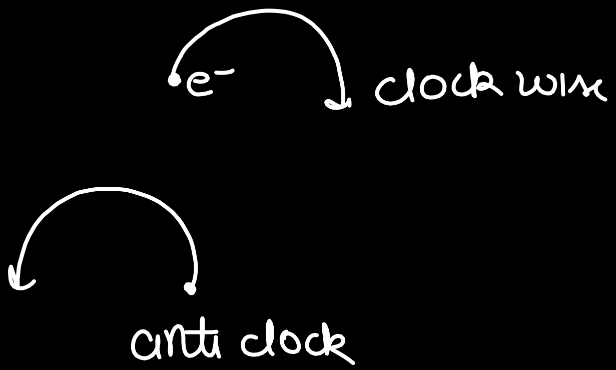


$l = 2$ $m = -2, -1, 0, 1, 2$

(d)



#51. Spin Q NO (s)

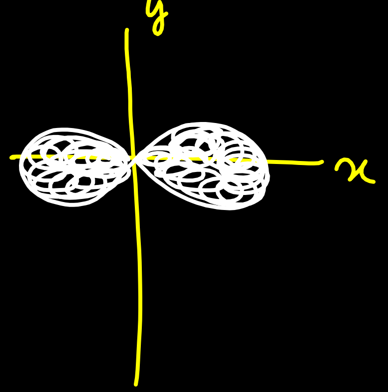


$s = +\frac{1}{2}$

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

#52 Orbital

3D space – where the prob to find e^- is max



#53: Degenerate orbitals

↳ having same energy

$l = 0$ — s
1 — p
2 — d
3 — f

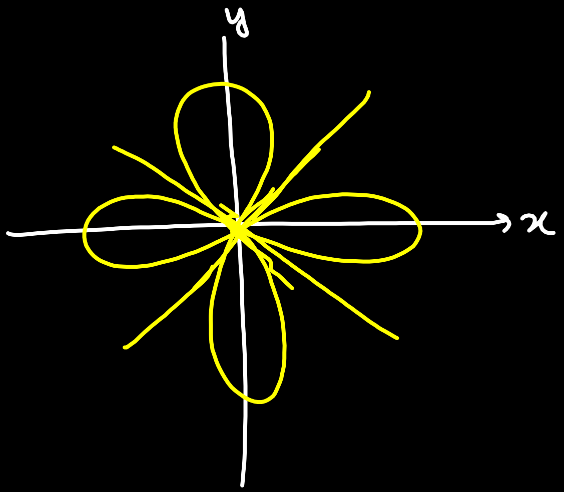
energy (n+l) rule

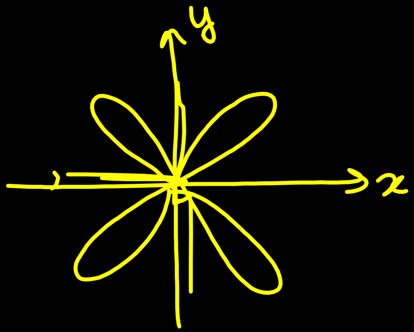
	3p	3s	2p
n	3	3	2
l	1	0	1
n+l	4	3	3

2p < 3s < 3p

#54. nodal plane.

$d_{x^2-y^2}$



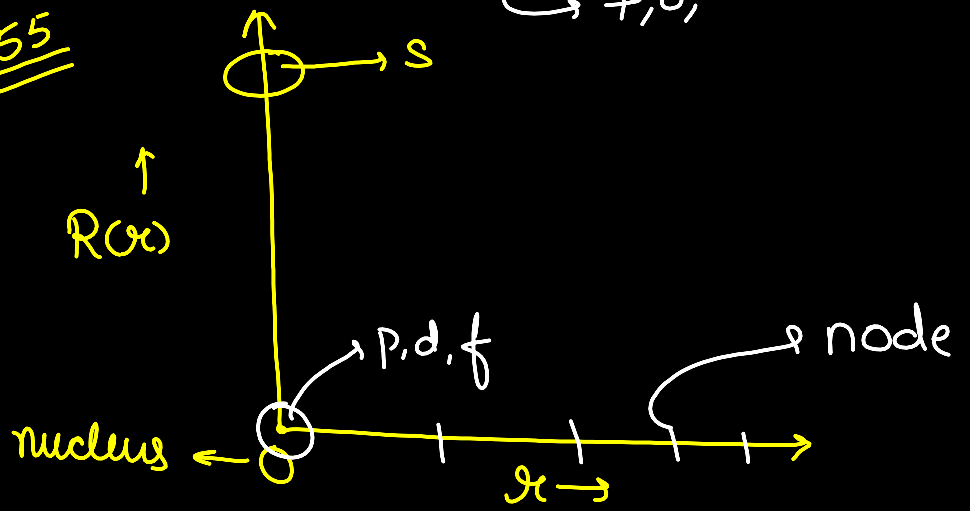


d_{xy}

#55

Radial wave fn v/s r

↳ +, 0, −

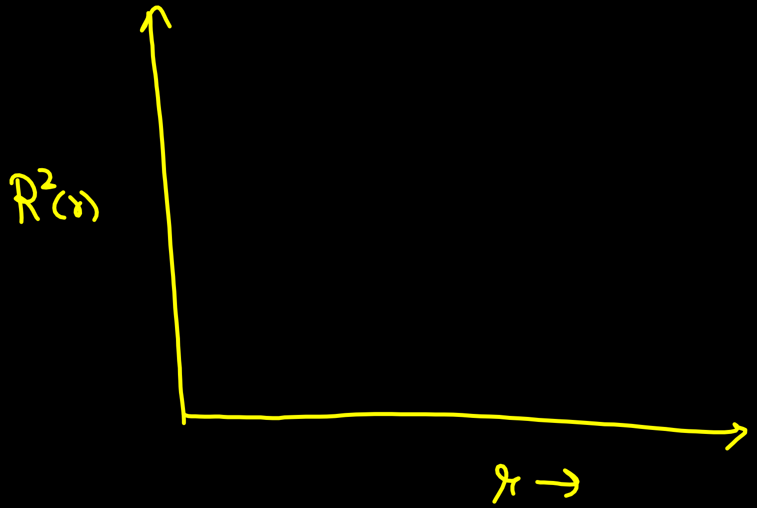


#56.

Radial prob density v/s r

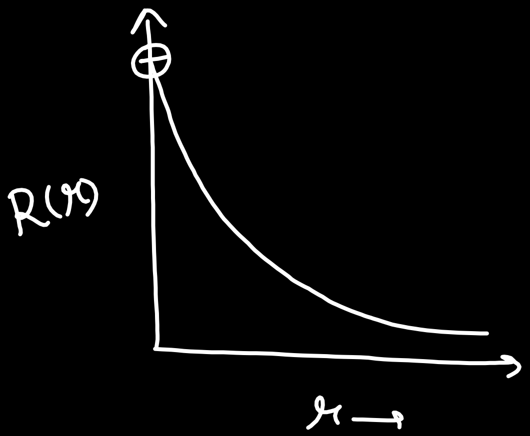
$R^2(r)$ v/s r

↳ +



(1S)

Q.



1S

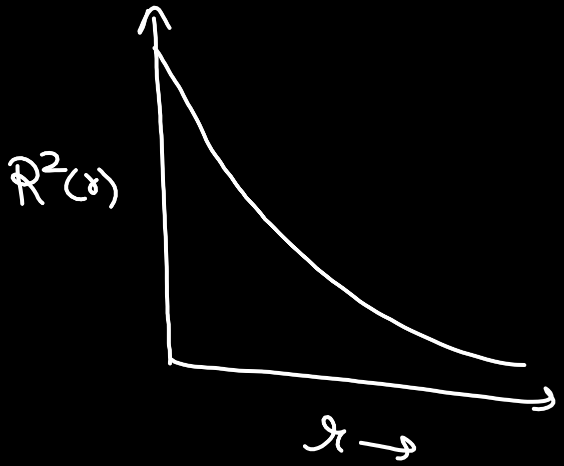
$n = 1$

$l = 0$

Radial node : $n - l - 1$

$1 - 0 - 1$

$= 0$



2S

$n = 2$

$l = 0$

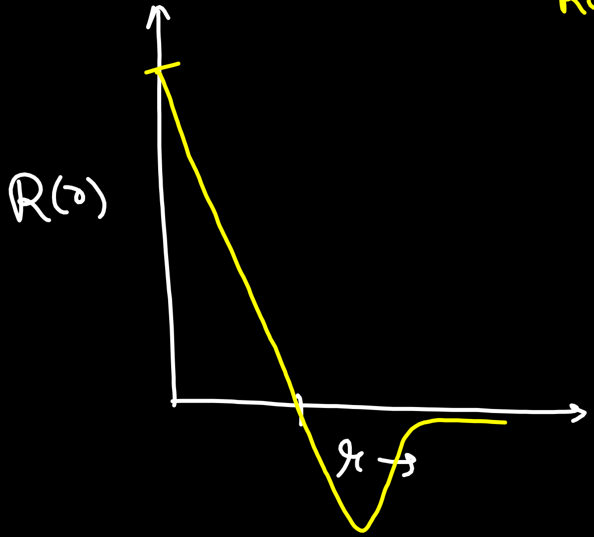
Radial nodes

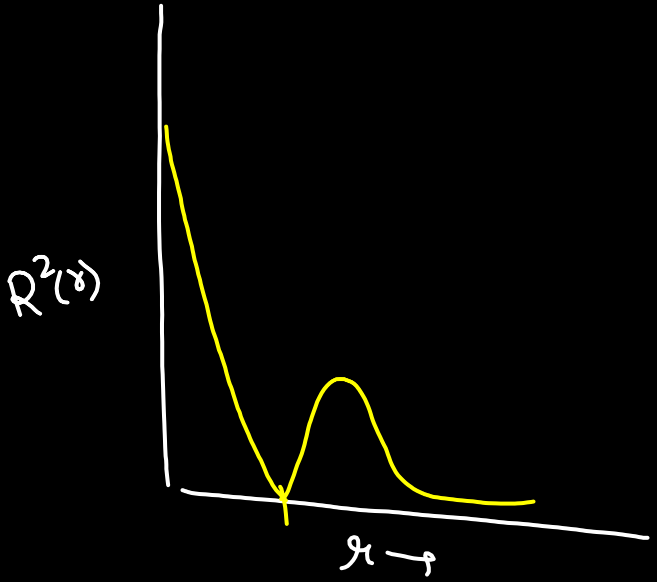
$n - l - 1$

$2 - 0 - 1$

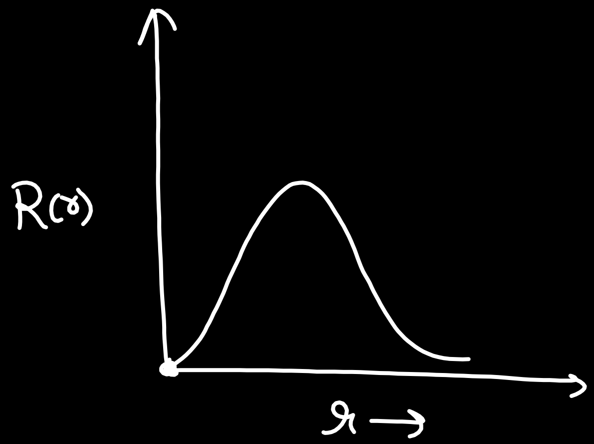
$= 1$

1 touch





3d



$n = 3$

$l = 2$

$n - l - 1$

$3 - 2 - 1$

$= 0$

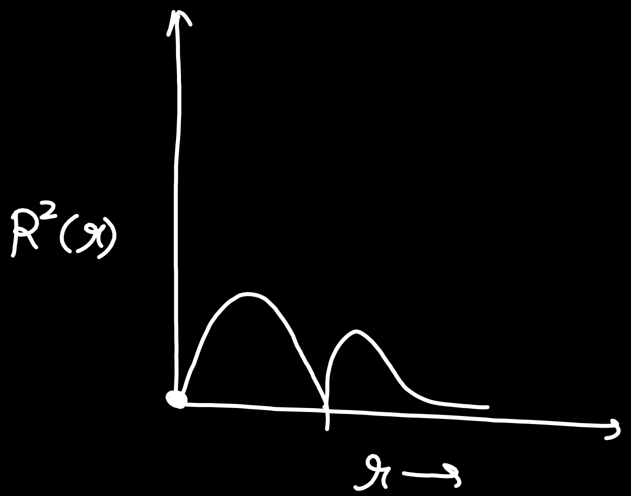
4d

$n = 4$

$l = 2$

$n - l - 1$

$4 - 2 - 1 = 4 - 3 = 1$



#57 Radial prob. distribution function

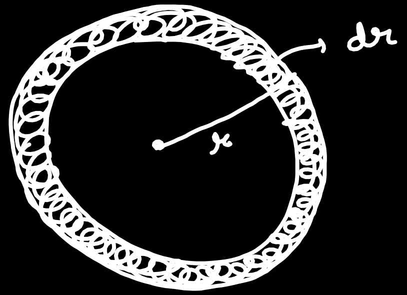
$\frac{dP}{dr}$ ——— ✗ $P(r)$

Prob at r

$$P(r) = \frac{dP}{dr} = \text{Prob @ } r$$

58.

$$\text{Radial Prob} = \text{Radial Prob den} \times \text{volume}$$



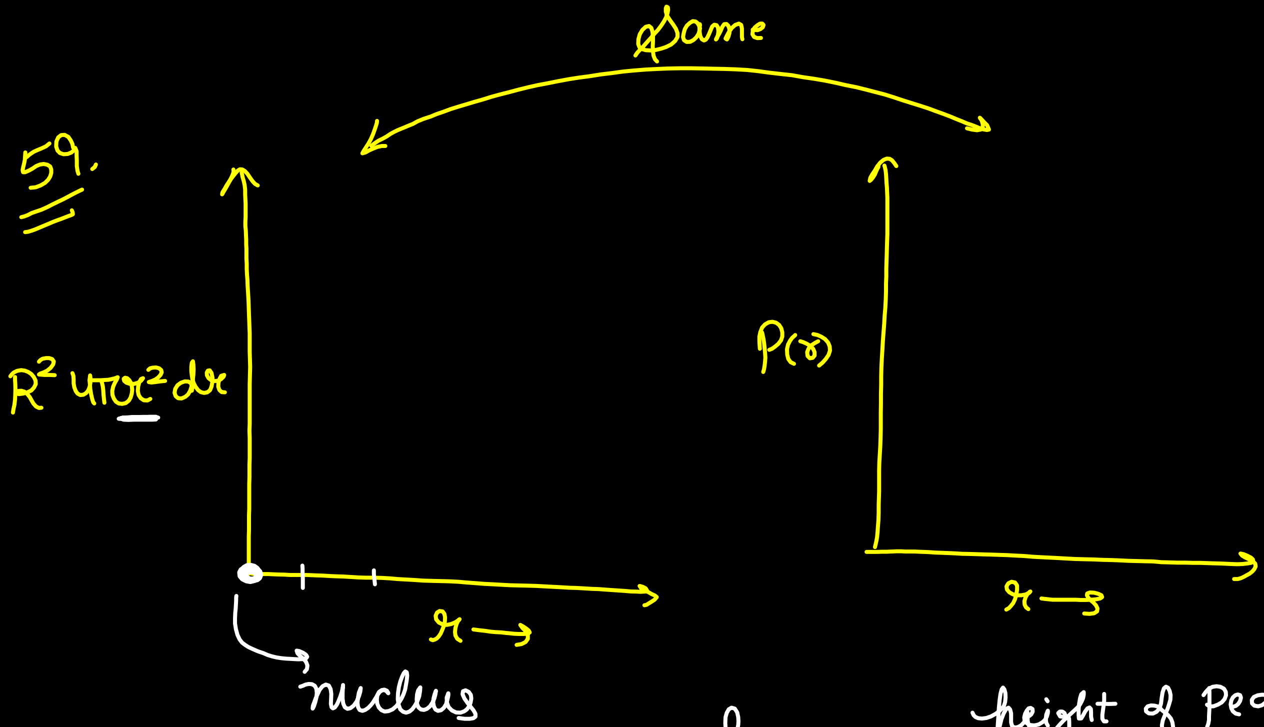
$$dV = \frac{4}{3}\pi(r+dr)^3 - \frac{4}{3}\pi r^3$$

$$= \boxed{4\pi r^2 dr}$$

$$\boxed{dP = R^2(r)\, 4\pi r^2 dr}$$

$$\boxed{P(r) = \frac{dP}{dr} = R^2(r) 4\pi r^2}$$

59.



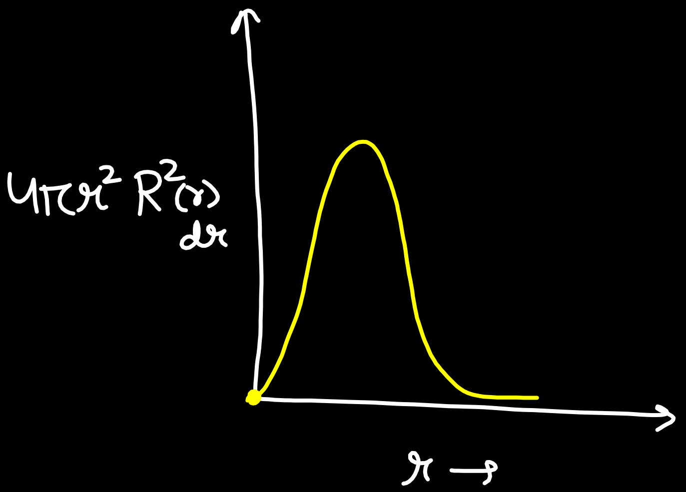
s, p, d, f → start from 0

1st Quad

touch on x-axis → nodes

height of peak ↑

60.



3d

$n = 3$

$l = 2$

$n - l - 1$

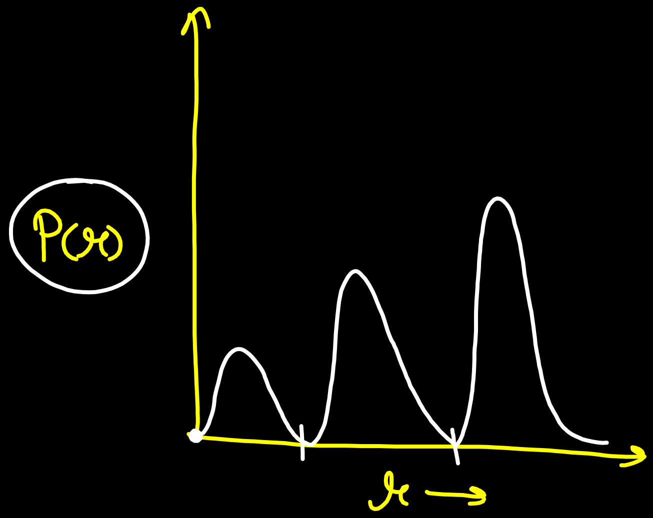
$3 - 2 - 1$

$3 - 3$

0

Q

4P



4p

n = 4

l = 1

n − l − 1

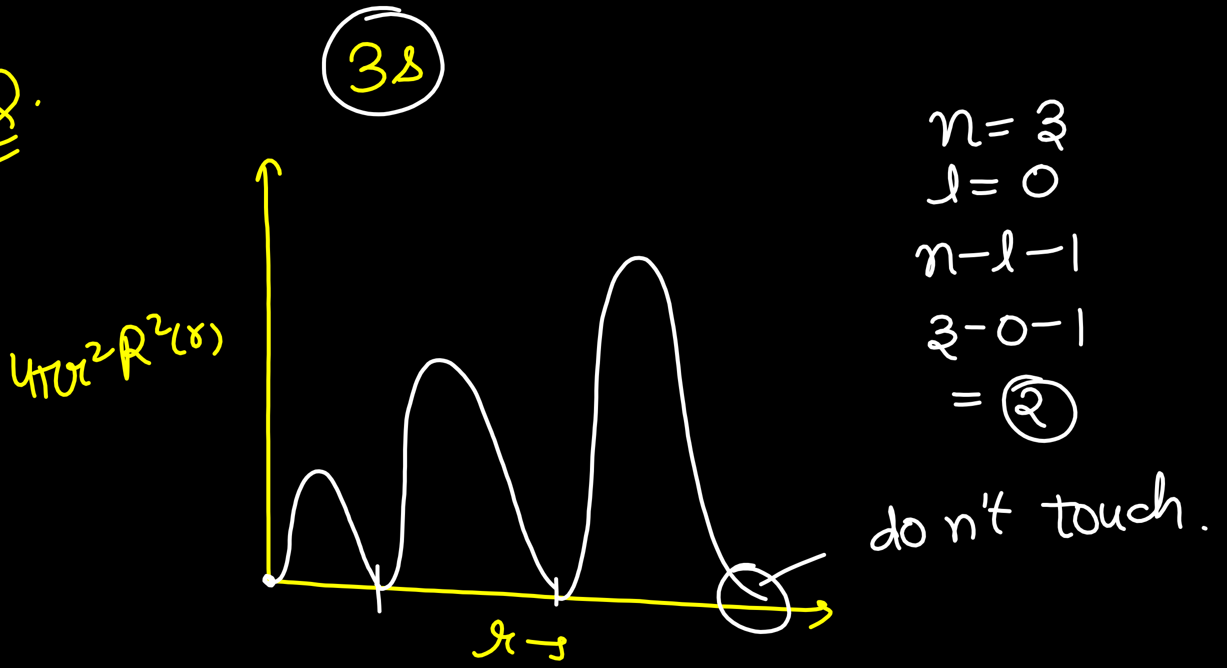
4 − 1 − 1

4 − 2

= 2

l =	0	1	2
	s	p	d

Q.



$n = 3$

$l = 0$

$n - l - 1$

$3 - 0 - 1$

$= 2$

unacademy

Nurture Batch

for IIT JEE Main and Advanced 2024

Code: SAKSHI

Batch highlights:

- Curated by India's Top Educators
- Coverage of Class 11 JEE syllabus
- Enhance conceptual understanding of JEE Main & JEE Advanced subjects
- Systematically designed courses
- Strengthen JEE problem-solving ability

Prashant Jain
Mathematics Maestro

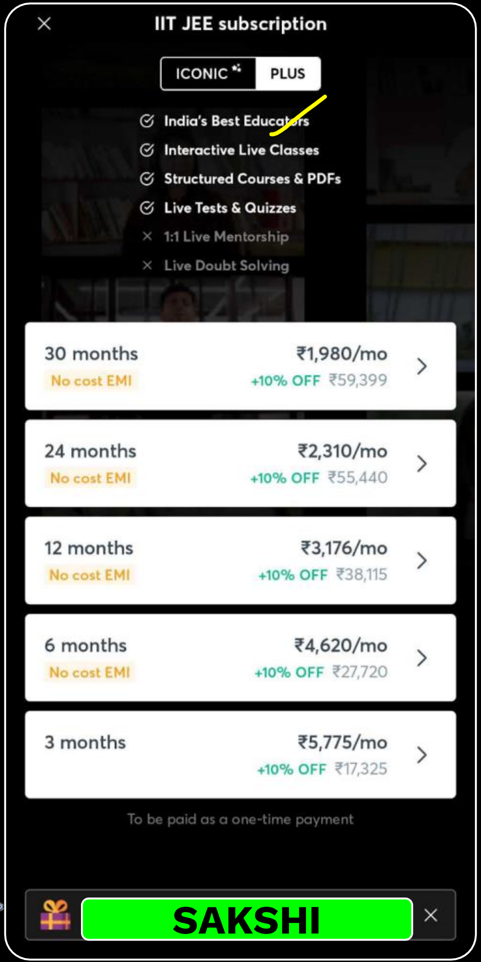
Nishant Vora
Mathematics Maestro

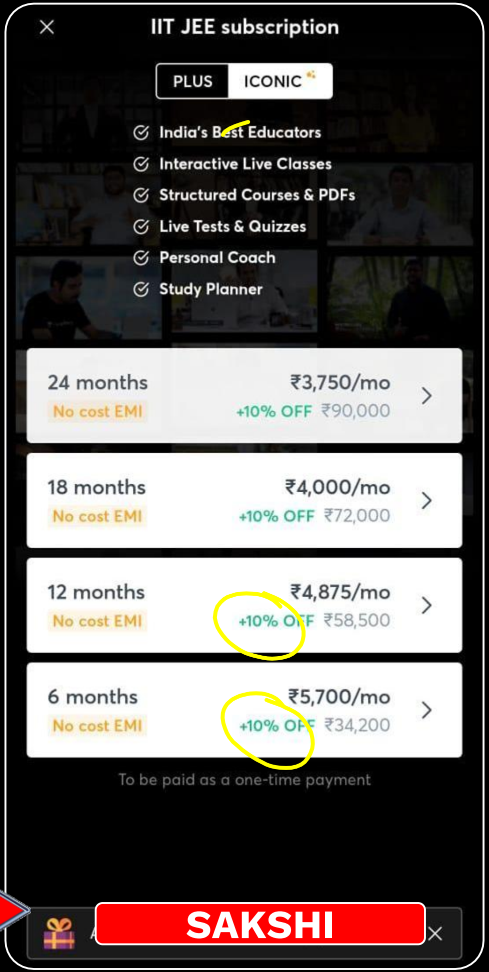
Ajit Lulla
Physics Maestro

Abhilash Sharma
Physics Maestro

Sakshi Vora
Chemistry Maestro

Megha Khandelwal
Chemistry Maestro


IIT JEE subscription
ICONIC
PLUS
India's Best Educators
Interactive Live Classes
Structured Courses & PDFs
Live Tests & Quizzes
1:1 Live Mentorship
Live Doubt Solving
30 months
No cost EMI
₹1,980/mo
+10% OFF ₹59,399
24 months
No cost EMI
₹2,310/mo
+10% OFF ₹55,440
12 months
No cost EMI
₹3,176/mo
+10% OFF ₹38,115
6 months
No cost EMI
₹4,620/mo
+10% OFF ₹27,720
3 months
₹5,775/mo
+10% OFF ₹17,325
To be paid as a one-time payment
SAKSHI


IIT JEE subscription
PLUS
ICONIC
India's Best Educators
Interactive Live Classes
Structured Courses & PDFs
Live Tests & Quizzes
Personal Coach
Study Planner
24 months
No cost EMI
₹3,750/mo
+10% OFF ₹90,000
18 months
No cost EMI
₹4,000/mo
+10% OFF ₹72,000
12 months
No cost EMI
₹4,875/mo
+10% OFF ₹58,500
6 months
No cost EMI
₹5,700/mo
+10% OFF ₹34,200
To be paid as a one-time payment
SAKSHI


✦ NOW LIVE ✦
COMPETE
Battle and know where you stand
Win a laptop and prizes up to ₹2 Lakhs*
*Terms and Conditions apply


unacademy
unacademy

Thank You