VIDYAPEETH

BATCH CODE: 19-PJ301EA 2025

SUBJECT NAME: CHEMISTRY

CHAPTER NAME: Atomic Structure

Lecture No. 02

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Today's Goal

Subtopic

Black body radiation

discovery of → p
→ n

→ Anode Rays ⇒ { proton }

→ Structure → Thomson's model ×

→ Rutherford's Model → { α-particles scattering expo }

→ failure of model { Maxwell
E-M. }

→ Bohr's model { one electron System }

Black Body Radiation
(Plank's hypothesis)

Dual nature
(de-Broglie)

Photoelectric Effect

spectrum

Bohr's Atomic Model :→

{ One electron system } $(p+n) = H$

$(p) = Z$

⇒ $\boxed{\text{Quantisation}}$

$\boxed{n = \text{Energy level}}$

or

Shell

or

Orbit

$$\text{Angular momentum} = n \cdot \frac{h}{2\pi}$$

$$m \underline{v_n}\, \underline{r_n} = n \cdot \left(\frac{h}{2\pi}\right)$$

h = Universal Plank's Constant

I^{st} Energy shell | I^{st} Shell | I^{st} orbit

Bohr's orbit $(n = 1)$

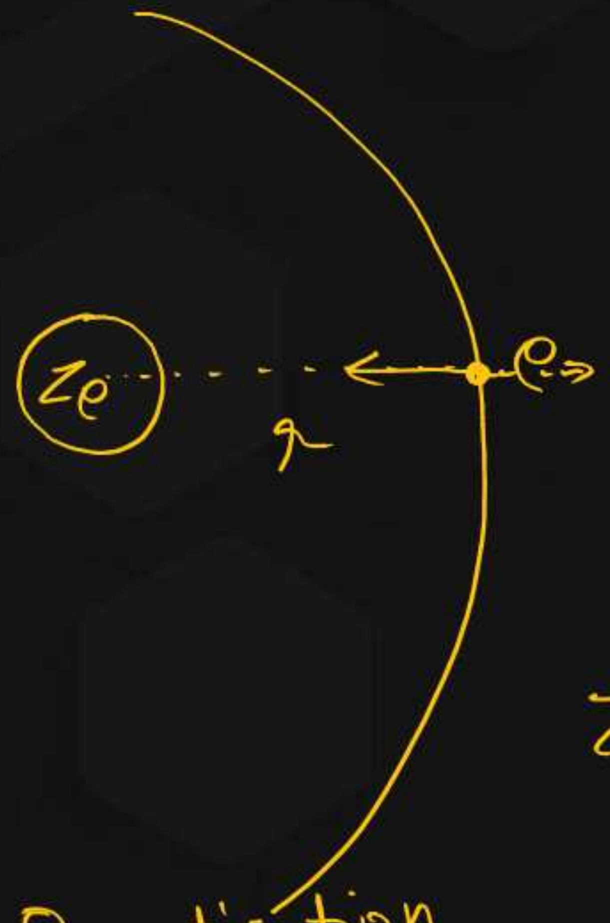
$n = 1$ ⇒ $$\boxed{mvr = \frac{h}{2\pi}}$$

$n = 2$ $$m v_2 r_2 = 2 \cdot \left(\frac{h}{2\pi}\right)$$

#1 r_n (Radius of n...) ; Atomic number Z

$$F_e = \frac{1}{4\pi\varepsilon_0}\frac{Ze\cdot e}{r^2} \quad \text{— (1)}$$

$$F_c = \frac{mv^2}{r} \quad \text{— (2)}$$



electron present in it's path.

eq. (1) = eq. (2)

$$\frac{1}{4\pi\varepsilon_0}\cdot\frac{Ze^2}{r^2} = \frac{mv^2}{r}$$

Bohr's Quantisation

$$\boxed{mvr = n\cdot\frac{h}{2\pi}} \quad \text{— (3)}$$

$$\frac{1}{4\pi\varepsilon_0}\cdot\frac{Ze^2}{r^2} = \frac{m}{r}\times\left(\frac{nh}{2\pi m r}\right)^2$$

$$\Rightarrow \frac{1}{4\pi\varepsilon_0}\cdot Ze^2 = \frac{n^2h^2\cdot m}{4\pi^2\cdot m^2\cdot r} = \frac{n^2h^2}{4\pi^2\cdot m\cdot r}$$

$$\Rightarrow \frac{Ze^2}{\varepsilon_0} = \frac{n^2h^2}{\pi\cdot m\cdot r}$$

$$\pi m \underline{r}\, Z\cdot e^2 = n^2\cdot h^2\cdot\varepsilon_0$$

$$r = \frac{n^2}{Z}\cdot\left(\frac{h^2\cdot\varepsilon_0}{\pi m\, e^2}\right) = \frac{n^2}{Z}\cdot K$$

$$\boxed{r_n = K\cdot\frac{n^2}{Z}}$$

$$r_n = K \cdot \frac{n^2}{Z}$$

For H-atom

$Z = 1$, $n = 1$

$$\boxed{r = K}$$

$$\boxed{r_1 = r_0}$$

$$\boxed{r_0 = 0.529\,\mathring{A}}$$

Bohr's orbit

$$\boxed{r_n = r_0 \cdot \frac{n^2}{Z}}$$

(II) Energy of n^{th} orbit :→

$$P.E. = -\frac{1}{4\pi\varepsilon_0} \frac{Ze \cdot e}{r}$$

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

$$K.E. = \frac{1}{2}\left(\frac{1}{4\pi\varepsilon_0} \cdot \frac{Ze \cdot e}{r}\right)$$

Total energy $= P.E. + K.E.$

$$E = \left(-\frac{1}{4\pi\varepsilon_0} \cdot \frac{Ze^2}{r}\right) + \frac{1}{2}\left(\frac{1}{4\pi\varepsilon_0} \cdot \frac{Ze^2}{r}\right)$$

$$\boxed{E = -\frac{1}{2} \cdot \frac{1}{4\pi\varepsilon_0} \cdot \frac{Ze^2}{r}}$$

$$\boxed{E_T = \frac{1}{2} \cdot (P.E.) = -(K.E.)}$$

$$E_n = -\frac{1}{2} \cdot \frac{1}{4\pi\varepsilon_0} \cdot \frac{Ze^2}{r_n}$$

$$E_n = -\frac{1}{2} \cdot \frac{1}{4\pi\varepsilon_0} \cdot \frac{Ze^2 \times \pi m e^2 \cdot Z}{n^2 h^2 \cdot \varepsilon_0}$$

$$E_n = -\frac{Z^2}{n^2}\left(\frac{e^4 \cdot m}{8\varepsilon_0^2 \cdot h^2}\right)$$

$$\boxed{E_n = -K \cdot \frac{Z^2}{n^2}}$$

$$\boxed{E_n = -K \cdot \frac{Z^2}{n^2}}$$

For H atom

$Z = 1$

$n = 1$ (Bohr's orbit)

$$\boxed{E_1 = -K}$$

$$\boxed{K = 13.6 \text{ eV}}$$

$E_1 = -K$

$E_2 = -\frac{K}{4}$

$E_3 = -\frac{K}{9}$

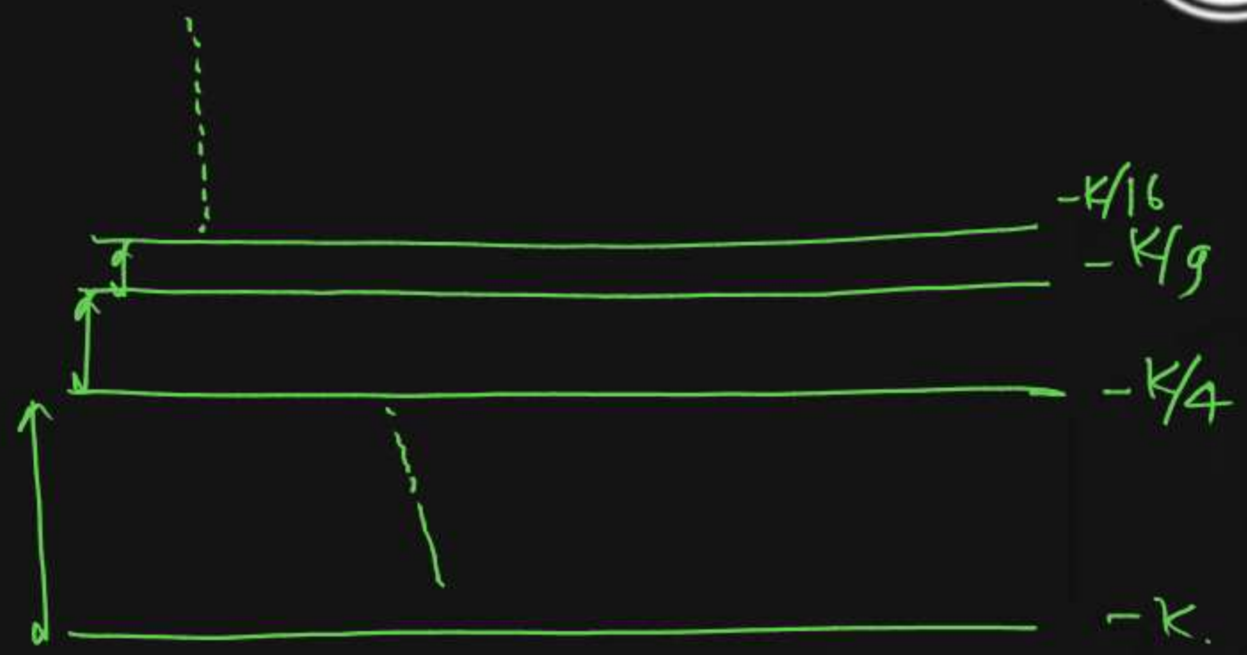
$n \to \infty$

$E_\infty \to 0$

$$\boxed{I.E. = E_\infty - E_1}$$

$= 0 - (-K)$

$= K$



I.P.

#

$$mvr = n\cdot\frac{h}{2\pi}$$

$$v = \frac{n\cdot h}{2\pi\cdot m\left(\frac{n^2}{Z}\cdot K\right)}$$

$$v = \frac{Z}{n}\left(\frac{h}{2\pi\cdot m\cdot K}\right)$$

$$\boxed{V_n = \frac{Z}{n}(V_0)}$$

V_0 = Speed in Bohr's orbit

2.18×10^6 m/sec.

$$T = \frac{2\pi r}{v}$$

$$T = \frac{2\pi\cdot r_0\cdot n^2/Z}{v_0\cdot(Z/n)}$$

Time period.

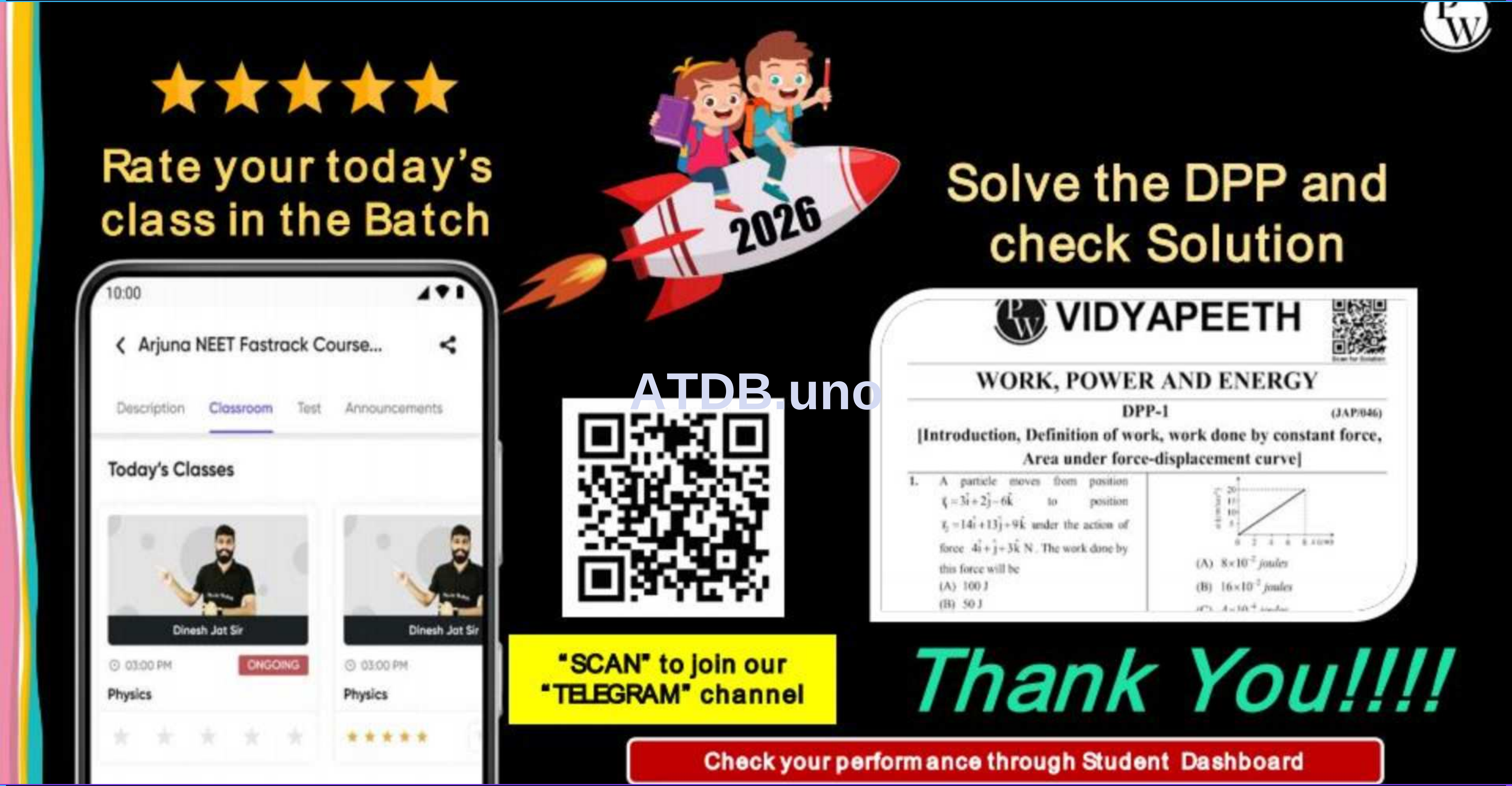
$$\boxed{T_n = \left(\frac{2\pi\cdot r_0}{v_0}\right)\cdot\frac{n^3}{Z^2}}$$

#Pb: find ratio of radius of II orbit of He (Z=2) to III orbit of Li (Z=3)

$$r_2 = r_0 \cdot \left(\frac{n^2}{Z}\right) = r_0 \cdot \frac{4}{2} = 2r_0$$

$$r_3 = r_0\left(\frac{n^2}{Z}\right) = r_0\left(\frac{9}{3}\right) = 3r_0$$

$$\frac{2}{3}$$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