VIDYAPEETH

BATCH CODE: 19-PJ301EA 2025

SUBJECT NAME: CHEMISTRY

CHAPTER NAME:

Atomic Structure

Lecture No. 04

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Today's Goal

Subtopic

Dual nature

Spectrum of Hydrogen

→

Dual nature →

- de-Brogelie relation

Plank's eq $\quad E = \dfrac{hc}{\lambda}$ — ①

Einstein eq. $\quad E = mc^2$ — ②

$$\Rightarrow \frac{hc}{\lambda} = mc^2$$

$$\Rightarrow \frac{h}{\lambda} = m \cdot c$$

$$\frac{h}{\lambda} = (m \cdot v) = p$$

$$\boxed{p \cdot \lambda = h}$$

p ↓ particle nature; λ ↓ wave nature.

a moving object associated with dual nature wave & particle nature & product always constant.

wave associated → de-Brogelie wavelength

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

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

$$\boxed{\lambda = \frac{h}{m \cdot v}}$$

#1

#2 $K.E. = \frac{1}{2} m v^2$

$\Rightarrow 2 \cdot m \cdot (K.E.) = m^2 v^2$

$\Rightarrow p^2 = 2m \cdot (K.E.)$

$p = \sqrt{2m(KE)}$

$$\boxed{\lambda = \frac{h}{\sqrt{2m \cdot (K.E.)}}}$$

#2

#3 a charge particle is accelerated through a pontential V volt.

$(K.E.) = q \cdot V$

$$\boxed{\lambda = \frac{h}{\sqrt{2 \cdot m \cdot q \cdot V}}}$$

#3/2

V = Potential (Volt)

Spectrum :→

H- like atom

① Emmision — Absorptive

② Line — Band

③ Continuous — discontinous

Spectrum of Hydrogen (Line)

$n_2 > n_1$

$$E_{n_1} = -K\frac{Z^2}{n_1^2} \qquad E_{n_2} = -K\cdot\frac{Z^2}{n_2^2}$$

$$\Rightarrow E_{n_2} - E_{n_1} = \boxed{\Delta E = KZ^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]} \quad (1)$$

Planks Theory Emmited radiation

$$\Delta E = \frac{hc}{\lambda} \quad (2)$$

$$\frac{hc}{\lambda} = KZ^2\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

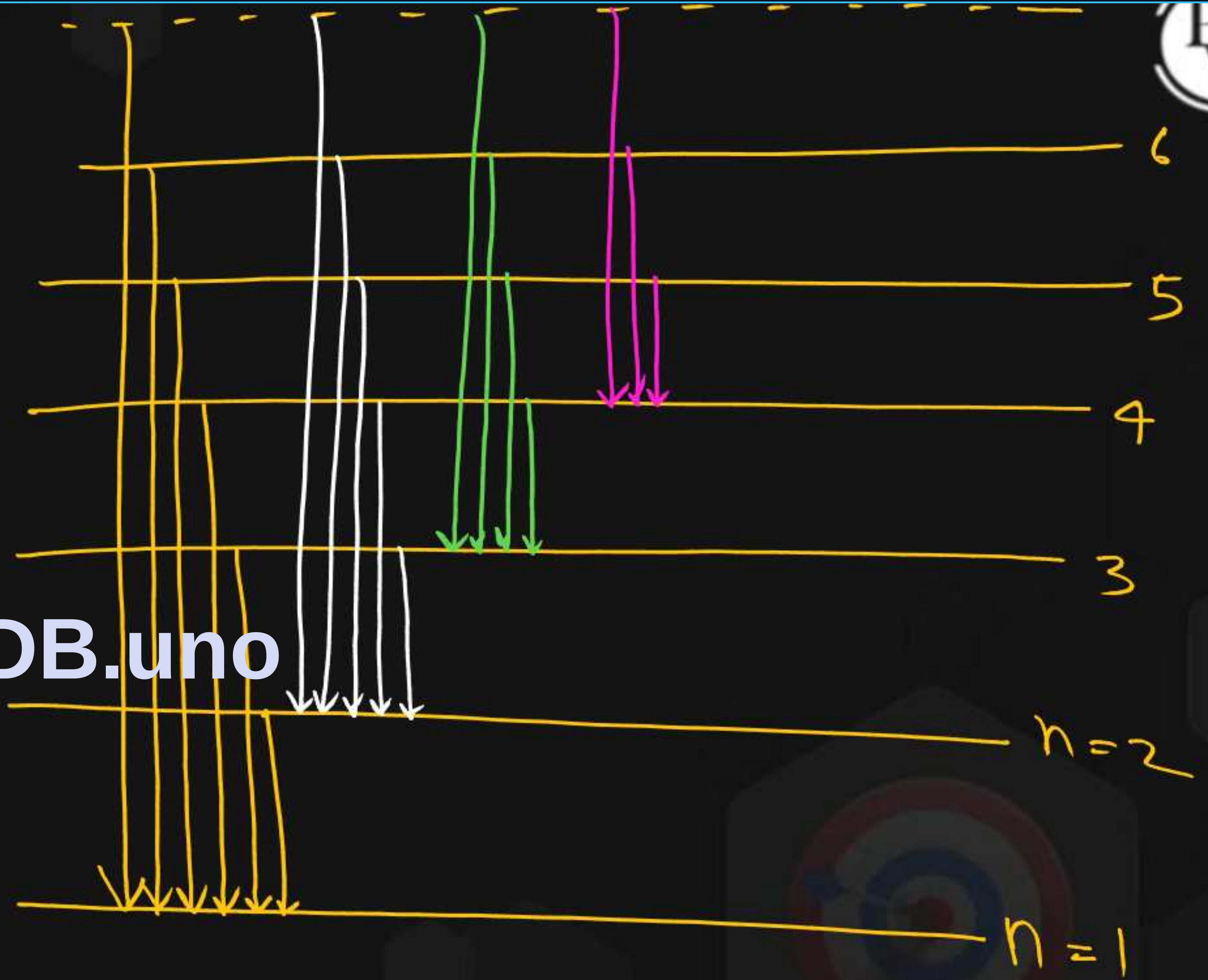
$$\Rightarrow \frac{1}{\lambda} = \left(\frac{K}{hc}\right) Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$$

$$\Rightarrow \boxed{\frac{1}{\lambda} = R_H \cdot Z^2 \left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]}$$

R_H = Rydberg's constant (cm^{-1})

n_1 = Returning level

n_2 = from where returning



$E \propto \frac{1}{\lambda}$

→ $\lambda_{max.}$ → I^{st} S.L.

→ $\lambda_{min.}$ → from ∞

$n_1 = 1$ Lyman series $\frac{1}{\lambda} = R_H\left[1 - \frac{1}{n^2}\right]$ $n > 1$

$\boxed{\lambda = \text{wavelength}}$

$\boxed{\frac{1}{\lambda} = \text{wave number}}$

$n_1 = 2$ Balmer series (Series of colourful lines) $\frac{1}{\lambda} = R_H\left[\frac{1}{4} - \frac{1}{n^2}\right]$ $n > 2$

$n_1 = 3$ Paschen Series $\frac{1}{\lambda} = R_H\left[\frac{1}{9} - \frac{1}{n^2}\right]$ $n > 3$

$n_1 = 4$ Brackett

$n_1 = 5$ Pfund

$n_1 = 6$ Humphrey

	I^{st} ($\boxed{\lambda_{max}\uparrow}$)	II^{nd}	III^{rd}	IV^{th}	⋮ λ_{min}
Lyman	$2 \rightarrow 1$	$3 \rightarrow 1$	$4 \rightarrow 1$	$5 \rightarrow 1$	$\infty \rightarrow 1$
Balmer	$3 \rightarrow 2$	$4 \rightarrow 2$	$5 \rightarrow 2$	$6 \rightarrow 2$	$\infty \rightarrow 2$
Paschen	$4 \rightarrow 3$	$5 \rightarrow 3$	$6 \rightarrow 3$	$7 \rightarrow 3$	$\infty \rightarrow 3$

Q → $\boxed{\text{Balmer}}$

$$\frac{1}{\lambda_{max}} = R\left[\frac{1}{4} - \frac{1}{9}\right] = \frac{5R}{36} \qquad \Bigg| \qquad \frac{1}{\lambda_{min.}} = R\left[\frac{1}{4} - 0\right] = \frac{R}{4}$$

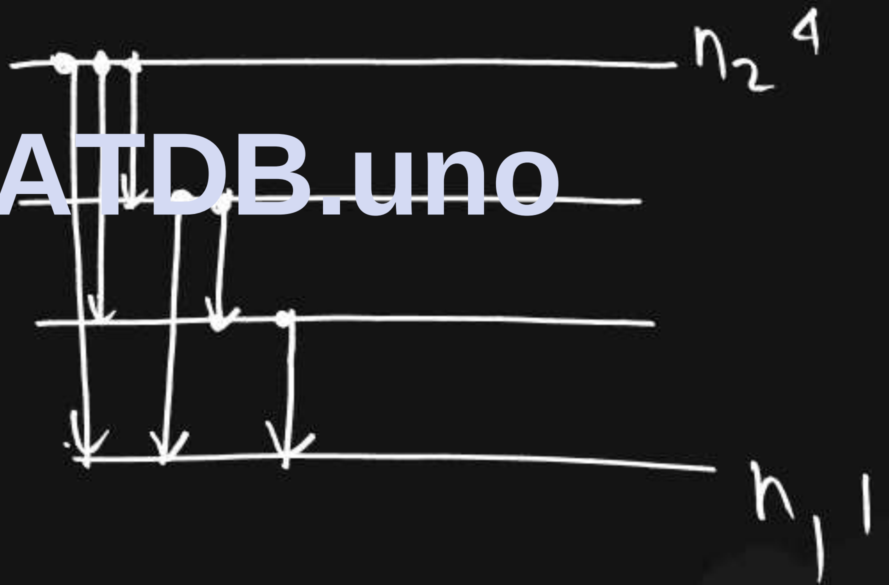
$$\lambda_{max.} = \frac{36}{5R} \qquad\qquad \lambda_{min.} = \frac{4}{R}$$

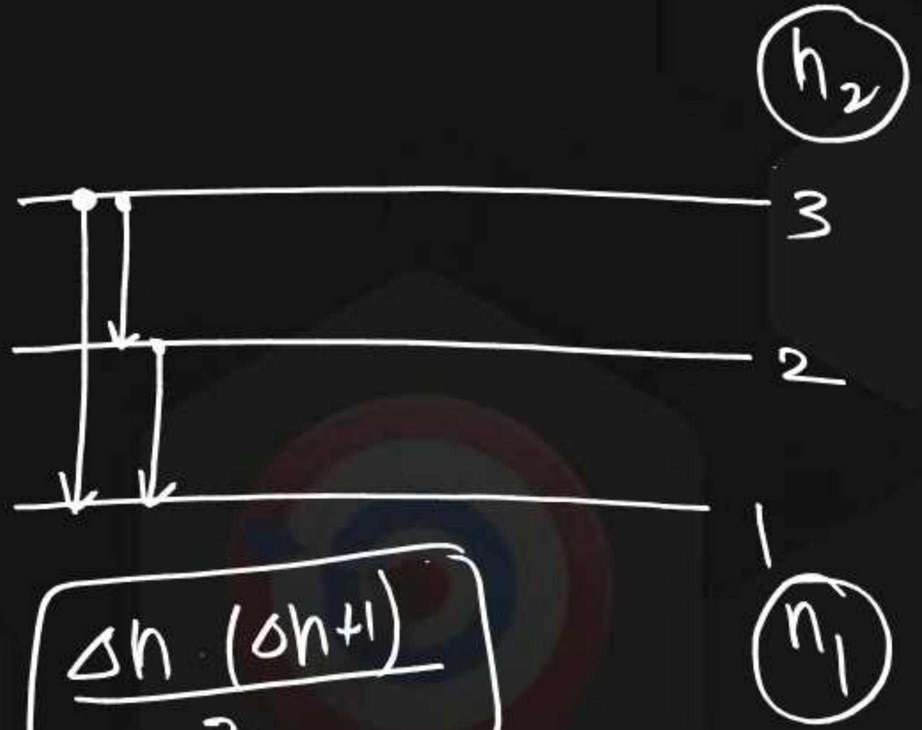
$$\frac{\lambda_{max.}}{\lambda_{min.}} = \frac{\frac{36}{5R}}{\frac{4}{R}}$$

$$= \frac{\overset{9}{\cancel{36}} \times \cancel{R}}{5\cancel{R} \times \cancel{4}}$$

$$= 9 : 5$$

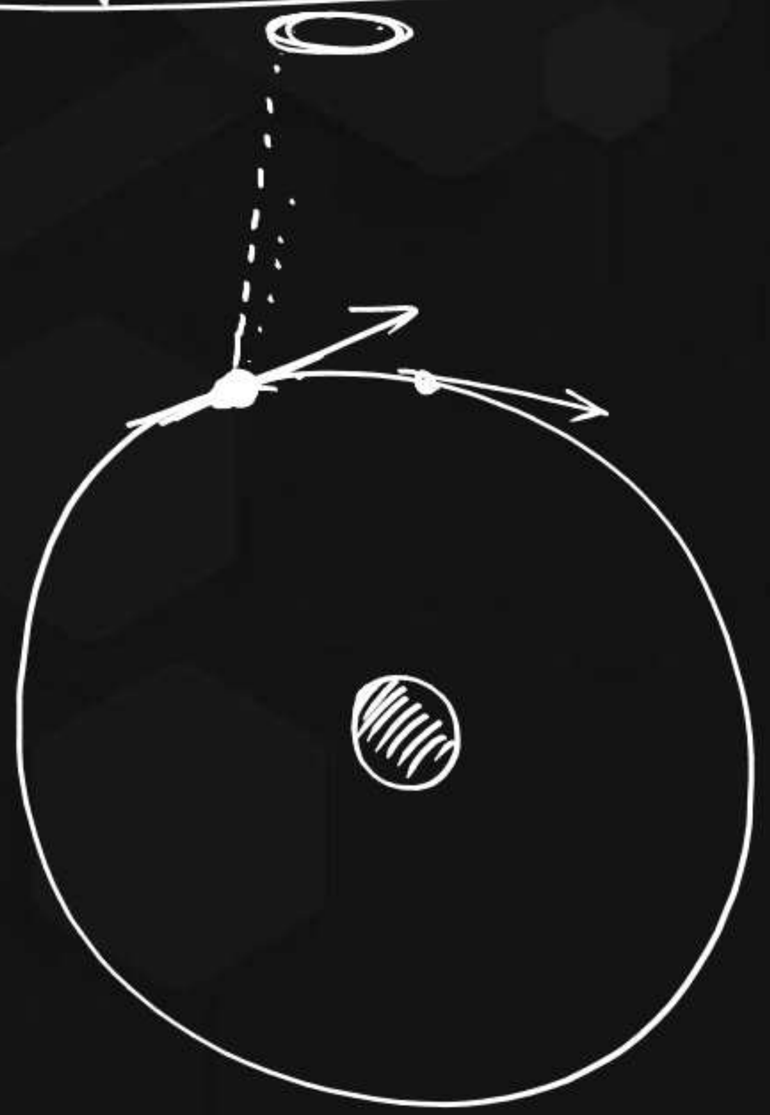
Q.





$$\boxed{\frac{\Delta n\,(\Delta n+1)}{2}}$$

Heisenberg's Uncertainity principle.



Uncertainity in momentum $= \Delta p$

Uncertainity in position $= \Delta x$

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

The product of uncertainity in momentum & uncertainity in position is always greater than or equal to $\frac{h}{4\pi}$

$\Delta p \propto \frac{1}{\Delta x}$

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

#28

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

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

$$\lambda = \frac{\cancel{h} \cdot 2\pi r_n}{n \cancel{h}}$$

$$\boxed{\lambda = \frac{2\pi r_n}{n}}$$

$$\lambda = \frac{2\pi \times r_0 \left(\frac{\cancel{16}^{4}}{1}\right)}{\cancel{4}} = 8\pi r_0$$

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

$$= \frac{1}{2}\left[\frac{1}{4\pi\varepsilon_0}\cdot\frac{Ze^2}{r}\right]$$

$$= \frac{1}{2}\cdot\frac{1}{4\pi\varepsilon_0}\cdot\frac{1\times e^2}{r_0\cdot 4}$$

$$= \frac{1}{32\pi\varepsilon_0}\frac{e^2}{r_0}$$

$$2\times 4\times\pi^2\times 4\times 10$$

$$320\times\pi^2$$

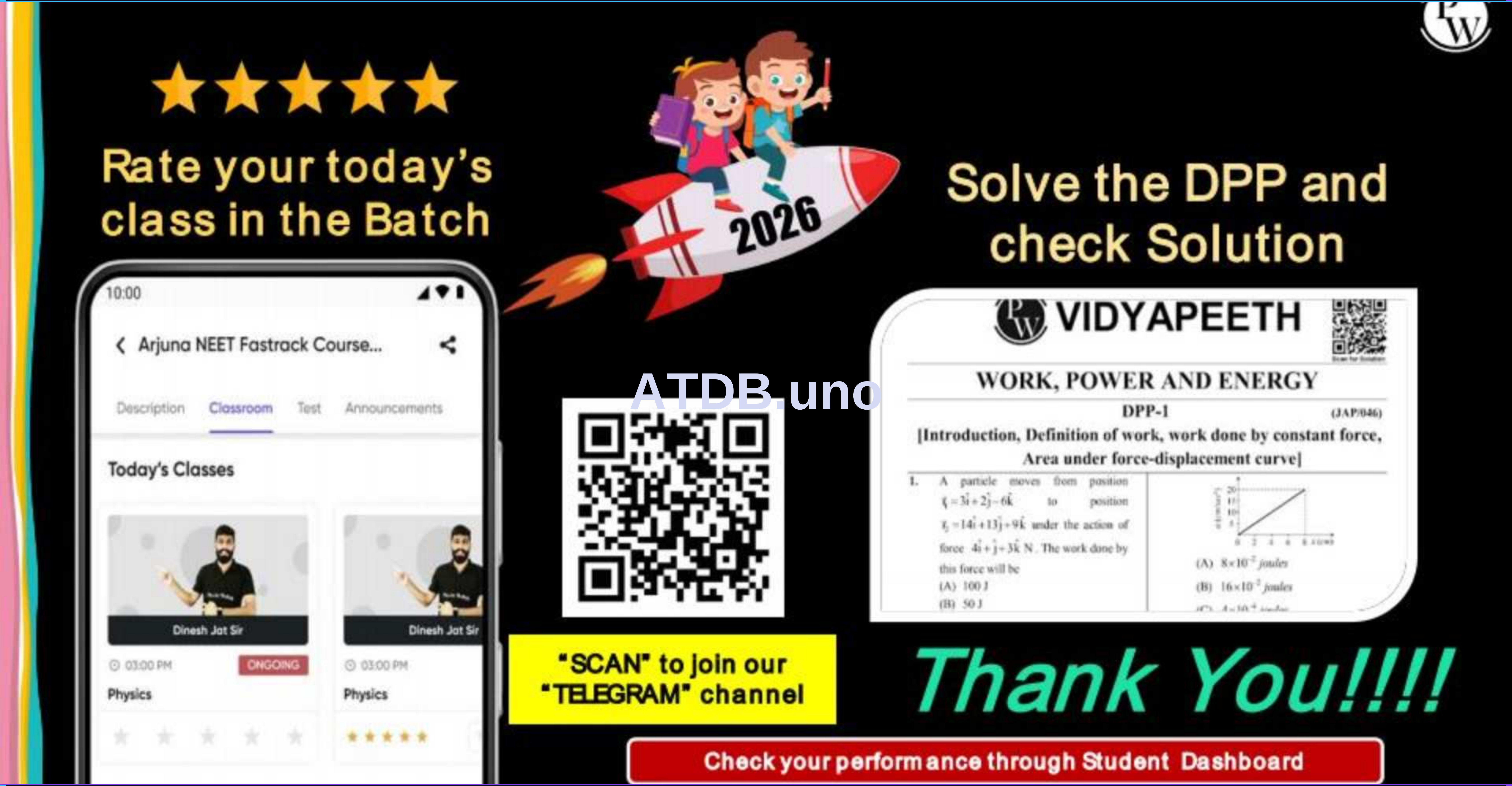
$$mvr = \frac{nh}{2\pi}$$

$$K.E. = \frac{1}{2}m\left(\frac{n^2h^2}{4\pi^2\times m^2\times r^2}\right)$$

$$= \frac{1}{2}\frac{n^2h^2\cdot Z^2}{4\pi^2\times m\times r_0^2\times n^4}$$

$$= \frac{1}{2}\frac{h^2}{4\pi^2\times m\cdot r_0^2\times n^2} = x\frac{h^2}{ma_0^2}$$

$$= \frac{h^2}{\boxed{2\times 4\times\pi^2\times 4}\, ma_0^2}$$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