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Part - I

Atomic Structure

① Velocity

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

$$v \propto \frac{Z}{n}$$

↓

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

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

$$T.P \propto \frac{n^3}{Z^2}$$

↓

Frequency (ν)

$$\nu = \frac{1}{T}$$

$$\nu = \frac{Z^2}{n^3}$$

③ Calculation of Energy :-

$$F = \frac{k q_1 q_2}{r^2} \quad q_1 \cdots q_2$$

$$P.E. = \int \vec{F} \, d\vec{r} \quad \infty \text{ to } r$$

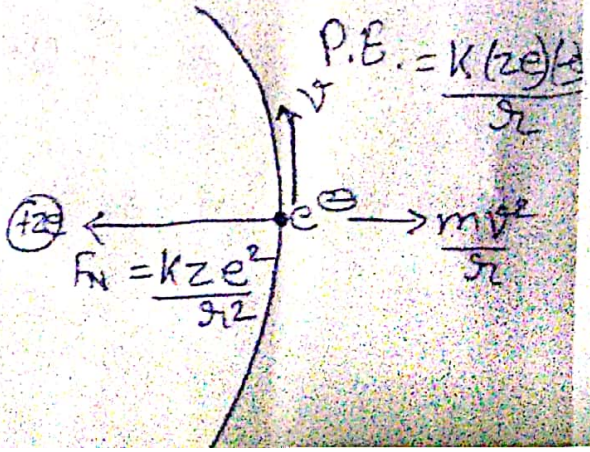
$$P.E. = \frac{k q_1 q_2}{r}$$

$$T.E. = K.E. + P.E.$$

$$= \frac{1}{2} m v^2 - \frac{kze^2}{r}$$

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

$$\boxed{T.E. = -\frac{kze^2}{2r}}$$



$$r = \frac{n^2 h^2}{4\pi^2 m K z e^2}$$

$$\frac{K z e^2}{r^2} = \frac{mv^2}{r}$$

$$\frac{K z e^2}{r} = mv^2$$

$$T.E. = -\frac{K z e^2}{2 \times \frac{n^2 h^2}{4\pi^2 m K z e^2}}$$

$$T.E = \frac{-2\pi^2 m K^2 z^2 e^4}{n^2 h^2}$$

$$\boxed{T.E. = -2.18 \times 10^{-18} \frac{z^2}{n^2} \text{ J/atom}}$$

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

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

$$T.E. = -2.18 \times 10^{-18} \frac{z^2}{n^2} \times \frac{1}{1.6 \times 10^{-19}} \text{ ev/atom}$$

$$\boxed{T.E. = -13.6 \frac{z^2}{n^2} \text{ ev atom}}$$

$$T.E. = -2.18 \times 10^{-18} \frac{z^2}{n^2} \times 6.022 \times 10^{23} \text{ J/mol}$$

$$\boxed{T.E. = -1312 \frac{z^2}{n^2} \text{ KJ/mol}}$$

$$\boxed{T.E. = -312 \frac{z^2}{n^2} \text{ K cal/mol}}$$

$$\boxed{T.E. \propto \frac{z^2}{n^2}}$$

→ -ve sign of T.E. shows attraction force b/w nucleus and electron.

$$K.E. = \frac{K z e^2}{2r} \qquad K.E. \propto \frac{1}{r}$$

$r \uparrow$ K.E. $\downarrow$

$P.E. = -\frac{kze^2}{r}$ $P.E. \propto -\frac{1}{r}$ $r \uparrow$ $P.E \uparrow$

$T.E. = -\frac{kze^2}{2r}$ $T.E. \propto -\frac{1}{r}$ $r \uparrow$ $T.E. \uparrow$

$$\boxed{T.E. = \frac{P.E.}{2} = -K.E.}$$

H-atom

	T.E.	K.E.	P.E.
$n=1$	-13.6 eV	13.6	-2×13.6 eV
$n=2$	-3.4	3.4	-2×3.4
$n=3$	-1.51	1.51	-2×1.51
$n=4$	-0.85	0.85	-2×0.85
$n=5$	-0.54	0.54	-2×0.54
$n=6$	-0.38	0.38	-2×0.38
⋮			
$n=\infty$	0 (max.)	0 (min.)	0 (max.)

$E_2 - E_1 = -3.4 - (-13.6) = 10.2$ eV

$E_3 - E_1 = -1.51 - (-3.4) = 1.89$ eV

$E_4 - E_3 = -0.85 - (-1.51) = -0.85 + 1.51 = 0.66$

$E_5 - E_4 = -0.54 - (-0.85) = 0.54 + 0.85 = 0.31$

$E_6 - E_5 = -0.38 - (-0.54) = -0.38 + 0.54 = 0.16$