# ATOM MOLECULE

(1) $r \propto n^2$

$\frac{r_1}{r_4} = \frac{1^2}{4^2} = \frac{1}{16}$

(2) Data

$\Delta p = \Delta(mvr) = \Delta\left(\frac{nh}{2\pi}\right) = ?$

$3 \Rightarrow 1$

Solution :

$\Delta p = \Delta n \cdot \frac{h}{2\pi}$

$= \frac{(3-1) \times 6.63 \times 10^{-34}}{2 \times 3.14}$

$= 2.111 \times 10^{-34}\ kg\,m^2s^{-1}$

(3) Data

$4 \Rightarrow 3$

$R = 1.097 \times 10^7\ m^{-1}$

Solution

$\frac{1}{\lambda} = R\left(\frac{1}{p^2} - \frac{1}{q^2}\right)$

$\frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{1}{3^2} - \frac{1}{4^2}\right)$

$\lambda = 1.875 \times 10^{-6}\ m$

$\therefore \lambda = 18750\ \text{Å}$

(4) Data

(freq) $f = ?$

$n = 2$

$r_2 = 2.14 \times 10^{-10}\ m$

$v_2 = 1.09 \times 10^6\ m/s$

Solution

$v = r\omega$

$v = r \cdot 2\pi f$

$\frac{R^2}{2\varepsilon_0 mh} = \frac{\left(\frac{e^2}{4\pi\varepsilon_0 n^2}\right)^2}{\frac{n^2 h^2}{4\pi^2}} 2\pi f$

$\therefore f = \frac{me^4}{4\varepsilon_0^2 n^3 h^3}$

$f = \frac{v}{r \cdot 2\pi}$

$= \frac{1.09 \times 10^6}{2.14 \times 10^{-10} \times 2\pi}$

$= 8.11 \times 10^{14}\ Hz$

(5) Data

$R = ?$

$n = 2$

$E_2 = -3.4\ eV$

Solution

$\frac{Rch}{n^2} = E$

$$R = \frac{En^2}{ch}$$

$$= \frac{3.4 \times 1.6 \times 10^{-19} \times 4}{3 \times 10^8 \times 6.63 \times 10^{-34}}$$

$$= 1.095 \times 10^7 \, m^{-1}$$

(6) Data

$\infty \Rightarrow 3 \quad \lambda_p = ?$

$3\infty \Rightarrow 2 \quad \lambda_B = 6563 \text{ Å}$

Solution:

$$\frac{1}{\lambda} = R\left(\frac{1}{p^2} - \frac{1}{q^2}\right)$$

$$\frac{\lambda_B}{\lambda_p} = \frac{\left(\frac{1}{3^2} - \frac{1}{\infty^2}\right)}{\left(\frac{1}{2^2} - \frac{1}{\infty^2}\right)}$$

$$\frac{6563}{\lambda_p} = \frac{1/9}{\left(\frac{1}{4} - \frac{1}{9}\right)}$$

$$\lambda_p = 8204 \text{ Å}$$

(7)

Longest $4 \Rightarrow 3$

Shortest $\infty \Rightarrow 3$

$$\frac{1}{\lambda} = R\left(\frac{1}{p^2} - \frac{1}{q^2}\right)$$

$$\frac{1}{\lambda_S} = R\left(\frac{1}{3^2} - \frac{1}{\infty^2}\right)$$

$$\frac{1}{\lambda_L} = R\left(\frac{1}{3^2} - \frac{1}{4^2}\right)$$

$$\frac{\lambda_L}{\lambda_S} = \left(\frac{1}{3^2}\right) \Big/ \left(\frac{1}{3^2} - \frac{1}{4^2}\right)$$

$$= \frac{1}{9} \Big/ \left(\frac{1}{9} - \frac{1}{16}\right)$$

$$= \frac{1}{9} \Big/ \frac{7}{9 \times 16} = \frac{1}{9} \times \frac{9 \times 16}{7}$$

$$\lambda_L : \lambda_S = 16 : 7$$

(8) Data:

$\lambda_e = \lambda_{photon}$

$E_e > E_p$

Solution:

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

$$m^2 = \frac{m_0^2}{\frac{(c^2 - v^2)}{c^2}}$$

$$m^2c^2 - m^2v^2 = m_0^2c^2$$

$$m^2c^4 - m^2v^2c^2 = m_0^2c^4$$

$$(mc^2)^2 = (m_0c^2)^2 + p^2c^2$$

$$[\because p^2 = (mv)^2]$$

$\therefore E_e^2 = (m_0c^2)^2 + E_p^2$

$\therefore E_e > E_p$

NOTE:

$$E_p = \frac{hc}{\lambda} = pc$$

(9) $1 \Rightarrow 3$

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

$$\{(-1.51) - (-13.6)\} \times 1.6 \times 10^{-19} = \frac{hc}{\lambda}$$

$$\therefore \lambda = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{1.6 \times 10^{-19} \times 12.1}$$

$\lambda = 1.027 \times 10^{-7}$ m

$\lambda = 1027$ Å

$$\nu = \frac{c}{\lambda} = \frac{3 \times 10^8}{1.027 \times 10^{-7}}$$

$= 2.921 \times 10^{15}$ Hz

(10) $n = 2$

$r_2 = n^2 r_1 = 2^2 \times 0.54$

$= 2.16$ Å

$= 2.16 \times 10^{-10}$ m

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

$\therefore v = \frac{nh}{2\pi mr}$

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

$= \frac{2\pi r \times (2\pi mvr)}{nh}$

$= \frac{4\pi^2 \times mr^2}{nh}$

$= \frac{4\pi^2 \times 9.8 \times 10^{-31} \times (2.16 \times 10^{-10})^2}{2 \times 6.63 \times 10^{-34}}$

$= 1.25 \times 10^{-15}$

$1.25 \times 10^{-15} \equiv 1$ rev.

$10^{-8} = ?$

$\frac{10^{-8}}{1.25 \times 10^{-15}}$

$= 8 \times 10^{6}$ rev.

(11) $p = \frac{h}{\lambda} = \frac{6.63 \times 10^{-34}}{0.5 \times 10^{-10}}$

$p = 1.326 \times 10^{-23}$ kg m/s

(12) Data

$V = 50V$

$m_p = 1.673 \times 10^{-27}$ kg

$\lambda = ?$

Solution

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

$= \frac{6.63 \times 10^{-34}}{\sqrt{2 \times 1.673 \times 10^{-27} \times 1.6 \times 10^{-19} \times 50}}$

$= 4.052 \times 10^{-12}$ m

$= 0.04052$ Å

(13) $p = p_1 + p_2$

$M(0) = m_1 v_1 + m_2 v_2$

$0 = m_1 v_1 + m_2 v_2$

$m_1 v_1 = -m_2 v_2$

$p_1 = -p_2$ direction

$\frac{h}{\lambda_1} = \frac{h}{\lambda_2}$

$\therefore \frac{\lambda_1}{\lambda_2} = 1 : 1$