

JEE-2012

(Q) A diatomic molecule is made of two masses m_1 and m_2 which are separated by a distance r . If we calculate its rotational energy by applying Bohr's rule of angular momentum quantization, its energy will be given by (n is integer)

(a)
$$\frac{(m_1+m_2)^2 n^2 h^2}{2m_1^2 m_2^2 r^2}$$

(b)
$$\frac{n^2 h^2}{2(m_1+m_2) r^2}$$

(c)
$$\frac{2n^2 h^2}{(m_1+m_2) r^2}$$

(d)
$$\frac{(m_1+m_2) n^2 h^2}{2m_1 m_2 r^2}$$

Solⁿ :-
$$E = \frac{1}{2} I \omega^2$$

$$I = M.O.I$$

$$\omega = \frac{L}{I}$$

$$I = \frac{1}{2} [m_1 r_1^2 + m_2 r_2^2]$$

$L = \text{angular momentum}$

$$E = \frac{1}{2} [m_1 r_1^2 + m_2 r_2^2] \omega^2 \quad \text{--- (1)}$$

$$E = \frac{1}{2} [m_1 r_1^2 + m_2 r_2^2] \frac{L^2}{I^2}$$

$$L = \frac{n h}{2\pi}$$

$$E = \frac{1}{2} (m_1 r_1^2 + m_2 r_2^2) \times \frac{L^2}{(m_1 r_1^2 + m_2 r_2^2)^2}$$

$$E = \frac{n^2 h^2}{8\pi^2 [m_1 r_1^2 + m_2 r_2^2]}$$

(option D)