The key feature of Bohr's theory of spectrum of hydrogen atom is the quantization of angular momentum when an electron is revolving around a proton. We will extend this to a general rotational motion to find quantized rotational energy of a diatomic molecule assuming it to be rigid. The rule to be applied is Bohr's quantization condition. **(IIT JEE, 2010)**

4. A diatomic molecule has moment of inertia I. By Bohr's quantization condition, its rotational energy in the nth level ($n = 0$ is not allowed) is

a. $\frac{1}{n^2}\left(\frac{h^2}{8\pi^2 I}\right)$ **b.** $\frac{1}{n}\left(\frac{h^2}{8\pi^2 I}\right)$

c. $n\left(\frac{h^2}{8\pi^2 I}\right)$ **d.** $n^2\left(\frac{h^2}{8\pi^2 I}\right)$

5. It is found that the excitation frequency from ground to the first excited state of rotation for the CO molecule is close to $4/\pi \times 10^{11}$ Hz. Then the moment of inertia of CO molecule about its center of mass is close to (Take $h = 2\pi \times 10^{-34}$ J s)

a. 2.76×10^{-46} kg m^2 **b.** 1.87×10^{-46} kg m^2

c. 4.67×10^{-47} kg m^2 **d.** 1.17×10^{-47} kg m^2

6. In a CO molecule, the distance between C (mass = 12 a.m.u) and O (mass = 16 a.m.u.), where 1 a.m.u $5/3 \times 10^{-27}$ kg, is close to

a. 2.4×10^{-10} m **b.** 1.9×10^{-10} m

c. 1.3×10^{-10} m **d.** 4.4×10^{-11} m

4. d. $L = \frac{nh}{2\pi}$

$$\text{K.E.} = \frac{L^2}{2I} = \left(\frac{nh}{2\pi}\right)^2 \frac{1}{2I}$$

5. a. $hv = KE_{n=2} - kE_{n=1}$

$I = 1.87 \times 10^{-46}$ kg m^2

6. c. $r_1 = \frac{m_2 d}{m_1 + m_2}$ and $r_2 = \frac{m_1 d}{m_1 + m_2}$

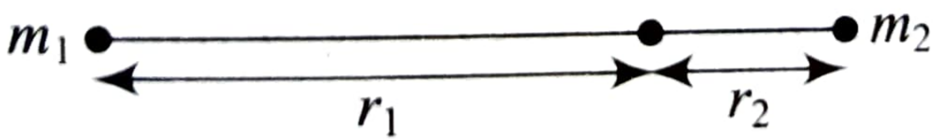

Fig. S4.22

$$I = m_1 r_1^2 + m_2 r_2^2$$

$\therefore \quad d = 1.3 \times 10^{-10}$ m