Bohr's Model: Matter Waves

1. Will a hydrogen atom expand or contract as it moves from ground state to an excited state? Expand

2. Is energy emitted or absorbed when the following electronic transitions occur in hydrogen?

   a) From n = 4 to n = 3 emitted

   b) From an orbit with radius 2.12 Å to one with 8.45 Å absorbed

   c) An electron is added to H^+ ion and ends up in n = 4 shell absorbed

3. What is the wavelength of hydrogen if the emission is from n = 6 to n = 3? Calculate the energy of this transition.

   This is the infrared region. In this case m = 3 and n = 6

   $\frac{1}{\lambda} = R_\infty\left(\frac{1}{m^2} - \frac{1}{n^2}\right) = 1.097 \times 10^{-2}\ nm^{-1} \times \left(\frac{1}{3^2} - \frac{1}{6^2}\right) = 0.0009142$

   $\frac{1}{0.0009142} = \mathbf{1094\ nm}$

   $\boldsymbol{E = \frac{hc}{\lambda} = \frac{(6.626\times10^{-34}\ J\cdot s)\times(2.998\times10^{8}\ m/s)}{1.094\times10^{-6}\ m} = 1.986 \times 10^{-25}\ J}$

4. Calculate the wavelength, in nm, when m = 2 and n = 6. What is the energy, in kj/mol, of this radiation?

$$\frac{1}{\lambda} = R_\infty\left(\frac{1}{m^2} - \frac{1}{n^2}\right) = 1.097 \times 10^{-2}\ nm^{-1} \times \left(\frac{1}{2^2} - \frac{1}{6^2}\right) = 0.002438\ nm^{-1}$$

$$\lambda = \frac{1}{0.002438\ nm^{-1}} = 410\ nm$$

$$E = \frac{hc}{\lambda} = \frac{(6.626\times10^{-34}\ J\cdot s)\times(2.998\times10^{8}\ m/s)}{4.10\times10^{-7}\ m} = \mathbf{4.85 \times 10^{-19} J}$$

$$\frac{4.85 \times 10^{-19} J}{photon} \times \frac{6.02 \times 10^{23}\ photons}{mol} \times \frac{1\ kJ}{1000\ J} = \mathbf{292\ kJ/mol}$$

5. What is the de Broglie wavelength, in m, of a fly with a mass of 1.85 mg flying at 1.58 m/s. Explain why we do not observe this wavelength.

$$\lambda = \frac{h}{m\mu} = \frac{6.626 \times 10^{-34}\ J \cdot s}{(1.85 \times 10^{-6} kg) \times 1.58\ m/s} = \mathbf{2.27 \times 10^{-28}\ m}$$

The wavelength is much smaller than the fly and cannot be observed.