PSEUDO-HYDROGEN ATOM / ONE-ELECTRON SYSTEM CATION (HYDROGEN-LIKE ATOM)

ONE ELECTRON SYSTEM
(For any cation which has single electron)

(ie. He^{+}, Li^{2+}, Be^{3+}, B^{4+} and C^{5+} ions)

$$E_n = -\frac{e^4 m Z^2}{8\epsilon_0^2 h^2 n^2}$$

$$\therefore \quad \Delta E = \frac{e^4 m Z^2}{8\epsilon_0^2 h^2}\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right]$$

or

$$\Delta E = (2.18 \times 10^{-18}\,J)\, Z^2 \left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right]$$

Remember! unit: $J\,photon^{-1}$

Problem-solving Example 18

How much energy does a B^{4+} ion lose when its electron move from n = 4 to n = 2. What is the wave number of the photon emitted.

Solution

Solution

$n_x = 2$; $n_y = 4$ (Remember! $n_x < n_y$)

$Z = 5$ for Boron, B atom (5 proton in the nucleus)

$$\therefore \Delta E = (2.18 \times 10^{-18} J)(5^2)\left[\frac{1}{2^2} - \frac{1}{4^2}\right]$$

$$= 1.02 \times 10^{-17} \text{ J photon}^{-1} \text{ (Ans)}$$

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

$$\therefore \bar{\nu} = \frac{\Delta E}{hc} = \left[\frac{1.02 \times 10^{-17}}{(6.626 \times 10^{-34} Js)(2.998 \times 10^{8} ms^{-1})}\right] m^{-1}$$

$$= 5.135 \times 10^{7} m^{-1} \text{ (Ans)}$$

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