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

Problem-solving Example 18

How much energy do a mole of B^{4+} ions lose when its electrons move from the third excited state to the second energy state? What is the wavelength of the photon emitted in nm?

Solution

Solution :

- B^{4+} ion ($Z = 5$)
- Electron moves from $n = 4$ (third excited state) to $n = 2$

$$\Delta E = (2.179 \times 10^{-18} J) Z^2 \left(\frac{1}{2^2} - \frac{1}{4^2}\right)$$

$$= (2.179 \times 10^{-18} J)(5^2)(0.1875)$$

$$\Delta E = 1.02 \times 10^{-17} J\,ion^{-1}$$

$$= (1.02 \times 10^{-17})(6.022 \times 10^{23}) J\,mole^{-1}$$

$$= 6.15 \times 10^{+6} J\,mol^{-1}$$

$$= 6.15 \times 10^{3} kJ\,mol^{-1} \text{ (Ans)}$$

* You cannot use this value to calculate the λ or ν.

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

remember the unit must be $J\,atom^{-1}$ @ $J\,photon^{-1}$

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

$$= \frac{(6.626 \times 10^{-34} Js)(2.998 \times 10^{8} ms^{-1})}{(1.02 \times 10^{-17} J\,ion^{-1})}$$

$$= 1.948 \times 10^{-8} m$$

$$= 1.948 \times 10^{-8} \times 10^{9} nm$$

$$= 19.48 nm \text{ (Ans)}$$

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