Problem-solving Examples – First Bohr Radius, a_o

Problem-solving Example 14

Calculate the ionization energy, ΔE_{IE} @ IE for hydrogen atom from the given data in $kJmol^{-1}$.

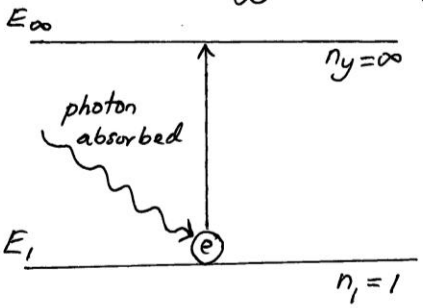
electron charge = $1.60217 \times 10^{-19} C$

first Bohr radius, $a_0 = 0.529 \text{ Å}$

$\epsilon_0 = 8.84 \times 10^{-12} N^{-1} m^{-2} C^2$

Solution :

Ionization energy, IE for hydrogen atom is the energy required to remove electron from the ground state, $n_x = 1$ to energy level, $n_y = \infty$



$$\Delta E_{IE} = \frac{e^2}{8\pi\epsilon_0 a_0}\left[\frac{1}{n_x^2} - \frac{1}{n_y^2}\right]$$

$$= \frac{(1.60217 \times 10^{-19})^2}{8\pi(8.84 \times 10^{-12})(0.529 \times 10^{-10} m)}\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right]$$

$$\Delta E_{IE} = 2.178 \times 10^{-18} J$$

$$= (2.178 \times 10^{-18})(6.022 \times 10^{23} mol^{-1})$$

$$= 1.312 \times 10^6 Jmol^{-1}$$

$$\Delta E_{IE} = 1312 \, kJmol^{-1} \text{ (Ans)}$$

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