

Answer on Question #80387, Chemistry/ Inorganic Chemistry

CALCULATE THE IONIZATION ENERGY OF HYDROGEN ATOM USING BOHR'S THEORY

Solution

According to Planck's equation

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

According to Rydberg equation:

$$\frac{1}{\lambda} = R_{\infty} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$$

Where $R_{\infty} = 1.09737316 \times 10^7 \text{ m}^{-1}$, Rydberg constant

λ is the wavelength of the photon

n_1 is the principal quantum number of the lower energy level

n_2 is the principal quantum number of the higher energy level

We are calculating ionisation energy so the electron goes to infinity with respect to the atom, i.e. it leaves the atom. Hence we set $n_2 = \infty$ and $n_1 = 1$ (for ground state)

Then

$$\frac{1}{\lambda} = R_{\infty} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) = R_{\infty} \left(\frac{1}{1^2} - \frac{1}{\infty^2} \right) = R_{\infty}$$

$$\frac{1}{\lambda} = R_{\infty}$$

Then

$$E = h\nu = \frac{hc}{\lambda} = hcR_{\infty}$$

$$E_i = 6.626 \times 10^{-34} \times 2.997 \times 10^8 \times 1.09737316 \times 10^7 = 2.179 \times 10^{-18} \text{ (J) or}$$

$$E_i = \frac{2.179 \times 10^{-18}}{1.6 \times 10^{-19}} = 13.6 \text{ eV}$$

Answer: $2.179 \times 10^{-18} \text{ J}$ or 13.6 eV