Optics

Atomic Transitions

Problem 1.- In the hydrogen spectrum, the ratio of the longest wavelengths for Paschen radiation to Balmer radiation is

Solution: The longest wavelength for Paschen radiation is a transition from n = 4 to n = 3 and for Balmer radiation it is n = 3 to n = 2, so

$$\frac{1}{\lambda_{Paschen}} = R\left(\frac{1}{3^2} - \frac{1}{4^2}\right) = R\left(\frac{1}{9} - \frac{1}{16}\right) = R\left(\frac{7}{144}\right) \rightarrow \lambda_{Paschen} = \frac{144}{7}R^{-1}$$

$$\frac{1}{\lambda_{Balmer}} = R\left(\frac{1}{2^2} - \frac{1}{3^2}\right) = R\left(\frac{1}{4} - \frac{1}{9}\right) = R\left(\frac{5}{36}\right) \rightarrow \lambda_{Balmer} = \frac{36}{5}R^{-1}$$

$$\frac{\lambda_{Paschen}}{\lambda_{Balmer}} = \frac{\frac{144}{7}R^{-1}}{\frac{36}{5}R^{-1}} = \frac{20}{7}$$

Problem 2.- Calculate the two longest wavelengths that correspond to a Pfund transition in hydrogen (n-final=5).

Solution: The longest wavelengths correspond to transitions from n = 6 to 5 and from n = 7 to 5

$$\frac{1}{\lambda} = 1.0973\times10^7\left(\frac{1}{6^2} - \frac{1}{5^2}\right) \rightarrow \lambda = \mathbf{7.46\ \mu m}$$

$$\frac{1}{\lambda} = 1.0973\times10^7\left(\frac{1}{7^2} - \frac{1}{5^2}\right) \rightarrow \lambda = \mathbf{4.65\ \mu m}$$