Related Problems

Question 1 :

The longest wavelength doublet absorption transition is observed at 589 nm and 589.6 nm. Calculate the frequency of each transition and energy difference between two excited states.

Answer:

$$\lambda_1 = 589\ \text{nm} = 589 \times 10^{-9}\ \text{m}$$

$$\nu_1 = \frac{c}{\lambda_1} = \frac{3\times10^{8}\,\text{m s}^{-1}}{589\times10^{-9}\,\text{m}} = \frac{3000}{589}\times10^{14}\,\text{s}^{-1} = \mathbf{5{\cdot}0934 \times 10^{14}\ s^{-1}}$$

$$\lambda_2 = 589{\cdot}6\ \text{nm} = 589{\cdot}6 \times 10^{-9}\ \text{m}$$

$$\nu_2 = \frac{c}{\lambda_2} = \frac{3\times10^{8}\,\text{m s}^{-1}}{589{\cdot}6\times10^{-9}\,\text{m}} = \frac{3000}{589{\cdot}6}\times10^{14}\,\text{s}^{-1} = \mathbf{5{\cdot}0882 \times 10^{14}\ s^{-1}}$$

$$\Delta E = E_1 - E_2 = \frac{hc}{\lambda_1} - \frac{hc}{\lambda_2} = hc\left[\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right]$$

$$= (6{\cdot}626 \times 10^{-34}\ \text{Js} \times 3 \times 10^{8}\ \text{m s}^{-1})\left[\frac{1}{589 \times 10^{-9}\,\text{m}} - \frac{1}{589{\cdot}6 \times 10^{-9}\,\text{m}}\right]$$

$$= \frac{19{\cdot}878 \times 10^{-34} \times 10^{8}}{10^{-9}}\left[\frac{589{\cdot}6 - 589}{589{\cdot}6 \times 589}\right]\text{J}$$

$$= \frac{19{\cdot}878 \times 10^{-17} \times 0{\cdot}6}{589{\cdot}6 \times 589}\,\text{J} = \mathbf{3{\cdot}43 \times 10^{-22}\ J}$$