Atomic Spectroscopy

Planck's constant: $h := 6.62608 \cdot 10^{-34} \cdot joule \cdot sec$ Speed of light: $c := 2.9979 \cdot 10^{8} \cdot \frac{m}{sec}$

Conversion factors: $nm := 10^{-9} \cdot m$ $pm := 10^{-12} \cdot m$ $aJ := 10^{-18} \cdot joule$

Energy of a photon: $E_{photon} = h\nu = \frac{hc}{\lambda}$

Energy of the hydrogen atom: where n is a quantum number and can have integer values. $E_{atom} = \frac{-2.178 \cdot aJ}{n^2}$

Emission Spectroscopy

In emission spectroscopy a photon is created as the electron undergoes a transition from a higher to a lower energy state. Energy conservation requires

$$E_{atom}^{initial} = E_{atom}^{final} + E_{photon}$$

Example: Calculate the frequency, wavelength, and energy of the photon emitted when an electron undergoes a transition from the n=2 to the n=1 state.

$n_i := 2$ $n_f := 1$ $\nu := \frac{-2.178 \cdot aJ}{n_i^2} = \frac{-2.178 \cdot aJ}{n_f^2} + h \cdot \nu \;\Big|\; \begin{matrix} \text{solve}, \nu \\ \text{float}, 4 \end{matrix} \rightarrow \frac{.2465e16}{sec}$

Calculate the wavelength of the photon: $\lambda := \frac{c}{\nu}$ $\lambda = 121.619\,nm$

Calculate the energy of the photon: $h \cdot \nu = 1.633\,aJ$

Absorption Spectroscopy

In absorption spectroscopy a photon is absorbed and an electron is promoted to a higher energy level. Energy conservation rpquires

$$E_{atom}^{initial} + E_{photon} = E_{atom}^{final}$$

Example: Calculate the frequency, wavelength, and energy of the photon required to promote the electron from the n=1 to the n=3 level.

$\nu := \nu$ $n_i := 1$ $n_f := 3$ $\nu := \frac{-2.178 \cdot aJ}{n_i^2} + h \cdot \nu = \frac{-2.178 \cdot aJ}{n_f^2} \;\Big|\; \begin{matrix} \text{solve}, \nu \\ \text{float}, 4 \end{matrix} \rightarrow \frac{.2922e16}{sec}$

Calculate the wavelength of the photon: $\lambda := \frac{c}{\nu}$ $\lambda = 102.598\,nm$

Calculate the energy of the photon: $h \cdot \nu = 1.936\,aJ$