

Atoms Formulas

Rydberg for 1-electron atoms: $\frac{1}{\lambda} = RZ^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$ with $n_2 > n_1$

$$R = 1.097 \times 10^7 \text{ m}^{-1} = \frac{1}{91.13 \text{ nm}} \quad Z = \text{atomic number}$$

Photon energy: $E = E_{\text{Bohr}} Z^2 \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right)$ with $E_{\text{Bohr}} = 13.6 \text{ eV}$

$$\text{Electron orbit in Coulomb field: } E = -\frac{1}{2} \frac{q^2 Z}{4\pi\epsilon_0 r} = -Z \cdot \frac{0.7202 \text{ eV} \cdot \text{nm}}{r} = -\frac{m_e}{2} \left(\frac{q^2 Z}{4\pi\epsilon_0} \right)^2 \frac{1}{L^2}$$

Bohr Model, $L = \hbar$, $Z = 1$:

$$E_{\text{Bohr}} = -\frac{m_e}{2} \cdot \left(\frac{q^2}{4\pi\epsilon_0 \hbar} \right)^2 = -13.6 \text{ eV} \quad a_0 = \frac{4\pi\epsilon_0 \hbar^2}{m_e q^2} = 52.97 \text{ pm} \quad \beta_{\text{Bohr}} = \frac{q^2}{4\pi\epsilon_0 \hbar c} = 7.293 \times 10^{-3}$$

$$\text{Bohr with general } Z \text{ and } n: \quad E_n = -\frac{Z^2}{n^2} \cdot E_{\text{Bohr}} \quad r_n = \frac{n^2}{Z} \cdot a_0 \quad \beta = \frac{Z}{n} \cdot \beta_{\text{Bohr}}$$

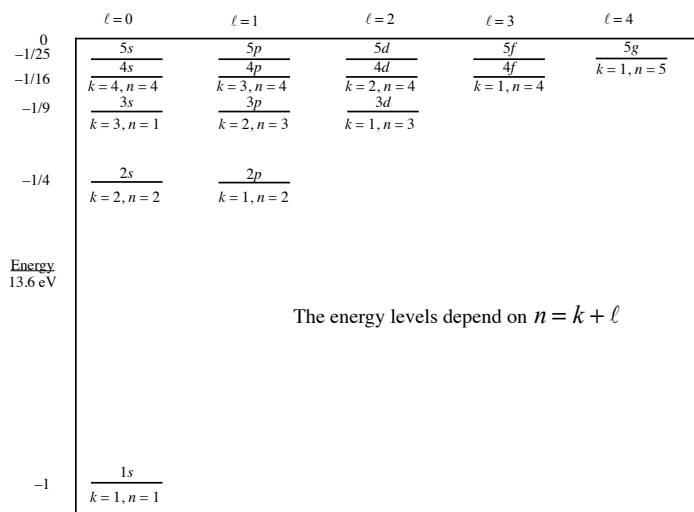
$$\text{Moseley's Law for X-Rays: } E = 13.6 \text{ eV} \cdot \left(\frac{1}{n_{\text{final}}^2} - \frac{1}{n_{\text{initial}}^2} \right) \cdot (Z - b)^2$$

$$\text{with } b = 1 \text{ for } n_{\text{final}} = 1 \text{ and } b = 7.4 \text{ for } n_{\text{final}} = 2 \quad E_{K\alpha} = 10.2 \text{ eV} \cdot (Z - 1)^2$$

de Broglie Relation: $\lambda = \frac{h}{p}$ for any particle as well as for photons

$$\text{for non-relativistic particles: } \lambda = \frac{h}{\sqrt{2mE_{\text{kinetic}}}} = \frac{hc}{\sqrt{2mc^2 E_{\text{eV}}}} = \frac{1.227 \sqrt{\text{eV}} \cdot \text{nm}}{\sqrt{E_{\text{eV}}}} \text{ for electrons}$$

Hydrogen energy levels



Atomic energy levels

