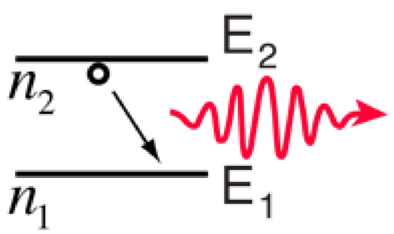
Electron Transitions

The Bohr model for an electron transition in hydrogen between quantized energy levels with different quantum numbers n yields a photon by emission with quantum energy:



A downward transition involves emission of a photon of energy:

$$E_{photon} = h\upsilon = E_2 - E_1$$

Given the expression for the energies of the hydrogenic electron states for atoms of atomic number Z:

$$h\upsilon = \frac{Z^2 m e^4}{8h^2\varepsilon_0^2}\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right] = -13.6Z^2\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]eV$$

This is often expressed in terms of the inverse wavelength or "wave number" as follows:

$$\frac{1}{\lambda} = R_H Z^2\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right] \quad \text{where} \quad R_H = \frac{me^4}{8h^3 c\varepsilon_0^2} \quad \text{is called the Rydberg constant.}$$

$$R_H = 1.09677576x10^7\,m^{-1} \quad \text{for hydrogen.}$$

$$R_\infty = 1.0973731x10^7\,m^{-1} \quad \text{in the limiting case for heavy elements}$$

The reason for the variation of R is that for hydrogen the mass of the orbiting electron is not negligible compared to the proton at the high accuracy at which spectral measurement is done. So the reduced mass of the electron is needed. But for heavier elements the movement of the nucleus can be neglected.

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Hydrogen Energy Levels

The basic hydrogen energy level structure is in agreement with the Bohr model. Common pictures are those of a shell structure with each main shell associated with a value of the principal quantum number n.

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