

Transitions in the Hydrogen Atom

Consider the three lowest energy levels of the hydrogen atom. What wavelengths of light will be emitted when the electron jumps from one state to another?

Solution:

$$\Delta E_{21} = 10.2 \text{ eV}$$

$$\Delta E_{31} = 12.1 \text{ eV}$$

$$\Delta E_{32} = 1.9 \text{ eV}$$

$E = -13.6 \text{ eV}/n^2$, so $E_1 = -13.6 \text{ eV}$, $E_2 = -3.4 \text{ eV}$, and $E_3 = -1.5 \text{ eV}$. There are three jumps to consider, 2-to-1, 3-to-1, and 3-to-2. The photon carries away the energy that the electron loses.

$$\lambda = h/p = hc/E$$

$$\lambda_{21} = 122 \text{ nm}$$

$$\lambda_{31} = 102 \text{ nm}$$

$$\lambda_{32} = 653 \text{ nm}$$

$$hc = 1240 \text{ eV}\cdot\text{nm}$$

Two wavelengths are in the ultraviolet.

The 3-to-2 transition gives a visible (red) photon.