

A group of hydrogen atoms are prepared in $n = 4$ states. List the wavelengths that are emitted as the atoms make transitions and return to $n = 2$ states.

$$n_1 = 4 \rightarrow n_2 = 2$$

$$n_1 = 4 \rightarrow 3 \rightarrow 2$$

$$\frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{1}{16} - \frac{1}{4} \right)$$

$$\Rightarrow \frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{1-4}{16} \right) \Rightarrow \frac{1.097 \times 10^7 \times 3}{16}$$

$$\Rightarrow \lambda = \frac{16 \times 10^{-7}}{3 \times 1.097} = 4.8617 \times 10^{-7}$$

$$= 1.861 \times 10^{-9} = 487 \text{ nm}$$

$$n_1 = 4 \text{ and } n_2 = 3$$

$$\frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{1}{16} - \frac{1}{9} \right)$$

$$\Rightarrow \frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{9-16}{144} \right) \Rightarrow \frac{1.097 \times 10^7 \times 7}{144}$$

$$\Rightarrow \lambda = \frac{144}{7 \times 1.097 \times 10^7} = 1875 \text{ nm}$$

$$n_1 = 3 \rightarrow n_2 = 2$$

$$\frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{1}{9} - \frac{1}{4} \right)$$

$$\Rightarrow \frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{4-9}{36} \right) \Rightarrow \frac{1.097 \times 10^7 \times 5}{66}$$

$$\Rightarrow \lambda = \frac{36 \times 10^{-7}}{5 \times 1.097} = 656 \text{ nm}$$