Answer on Question #77662, Chemistry / General Chemistry

calculate the energy difference between the second line of Lyman series and second line of Delmer series

Solution

In physics and chemistry, the Lyman series is a hydrogen spectral series of transitions and resulting ultraviolet emission lines of the hydrogen atom as an electron goes from $n \geq 2$ to $n = 1$ (where n is the principal quantum number), the lowest energy level of the electron. The transitions are named sequentially by Greek letters: from $n = 2$ to $n = 1$ is called Lyman-alpha, 3 to 1 is Lyman-beta, 4 to 1 is Lyman-gamma, and so on.

The second line in Lyman series is transition of an electron from n=3 to n=1.

To find energy of this transition we should use a) the Plank equation:

$$E = hv = \frac{hc}{\lambda}$$

where h- Plank constant, $h=6.626\cdot10^{-34}$ J·s

c-speed of light, $c= 2.998\cdot10^{8}$ m/s

λ- wavelength of a photon

and b) Rydberg equation:

$$\frac{1}{\lambda} = R_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

where λ- wavelength of a photon

R_H- Rydberg constant, $R=1.09737316\cdot10^{7}$ m^{-1}

n_1, n_2 –integers greater or equal to 1 such that $n_1<n_2$, corresponding to the principal quantum numbers.

Combining two equation we'll get:

$$E = hv = \frac{hc}{\lambda} = R_H\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \times hc$$

Find the energy of electron transition from n=3 to n=1 (second line in Lyman series):

$$E = 1.09737316 \times 10^{7} m^{-1}\left(\frac{1}{1^2} - \frac{1}{3^2}\right) \times 6.626 \times 10^{-34} \times 2.998 \times 10^{8} = 1.938 \times 10^{-18} J$$

NOTE: obviously there is a mistake in the name of series: NOT Delmer but Balmer series, as there are the following spectral series known for hydrogen atom: Lyman, Balmer, Paschen, Brackett, Pfund, Humphreys and further unnamed series.

The Balmer series is characterized by the electron transitioning from *n* ≥ 3 to *n* = 2, where *n* refers to the principal quantum number of the electron. The transitions are named sequentially by Greek letter: *n* = 3 to *n* = 2 is called H-α, 4 to 2 is H-β, 5 to 2 is H-γ and so on.

Find the energy of electron transition from n=4 to n=2 (second line in Balmer series):

$$E = 1.09737316 \times 10^7 m^{-1} \left(\frac{1}{2^2} - \frac{1}{4^2}\right) \times 6.626 \times 10^{-34} \times 2.998 \times 10^8 = 4.087 \times 10^{-19} J$$

Find the energy difference between the second line of Lyman series and second line of Balmer series :

$$\Delta E = 1.938 \times 10^{-18} J - 4.087 \times 10^{-19} J = 1.5293 \times 10^{-18}\ J$$

Answer: $1.5293 \times 10^{-18}\ J$