Answer on Question #41173-Chemistry-Physical chemistry

Question:

Electron in hydrogen atom first jumps from third excited state to second excited state and then from second excited to the first excited state. The ration of the wavelengths λ1 : λ2 emitted in the two cases:

(1)27/5

(2) 20/7

(3) 7/5

(4) 27 / 20

Solution:

According to the laws of quantum mechanics, for systems with only one electron, an energy is associated with each electron configuration and, upon certain conditions, electrons are able to move from one configuration to another by emission or absorption of a quantum of energy, in the form of a photon.

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:

$$E_{photon} = h\nu = E_{n2} - E_{n1}$$

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

Rydberg constant:

$$R_H = \frac{2\pi^2 m e^4}{h^2}$$

$$R_H = 1.0973731\ 107\ m^{-1}$$

3→2:

$$E_{photon} = E_3 - E_2$$

$$\frac{1}{\lambda_{32}} = R_H \left(\frac{1}{2^2} - \frac{1}{3^2}\right)$$

2→1:

$$E_{photon} = E_2 - E_1$$

$$\frac{1}{\lambda_{21}} = R_H \left(\frac{1}{1^2} - \frac{1}{2^2}\right)$$

$$\frac{\lambda_{32}}{\lambda_{21}} = \frac{\left(\frac{1}{1^2} - \frac{1}{2^2}\right)}{\left(\frac{1}{2^2} - \frac{1}{3^2}\right)} = \frac{\frac{3}{4}}{\frac{5}{36}} = \frac{3 * 36}{4 * 5} = \frac{27}{5}$$

Answer: (1) 27/5