Answer on the question #54661 – Chemistry – General chemistry

Question:

(a) The molar extinction coefficient of a compound, X, at 370 nm wave length is 250 m2 mol -1. Its solutions of concentration 7.5*10-2 mol m-3 is taken in a cell of thickness 0.010 m. Find the ratio of the intensity of transmitted radiation to the intensity of the incident radiation.

(b) For 12C 16O, the fundamental frequency is 2143 cm -1. Calculate the fundamental frequency of 14C 16O

Answer:

(a) The relation of the transmitted radiation to the incident radiation is called transmittance:

$$T = \frac{I_{transmitted}}{I_{incident}}.$$

By definition, the transmittance and optical density are related as:

$$T = 10^{-A}.$$

Taking into account Beer-Lambert law:

$$A = \varepsilon lc,$$

where ε is the extinction coefficient, l is the length of the light pathway through the solution and c is the concentration of the sample.

$$T = 10^{-\varepsilon lc} = 10^{-250*7.5*10^{-2}*0.01} = 0.65$$

Then, the ratio of the transmitted radiation to the incident radiation is equal to 0.65.

(b) According to harmonic oscillator theory, the vibrational frequency can be calculated using the equation:

$$\nu = \frac{1}{2\pi}\sqrt{\frac{k}{\mu}},$$

where μ is reduced mass and k is the force constant. Reduced mass can be calculated within the formula:

$$\mu = \frac{m_1 m_2}{m_1 + m_2}.$$

Isotopic change will affect the reduced mass value, but not the force constant. Then, the new frequency value will be:

$$\nu_2 = \nu_1 \cdot \sqrt{\frac{\mu_1}{\mu_2}}.$$

The first reduced mass value is:

$$\mu_1 = \frac{12 * 16}{12 + 16} = 6.86.$$

The second reduced mass value is:

$$\mu_1 = \frac{14 * 16}{14 + 16} = 7.47.$$

The new frequency is:

$$\nu_2 = \nu_1 \cdot \sqrt{\frac{\mu_1}{\mu_2}} = 2143 \cdot \sqrt{\frac{6.86}{7.47}} = 2054 \text{ cm}^{-1}.$$