Answer on Question #44198, Physics, Other

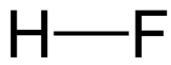
Question:

i) Calculate the number of vibrational degrees of freedom for hydrogen fluoride and chloroethene.

ii) For a compound, molar extinction coefficient is 215 m^2 mol-1 at 255 nm. What concentration of the compound in a solution will cause a 30% decrease in the intensity of 255 nm radiation? The cell thickness is 0.01 m.

Answer:

i) Hydrogen fluoride is a chemical compound with the formula HF, so it is linear molecule:



The degrees of vibrational modes for linear molecules can be calculated using the formula:

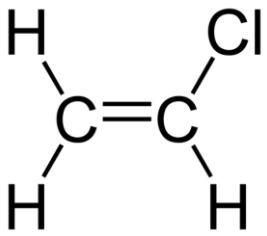
$$3n - 5$$

n is equal to the number of atoms within the molecule of interest.

For HF n=2:

$$3 \cdot 2 - 5 = 1$$

The molecular formula for chloroethene is C_2H_3Cl:



So, it is nonlinear molecule.

The degrees of freedom for nonlinear molecules can be calculated using the formula:

$$3n - 6$$

For C_2H_3Cl n=6:

$$3 \cdot 6 - 6 = 12$$

Answer: hydrogen fluoride 1, for chloroethene 12.

ii) The molar absorption coefficient (ε) is a measurement of how strongly a chemical species absorbs light at a given wavelength. It is an intrinsic property of the species; the actual absorbance, A, of a sample is dependent on the pathlength, ℓ, and the concentration, c, of the species via the Beer–Lambert law,

$$A = \varepsilon\, c\, l$$

From Beer–Lambert law:

$$A = -\ln\left(\frac{I}{I_0}\right)$$

If we have 30% decrease in the intensity:

$$\frac{I}{I_0} = \frac{100 - 30}{100} = 0.7$$

$$A = -\ln 0.7$$

And concentration equals:

$$c = \frac{A}{\varepsilon\, l} == -\frac{ln\, 0.7}{215\frac{m^2}{mol}\, 0.01m} = 0.166\frac{mol}{m^3}$$

Answer: $0.166\frac{mol}{m^3}$