Answer on Question #76742 – Chemistry – General Chemistry

A d1 octahedral complex is found to absorb visible light, with the absorption maximum occurring at 517 nm. Calculate the crystal-field splitting energy, Δ , in kJ/mol.

Solution:

The crystal-field splitting energy is equal to the energy of transition of the electron, that is linked to the wavelength of the emitted light λ as follows:

$$\Delta = E = \frac{hc}{\lambda},$$

Planck constant h = 6.62×10^{-34} $m^2\cdot kg\cdot s^{-1}$

Speed of light c = 3×10^{8} $m\cdot s^{-1}$

$$\Delta = \frac{6.62\times10^{-34}\left(m^2\cdot kg\cdot s^{-1}\right)\cdot 3\times10^{8}\left(m\cdot s^{-1}\right)}{517\times10^{-9}\,m} = 3.84\times10^{-19}\left(m^2\cdot kg\cdot s^{-2}\right) = 3.84\times10^{-19}\,J$$

This value is the splitting energy per ion. To convert it into J per mol, we should multiply it by Avogadro number, 6.02×10^{23} mol^{-1}:

$$\Delta = 3.84\times10^{-19}\cdot 6.02\times10^{23} = 231.1\ kJ\cdot mol^{-1}$$

Answer: 231.1 $kJ\cdot mol^{-1}$