Answer on Question #76270 – Chemistry – Inorganic Chemistry

c) What is the predicted magnetic moment of Cu^+ and Cu^{2+} ions in BM Unit (Atomic number of Cu 29)?

7. a) Given that the spacing of the lines in the microwave spectrum of $^{27}Al^{1}H$ is constant at 12.604 cm^{-1}. Calculate the moment of inertia and bond length of the molecule.

Solution:

c) Copper (Cu) atomic number = 29

The ground state electronic configuration is $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$ or [Ar] $4s^1 3d^{10}$

For Cu^+ one electron is removed from 4s orbital of Cu, the electronic configuration becomes [Ar] $4s^0 3d^{10}$. So, it has no unpaired electrons.

The formula to find the magnetic moment is $\sqrt{(n)(n+2)}$, n = unpaired electrons

μ = $\sqrt{(n)(n+2)}$ = $\sqrt{(0)(0+2)}$ = 0 BM

For Cu^{2+} the electronic configuration becomes [Ar] $4s^0 3d^9$, here in 3d orbital there is one unpaired electron. So, it has definitely some magnetic moment.

μ = $\sqrt{(n)(n+2)}$ = $\sqrt{(1)(1+2)}$ = $\sqrt{3}$ BM

7. a) If the spacing of lines is constant, the effects of centrifugal distortion are negligible. Hence we may use for the wavenumbers of the transitions

$F(J) - F(J-1) = 2BJ$

Since J = 1, 2, 3,…, the spacing of the lines is $2B$

12.604 cm^{-1} = $2B$,

B = 6.302 cm^{-1} = 6.302×10^2 m^{-1}

$$I = \frac{\eta}{4\pi c B} = m_{eff} R^2$$

$$\frac{\eta}{4\pi c B} = \frac{1.0546 \times 10^{-34} J \cdot s}{(4\pi) \times (2.9979 \times 10^8 m \cdot s^{-1})} = 2.7993 \times 10^{-44} kg \cdot m$$

$$I = \frac{2.7993 \times 10^{-44} kg \cdot m}{6.302 \times 10^2 m^{-1}} = 4.442 \times 10^{-47} kg \cdot m^2$$

$$m_{eff} = \frac{m_{Al} m_H}{m_{Al} + m_H} = \left(\frac{(26.98) \times (1.008)}{(26.98) + (1.008)} \right) u \times \left(1.6605 \times 10^{-27} kg \cdot u^{-1}\right) = 1.6136 \times 10^{-27} kg$$

$$R = \left(\frac{I}{m_{eff}} \right)^{1/2} = \left(\frac{4.442 \times 10^{-47} kg \cdot m^2}{1.6136 \times 10^{-27} kg} \right)^{1/2} = 1.659 \times 10^{-10} m = 165.9 \, pm$$