Batch B Sem I

CML 100-Minor 2: 2014-2015 - Semester I

11th October 2014 **Marks: 20** **Time: 1 hour**

Q1. The coordination complexes, **A and B** with M(II) ion are represented by $t_{2g}^4 e_g^2$ **and** ~~$t_{2g}^3 e_g^3$~~ $e^3 t^3$ electronic configurations respectively. Identify **A and B** and calculate crystal field stabilization energy of each complex **(2 marks)**

Q2. Photochemical reaction of a metal carbonyl, $M(CO)_5$ **(A)** results in the formation of a bimetallic complex, $M_2(CO)_9$ **(B)** with the elimination of CO. Assuming that both **A** and **B** follow EAN rule, Identify **M** and draw the structure of the complex, **B** **(2 marks)**

Q3. State whether the following statements are **TRUE** or **FALSE**? Justify your answer in ONE or TWO lines.

(i) Octahedral complexes of Co(II) metal ion in both low and High spin states show significant tetragonal distortion.

(ii) The ionic radii of $[Fe(CN)_6]^{4-}$ is smaller than that of $[Fe(H_2O)_6]^{2+}$

(iii) The function of both Hemoglobin and myoglobin is identical in biological systems.

(iv) In the infrared spectra, the C-O stretching band of $Cr(CO)_6$, $[V(CO)6]^-$ and $[Ti(CO)_6]^{2-}$ appears at 1750, 1860 and 2000 cm^{-1}, respectively. **(4x2 = 8 marks)**

Q5. The oxidative addition of Et_3SiH on a square planar complex, $Ir(CO)(Br)(Ph_2PCH_2CH_2PPh_2)$, **(A)** gives an Ir(III) complex **(B)**. The complex **B** undergoes reductive elimination subsequently with the elimination of HBr and forms a square planar complex **(C)**. Calculate the valence electrons of **(B)** and **(C)** and draw their structures. (Hint: **Ir belongs to Co group**) **(2 marks)**

Q6. State True/False with a one sentence reason. **$(1/2 \times 6 = 3$ marks)**

a. For the $v = 17$ harmonic oscillator wavefunction, there is a node at the origin.

b. For the harmonic oscillator the potential energy can be greater than the total energy.

c. The spacing between rotational levels remains constant as the quantum number l increases.

d. The $\hat{L}^2$ eigenvalues are degenerate except for $l = 0$.

e. If two operators $\hat{A}$ and $\hat{B}$ commute they have a simultaneous set of eigenfunctions

f. The value zero is never allowed as an eigenvalue.

Q7. Plot the radial distribution function (r^2R^2) as a function of r for the wavefunction given by $\frac{1}{4(2\pi)^{1/2}}\left(\frac{1}{a_0}\right)^{5/2} r\, e^{-r/2a_0} \sin\theta\cos\phi$. Determine the most probable radius for this wavefunction. Determine the three quantum numbers associated with this wavefunction. What is the degeneracy associated? **(1+1+1/2 +1/2 = 3 marks)**