P.G. 1st Semester - 2016

CHEMISTRY

(CBCS)

Paper : MCHECCT-104

Full Marks : 40 Time : 2 Hours

The figures in the right-hand margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

Answer any **five** questions, taking at least **two** from each Group.

GROUP-A

1. a) Find out the point group of the following molecules (any **three**):

   i) Diborane (B_2H_6)

   ii) $XeOF_4$

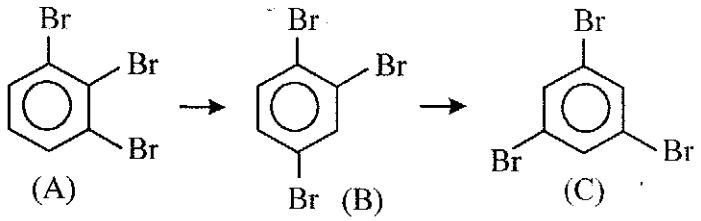
   iii) Cyclopentadienytanaion

   iv) Maleic acid

   v) Mer–$[M(CO)_3L_3]$ (where M=Metal, L=Monodentate ligand).

   b) Obtain a complete list of symmetry operations that are possible in a molecule having point group C_{4h} using stereographic projection method.

   c) Consider the following isomeric transformations and just write down the point group of the following species 'A' to 'C'.



   d) Which of the following point groups contain 'i' as a symmetry element?

   D_{3h}, D_{5d}, C_{2h}, C_{3v} $3+2\frac{1}{2}+1\frac{1}{2}+1=8$

2. a) Find out the matrix representation of all possible symmetry operators present in water molecule taking $\left\{\frac{1}{\sqrt{2}}(\vec{v}_1+\vec{v}_2),\ \frac{1}{\sqrt{2}}(\vec{v}_1-\vec{v}_2)\right\}$ as basis, where $\vec{v}_1$ and $\vec{v}_2$ are two unit vectors directed along two O–H bonds.

   b) Prove that similarity transformation does not change the trace of a matrix.

   c) Find out a complete list of symmetry operations that are possible in any one of the Platonic solids. 3+3+2=8

3. a) Give one example of real molecule for each of the following point groups (any **four**):

C_3, C_{3h}, I_h, D_{4d}, D_2, D_{5d}

b) When UV light of wavelength $743.7\,\mathring{A}$ falls on a metal plate $(W = 4.1\ eV)$, the photoelectrons are emitted from plate. Calculate the stopping potential (V_0) required to stop the emission of photoelectrons.

c) Find out spectroscopic term symbols for the electronic configuration $2s^1 2p^1$.

d) Calculate the total number of possible microstates that are associated with the electronic configuration

i) $2p^1 3p^1$

ii) $2p^2$ 2+2+2+2=8

4. What is the origin of radiations from a heated black body? Write down the expression of average energy $(\bar{\epsilon})$ per oscillator according to Planck's formulation. Total number of photons emitted per unit volume of the cavity of a heated black body (within the frequency range ν to $\nu + d\nu$) is given by $\frac{8\pi\nu^2}{c^3}d\nu$. Hence arrive at

a) Wien's displacement law

b) Stephan-Boltzmann law 1+1+3+3=8

GROUP-B

5. a) What is 'hot band' in vibrational spectroscopy? Is it possible to see them at room temperature?

b) Normally overtones are less intense. Do you think their intensity can be increased?

c) What is anhasmonicity constant? 3+3+2=8

6. a) Rotational spectroscopy is the sophisticated method to determine the bond length in a molecule. How spectral information is related to bond length?

b) Find the relation between rotational constant and J_{max}.

c) The rotational constant for $H^{35}Cl$. What is the value of 'B' for $H^{37}Cl$? 3+2+3=8

7. a) Calculate the angle between the two orientations of spin angular momentum vectors for the cas $I = \frac{1}{2}$.

b) How does energy exchange take place during spectral transition?

c) Define sheilding constant and chemical shift and establish a relation between them. Mention the factors on which the chemical shift depends. 2+2+4=8

8. a) Derive Maxwell-Boltzmann distribution law.

b) How do the rotational partition functions of H_2 and HD differ? 6+2=8
