

2006

CHEMISTRY - I (Optional)

000053

Standard : Degree

Total Marks : 200

Nature : Conventional

Duration : 3 Hours

Note :

- (i) Answers must be written in **English** only.
- (ii) Question No. 1 is **Compulsory**. Of the remaining questions, attempt **any four** selecting one question from **each** section.
- (iii) Figures to the **RIGHT** indicate marks of the respective question.
- (iv) Use of log table, Non-Programmable calculator is permitted, but any other Table / Code / Reference book are not permitted.
- (v) Make suitable assumptions, wherever be necessary and state the same.
- (vi) Number of optional questions upto the prescribed number in the order in which they have been solved will only be assessed. Excess answers will not be assessed.
- (vii) Credit will be given for orderly, concise and effective writing.
- (viii) Candidate should not write roll number, any name (including their own), signature, address or any indication of their identity anywhere inside the answer book otherwise he will be penalised.
- (ix) For each slab of 10 and 15 marks, the examinee is expected to write answers in 125 and 200 words respectively.

1. Answer any Four of the following questions :

- (a) (i) What is meant by coordination number ? Explain the geometry adopted by complexes with coordination number 5 with suitable example. 5
- (ii) Draw all the possible isomeric structures of the complex $[\text{Pt}(\text{NO}_2)(\text{Py})(\text{NH}_3)(\text{NH}_2\text{OH})]^+$ 3
- (iii) Name the following coordination compounds – $[\text{Cu}(\text{NH}_3)_4]\text{SO}_4$ and $\text{K}_4[\text{Mo}(\text{CN})_8]$ 2
- (b) Explain the different types of Carbonyl groups observed in metal carbonyls. Discuss the structure of iron pentacarbonyl. 10

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- (c) Answer the following :
- (i) Explain the Schulze - Hardy rule for coagulation. 10
 - (ii) Define and explain Gold number in context of colloids.
 - (iii) Describe the cleansing action of soap on the basis of Miscelle formation.
- (d) (i) Give a labelled phase diagram of water system. Discuss the areas (region bounded by two lines) and triple point only with respect to phase rule. 7
- (ii) Calculate the number of phases, components and degree of freedom in the following system : 3
- A mixture of nitrogen and oxygen gases contained in a vessel.
- (e) Discuss in brief the contaminants found in industrial waste water from different types of industries. Which methods are used to treat such waste water ? 10

SECTION - A

2. (a) (i) Draw $4\pi r^2 R^2$ v/s r curves for 3s, 3p, 3d electrons and explain how these curves depict the variation of probability density of electronic charge with respect to r (distance of charge from nucleus). 5
- (ii) Why and in what ways does Lithium resemble Group 2 metals ? 5
- (b) On basis of molecular orbital theory prove that the molecule of oxygen is paramagnetic in nature. 10
- (c) Why is diborane called an electron deficient compound ? What is unusual about the bonding in this compound ? 10
- (d) Discuss the main points of difference in the properties of the elements of the First transition series with those of the elements of second and third transition series. 10
3. (a) (i) Explain what do you understand by Heisenberg's uncertainty principle. What is the uncertainty involved in measurement of velocity when a microscope using suitable photon is employed to locate an electron in an atom within a distance of 0.1°A 5
- Mass of electron = 9.1×10^{-31} kg
Plancks constant (h) = 6.626×10^{-34} Js.
- (ii) Explain the anomalous behaviour of beryllium. 5
- (b) Draw the molecular orbital diagram of NO molecule. Write the electronic configuration, bond order and comment on magnetic behaviour. 10
- (c) What are interhalogens ? Give their general characteristics. Mention the different types interhalogens with suitable example. 10

- (d) Answer the following :
 (Given Z for Cr = 24, Mn = 25, Cu = 29, Sc = 21, Zn = 30)
 (i) Calculate the magnetic moment μ_s of Sc^{3+} .
 (ii) Why are transition elements metals ?
 (iii) Which of Cr or Mn is more paramagnetic ? Why ?
 (iv) Which of Cu^+ or Cu^{2+} is expected to be coloured ? Why ?
 (v) Why does Zinc show oxidation state of two only ?

SECTION - B

4. (a) What are the salient features of crystal field theory ? Describe the crystal field splitting in tetrahedral complexes. 10
- (b) Explain the Gouy's technique for determination of magnetic susceptibility. Mention two applications of magnetic susceptibility. 10
- (c) (i) State the purpose of Orgel diagram. Draw the Orgel diagram and crystal field absorption for $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ 5
 (ii) What is lanthanide contraction ? Explain the cause for it. 5
- (d) How is Plutonium recovered or separated from spent fuel by TBP method ? 10
5. (a) Discuss the factors that influence the magnitude of crystal field splitting. 10
- (b) Explain the terms : 10
 (i) Magnetic Susceptibility.
 (ii) Diamagnetism.
 (iii) Paramagnetism.
 (iv) Ferromagnetism.
- (c) (i) Discuss any two types of electronic transitions. 5
 (ii) Explain the principle involved in separation of lanthanides by ion-exchange method. 5
- (d) Give a comparative account of properties of lanthanides and actinides. 10

SECTION - C

6. (a) (i) Explain the solvent system concept of acids and bases. 5
 (ii) Describe the classification of non-aqueous solvents with suitable example. 5
- (b) Give an account of Maxwell's distribution of velocities. Explain how velocities change with temperature. 10
- (c) How are solids, liquid and liquid crystal different from each other ? Explain the nematic structure of liquid crystal. 10
- (d) Define crystal and unit cell. Explain the law of symmetry in detail. 10

Marks

7. (a) (i) On basis of Bronsted Lowry concept explain the terms acid and base with suitable example. 5
- (ii) Give an explanation for different types of reactions in liquid sulphur dioxide with suitable examples. 5
- (b) (i) Derive the reduced equation of state and state the law of corresponding state. 7
- (ii) The reduced volume and temperature of a gas are 10.2 and 0.7. What will be its pressure if its critical pressure is 42 atmospheres. 3
- (c) Give an account of intermolecular forces in liquid. 10
- (d) Why X-rays are useful in determining crystal structure. Derive Bragg's equation. 10

SECTION - D

8. (a) Explain three methods used to determine order of reaction. 15
- (b) (i) Explain the term work function and Free energy. Derive relationship between them. 5
- (ii) Show how free energy varies with temperature and pressure. 5
- (iii) Calculate the free energy change at 300K when change in enthalpy of reaction is -94.47 kJ and enthalpy change is -188.9 J in the same reaction. State whether the reaction is spontaneous or non-spontaneous. 5
- (c) Derive Clayperon-Clausius equation. Calculate heat of vapourisation of water between 363K and 373K. The vapour pressure of water are $0.706 \times 10^5 \text{ Nm}^{-2}$ at 363K and $1.013 \times 10^5 \text{ Nm}^{-2}$ at 373K. $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$ 10
9. (a) (i) What is first order reaction ? Explain the Kinetic characteristics for first order reaction. 10
- (ii) Differentiate between order and molecularity of a reaction. 5
- (b) (i) Define bond energy and name the factors on which it depends. Calculate the bond energy of HCl, given that H-H bond energy is 433 kJ mol^{-1} , Cl-Cl bond energy is 242 kJ mol^{-1} and $\Delta H_f \text{ HCl}$ is -91 kJ mol^{-1} 8
- (ii) Describe Nernst heat theorem. 7
- (c) What do you understand by the term thermodynamic equilibrium ? Write the expression for K_p and K_c for the general reaction
 $aA + bB \rightleftharpoons cC + dD$
 Show how K_p is related to K_c . 10