WEST BENGAL STATE UNIVERSITY

B.Sc. Honours 4th Semester Examination, 2022

CEMACOR09T-CHEMISTRY (CC9)

INORGANIC CHEMISTRY-III

Time Allotted: 2 Hours | Full Marks: 40

The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.

Answer any *three* questions taking *one* from each unit

Unit-I

1. (a) Define the following with example: 1×4 = 4
   Alloy , Mineral , Ore and Slag
   (b) What does roasting mean in metallurgy? 2
   (c) Describe briefly the extraction of Ti metal from its ore by Kroll process. 4

2. (a) What do you mean by parting process? Describe briefly how Gold metal can be obtained from the mixture by parting process. 1+3
   (b) Consult the Ellingham diagram and determine if there are conditions under which Aluminium might be able to reduce MgO? 3
   (c) In some modern process of hydrometallurgy, the beneficiation and conservation are carried out in one step. Give examples. 3

Unit-II

3. (a) Compare and Contrast the properties of B and Al considering the following points: 5
      (i) Elemental states
      (ii) Hydrides
      (iii) Halides.
   (b) The fluorocarbons are remarkably chemically inert. — Comment. 2
   (c) Depict the structural features of Diborane. Explain the reactivity of Diborane as a Lewis acid with reference to ammonia and amines. 3
   (d) Give example of a three dimensional silicate and on the basis of its structure mention its use. 3
   (e) Cyanogen is a pseudohalogen. — Justify. 2
   (f) Suggest a method of preparation of XeO_2F_2 and also draw its structure. 2
   (g) What happens when 3
      (i) Ferric chloride solution is added gradually to a sodium thiosulphate solution.
      (ii) Silver nitrate is added to a concentrated solution of ammonium persulphate.

4. (a) Predict and explain the order of the 'tendency of polymerisation' of the following oxyanions: 3

$$SO_4^{2-} \ , \ ClO_4^{-} \ , \ PO_4^{3-} \ , \ SiO_4^{4-}$$

(b) Amongst inert gases, Xenon is most suitable to form chemical compounds — Explain. 2

(c) Discuss the structure and bonding of $(SN)_x$ [$x = 4$]. 3

(d) State two evidences of chemical reaction to establish that SCN^- is a pseudohalide. 2

(e) Write down the structures of trimeta-phosphoric acid and tripoly-phosphoric acid. Hence, comment on the basicities of the two acids. 2

(f) Why fluorocarbons are very stable and not easily oxidisable? 2

(g) What are interhalogens? On the basis of hybridization, mention the structures of different types of interhalogen compounds. 3

(h) Give the structure of cyclic trimetasilicate ion. Give an example to show that hydrazine behaves as a reducing agent. 3

Unit-III

5. (a) How would you show that the thiocyanate ion acts as an ambidentate ligand? 2

(b) Write down the structures of different isomeric forms of $[Cr(ox)_3]^{3-}$. 2

(c) How many isomers are possible for $[Co(NH_3)(OH)_2Cl_3]^{2-}$? 2

(d) How will you distinguish between the following pairs of isomers? 2+2

(i) $[Co(NH_3)_6]\,[Cr(NO_2)_6]$ and $[Cr(NH_3)_6]\,[Co(NO_2)_6]$

(ii) $[Cr(NH_3)_6]\,[Cr(NO_2)_6]$ and $[Cr(NH_3)_4(NO_2)_2]\,[Cr(NH_3)_2(NO_2)_4]$

6. (a) Molar conductance at a dilution of 1024 litres of $PtCl_4.2NH_3$; $PtCl_4.3NH_3$; $PtCl_4.6NH_3$ are 7, 97 and 520 $Ohm^{-1}cm^2$ respectively. Rationalise these data in the light of Werner's theory. 3

(b) Acetyl acetone is a potential ligand that forms a square planar complexes with Cu(II). Draw the structure of the complex and predict the formal charge on the complex. 2

(c) Metal chelates are more stable than non-chelated complexes. — Comment. 3

(d) Write the IUPAC name of $[(SCN)_3(H_2O)_2Cr–OH–Co(NH_3)_5](SO_4)$ and the formula of pentaammineazidocobalt(III) sulphate. 2

N.B. : *Students have to complete submission of their Answer Scripts through E-mail / Whatsapp to their own respective colleges on the same day / date of examination within* 1 *hour after end of exam. University / College authorities will not be held responsible for wrong submission (at in proper address). Students are strongly advised not to submit multiple copies of the same answer script.*

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WEST BENGAL STATE UNIVERSITY

B.Sc. Honours 4th Semester Examination, 2022

CEMACOR08T-CHEMISTRY (CC8)

PHYSICAL CHEMISTRY-III

Time Allotted: 2 Hours | Full Marks: 40

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Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.

Answer any *three* questions taking *one* from each unit

Unit-I

1. (a) Consider a one component system. Explain the variation of the slope of μ vs. T plot at constant pressure as we go from **solid ⟶ liquid ⟶ gas**. 4

   (b) The melting point of pure phenol is **40.5°C**. A solution containing 0.18 gm acetanilide in 13.0 gm phenol freezes at **39.5°C**. Calculate the cryoscopic constant of phenol. Why the concentration is expressed in molality instead of molarity? 3+1

   (c) What do you mean by the abnormal colligative properties? What is Van't Hoff factor? Consider a **0.6%** aqueous solution of NaCl. It is experimentally observed that the solution freezes at **– 0.3°C**. Calculate the Van't Hoff factor and degree of dissociation of NaCl in the aforesaid solution. 2+1+3

2. (a) State Gibbs phase rule of a thermodynamic system at equilibrium. Find out the number of Phase(s), Component(s) and Degree(s) of Freedom of the following systems at equilibrium. 2+3

   (i) $\mathbf{CaCO_3\,(s) \rightleftharpoons CaO\,(s) + CO_2\,(g)}$; (ii) $\mathbf{NH_4Cl\,(s) \rightleftharpoons NH_3\,(g) + HCl\,(g)}$

   (b) State Raoult's law and Henry's law. Show that Henry's law follows from Raoult's law for dilute solutions. 2+2

   (c) Consider the Maxwell's equation for a single phase given by $\left(\frac{\partial P}{\partial T}\right)_V = \left(\frac{\partial S}{\partial V}\right)_T$. 2+3

   Derive Clapeyron equation from this relation. Show that

$$\left(\frac{\partial P}{\partial T}\right)_{\text{solid} \rightarrow \text{gas}} > \left(\frac{\partial P}{\partial T}\right)_{\text{liquid} \rightarrow \text{gas}}$$

Unit-II

3. (a) What do you mean by activity and activity coefficient of an ionic solution? Discuss how the electrophoretic and relaxation effects play the role to reduce the ionic mobility in Debye-Hückel theory. 2+4

(b) Calculate the equilibrium constant for the reaction given by 2+3

$$Cu^{2+} + Zn \rightleftharpoons Cu + Zn^{2+}$$

[Given: $E^0_{Cu^{2+}/Cu} = 0.337$ V ; $E^0_{Zn^{2+}/Zn} = -0.763$ V at 25°C**].**

(c) Discuss the principle of determination of pH of a solution by using quinhydrone electrode. 3

4. (a) What do you mean by reversible and irreversible electrochemical cells? Explain with an example. 2+2

(b) Determine the standard equilibrium constant of the following reaction at 298 K. 4

$$2Fe^{3+} + Sn^{2+} \rightarrow 2Fe^{2+} + Sn^{4+}$$

$[E^0_{Fe^{3+}/Fe^{2+}} = 0.771$ V ; $E^0_{Sn^{4+}/Sn^{2+}} = 0.150$ V$]$

(c) What is the principle underlying potentiometric titrations? Explain how can we determine the pH of a solution using Quinhydrone electrode. 1+3

(d) State whether the statement is true or false: 2

"In order to minimize Liquid Junction Potentials, one must use a salt bridge containing a salt such that $t_+ = t_-$."

Unit-III

5. (a) Find the value of the commutator, $[L_x, L_y]$. 4

(b) Show that $Y_1^{-1}(\theta, \phi)$ is normalized and orthogonal to $Y_0^0(\theta, \phi)$. 4

Given: $Y_1^{-1}(\theta, \phi) = (3/8)^{1/2} \sin\theta e^{-i\phi}$ and $Y_0^0(\theta, \phi) = (1/4\pi)^{1/2}$

(c) Write down the electronic Hamiltonian of H_2^+. 2

(d) Draw the radial probability density with respect to distance from the nucleus for 2*s* orbital of hydrogen atom. 2

6. (a) Write down the time-independent Schrödinger equation for H-atom in polar coordinates with the meaning of the symbols. 2

(b) Find out the average distance of the electron of a hydrogen atom in 1*s* orbitals. 3

[Given: $\psi_{1s} = \left(\frac{1}{\pi a_0^3}\right)^{1/2} \cdot e^{-r/a_0}$ **]**

(c) Write the Hamiltonian operator for the hydrogen molecule stating the meaning of the symbols. 2

(d) Explain the concepts of molecular orbital theory and valence bond theory. State the strengths and limitations of valence bond approach to molecular bonding. 3+2

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