Birla Institute of Technology and Science, Pilani (Rajasthan)

First Semester (2022-23), 1st November, 2022

Mid-Semester Test (Closed Book)

CHEM F214: Inorganic Chemistry I

Marks: 55 **Time: 90 min**

Instruction to the students: There are **5** questions in all. Attempt all the questions. Answer all parts of the question together.

Q1. Predict and explain the products for the following reactions based on the concept of electronegativity:

(i) $CH_3I + Na^+[Mn(CO)_5]^- \rightarrow$ (ii) $CF_3I + Na^+[Mn(CO)_5]^- \rightarrow$ **[2+3]**

(b) Draw the qualitative curves of Ionization energy-electron affinity of oxygen and fluorine against their oxidation states and justify the nature of the plot **[3]**

(c) Find out the pK_a of chloric and perchloric acids where the electronegativity of Cl is 3.16. **[2]**

Q2. (a) Applying Drago's concept of systematics of Lewis acid-base interactions, calculate ΔH (in kcal mol^{-1}) (enthalpy of formation of Lewis acid-base adduct of Phenol (E_A = 2.27, C_A = 1.07) and pyridine (E_B = 1.78, C_B = 3.54). Which type of interaction is prevalent in the adduct? **[2+1]**

(b) Using acid-base theory, predict whether the following reactions have equilibrium constants greater or less than 1. Provide the justifications

(i) $CuI_2 + 2CuF$ (ii) $OH^- + CH_3HgSO_3^-$ **[4]**

(c) According to Irving-Williams series, the order of the stability constant of the complexes of few divalent metal ions with bidentate ligands is as follows: $Mn^{2+} < Fe^{2+} < Co^{2+} < Cu^{2+} > Zn^{2+}$. What does it indicate (Hint: Apply the acid-base concept)? If, this above mentioned order is associated with higher stability constants when ligand is $H_2NCH_2CH_2NH_2$ as compared to the ligand $^-OOC\text{-}COO^-$, what would be your comment? **[2+1]**

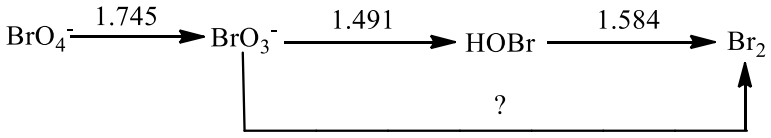
Q3. (a) Write down the order of basicity for the series of the bases comprising of trimethylamine, triethylamine and tripropylamine using the concept of 'B-strain'. Comment on their basicity based on theory of solvation. **[4]**

(b) A small piece of metal when placed in liquid NH_3, an intense blue colored solution is produced. This observation is independent of the metal chosen. What is the reason behind the observation? **[2]**

(c) Justify whether followings are acidic or basic, or amphoteric in **solvent $POCl_3$** with the mention of the species formed

(i) $SbCl_5$ **(ii)** $AlCl_3 + KCl$ **[2+2]**

Q4. (a) Complete the following and mention the most stable oxidation state with proper justification.



[2+2]

(b) Find out the symmetry elements and the point group of the following molecules:
(i) SF_5Cl **(ii)** *trans*-$C_2H_2Cl_2$ **[3+3]**

Q5. (a) With the light of VSEPR theory, draw the Lewis structure and find out the structures of the following molecules with the mention of hybridization**.**
(i) XeF_6 (At. No: of Xe = 54) and also justify the structure based on the fact that XeF_5^+ is formed very easily from XeF_6 **(ii)** $PbCl_2$ (At. No: of Pb = 82). **[3+2]**

(b) In case of B_2O_3, coordination number of 3 is observed. Find out the limiting value of r_c/r_a where, r_c, r_a = radius of the cation and anion respectively. **[2]**

(c) How do Hg^{2+} and Ca^{2+} ions have approximately same ionic radii? Mention the nature of the bonding these cations prefer. **[2+1]**

(d) (i) Use the Born-Haber cycle to calculate the enthalpy of formation of KBr, which crystallizes with the Rock salt structure. Use these data in the calculation: $\Delta H_{vap}(Br_2)$ = 298 $kJmol^{-1}$; Br_2 bond energy = 190.2 $kJmol^{-1}$; EA of bromine = -324.7 $kJmol^{-1}$ and ΔH_{sub} (K) = 81.3 $kJmol^{-1}$; Madelung constant = 1.748; ionization energy of K = 418.8$kJmol^{-1}$; $r_{K+} + r_{Br-}$ = 334pm; Born exponent = 11.13; ε_0 = 8.854188 x $10^{-12}C^2J^{-1}m^{-1}$; e = 1.60218 x 10^{-19}C.
(ii) Why is the Madelung constant represented as a converging series? **[4+1]**

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