

Birla Institute of Technology and Science, Pilani (Rajasthan)

First Semester (2023-24), 14th October, 2023

Mid-Semester Test (Closed Book)

CHEM F214: Inorganic Chemistry I

Marks: 60

Time: 90 min

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

Useful Data: Electronegativity χ : $\chi_H = 2.1$; $\chi_C = 2.5$; $\chi_{Si} = 1.8$; I_2 ($E_A = 0.5$, $C_A = 2.00$); $B(OCH_3)_3$ ($E_A = 0.54$, $C_A = 1.22$); Me_2S ($E_B = 0.25$, $C_B = 3.75$); $DMSO$ ($E_B = 2.40$, $C_B = 1.47$).

Q1. Silicon hydride reacts with the sources of protons to give molecular hydrogen whereas hydrocarbons do not. Explain the observation. If the bond energies of C-H, Si-H and H-H bonds are 413 kJ/mole, 160 kJ/mole and 436 kJ/mole respectively, calculate the bond energy of C-C bond. [2+3]

(b) Calculate the average bond energy of N-N bond from the following data:

Total heat of atomization of N_2H_4 and N_2F_4 are 1703 kJ/mole and 1305 kJ/mole respectively

Bond energies of N-H bond (assumed from NH_3) and N-F (assumed from NF_3) are 386 kJ/mole and 283.5 kJ/mole respectively. [3]

(c) Me_3N , pyridine, acetonitrile (CH_3CN) have distinctly different basicity. In presence of water how do they behave and why are the differences observed? [4]

Q2. (a) Using acid-base theory, predict whether the following reactions have equilibrium constants greater or less than 1. Provide the justifications

(i) $SO_2 + Ph_3P-HOCMe_3$ (ii) $[AgCl_2]^- + 2 CN^-$ [3+2]

(b) Compare the strength of acidity with proper reasoning: (i) aqua ion of Na^+ and Ag^+ (ii) conjugate acids of ClO_4^- , PO_4^{3-} , SO_4^{2-} , SiO_4^{4-} . [3+3]

(c) Fluorosulphuric acid and antimony pentafluoride form superacid. Write down the reaction. [2]

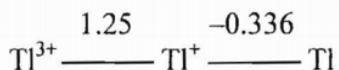
Q3. (a) Compare the basicity of Me_2S and $DMSO$ with respect to the acids I_2 and $B(OCH_3)_3$ by calculating the ΔH of the adduct formation. [5]

(b) Write down the reaction involved in each of the cases and comment on the comparative strength of the acids in the solvent, H_2SO_4 .

(i) $HClO_4$ in H_2SO_4 (ii) $H_2S_2O_7$ in H_2SO_4 [3+1]

(c) Draw the structures of $HMnO_4$ and $HClO_4$ and justify their relative acid strength. [3]

Q4. (a) Draw the Frost diagram from the given Latimer diagram for Tl (Thallium) in aqueous acid mentioning the axes and coordinates. Which species is the strongest oxidant and How do justify it?



[3+2]

(b) In a figure show the C_2 and C_3 rotational axes of symmetry (one each) for a perfect octahedron. How many of such axes are present for each of the cases? (ii) Find out the principal axis of rotation present in octahedron. [2+1+1]

(c) Write down the balanced reaction of oxidation of H_2O by Fe^{2+} . If $E^0(Fe^{2+}/Fe) = -0.44V$, and $E^0(O_2/H_2O) = 1.23 V$, then comment on the spontaneity of the above mentioned reaction [3]

Q5. (a) Find out the point groups of *cis-planar* and *trans-planar* configurations of H_2O_2 by mentioning all the symmetry elements. [3]

(b) In which of the species ICl_4^- or SF_4 is the bond angle closest to that predicted by VSEPR by predicting the structures of these molecules? [4]

(c) Find out the minimum size of the tetrahedral hole in terms of the radius of anions. [3]

(d) What could be the plausible reason(s) for $MgSO_4$ (radius of $Mg^{2+} = 0.72 \text{ \AA}$) to be more soluble in water than $SrSO_4$ (radius of $Sr^{2+} = 1.16 \text{ \AA}$)? [2]

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