WEST BENGAL STATE UNIVERSITY
B.Sc. Honours 2nd Semester Examination, 2021

CEMACOR03T-CHEMISTRY (CC3)

INORGANIC CHEMISTRY-I

Full Marks: 40

Time Allotted: 2 Hours

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 *four* questions taking *one* from each unit

Unit-I

1. (a) Determine the ground state term symbol of 'Cr' atom. 2

    (b) Explain why Aufbau principle is violated for the electron filling process of lanthanides. 2

    (c) An electron circles a nucleus of charge is Ze of the two orbits 1 and 2 of radii R_1 and R_2 respectively, its total energy is greater while in orbit 1. Prove that $R_1 > R_2$. Also, show that the velocity and acceleration in orbit 2 are greater than those in orbit 1. 2+2

    (d) Explain Heisenberg uncertainty principle with reference to the following expression 2
    $$\Delta x.\Delta p_x \geq h/4\pi$$

    (e) What is Pauli's exclusion principle? 1

2. (a) Draw the different shapes of Somerfield's orbits of hydrogen atom for $n = 4$. 2

    (b) What is de Broglie relationship? How de Broglie's equation can be used to explain Bohr's atomic model? 3

    (c) Calculate the difference in wavelength (nm) for the transition, $n = 1$ to $n = 2$ in hydrogen (H) and deuterium (D) (Given $R_H = 109679$ cm^{-1} and $R_D = 109712$ cm^{-1}). 3

    (d) What are radial wave function and radial probability function? Draw quantitatively the radial probability function curves for $3s$ and $3p$ orbitals and comment on the ionization energy of the electrons on those orbitals? 1+2

Unit-II

3. (a) Calculate Allred-Rochow electronegativity of Zn taking its covalent radius as 125 pm. 2

    (b) Qualitatively compare 1st ionization energies of Ca and Zn, both having $4s^2$ configuration in their valence shell. 2

    (c) The univalent radius of oxide ion is 175 pm. Calculate the crystal radius of O^{2-} ion. 2

(d) Arrange the following compounds in the order of increasing C-F bond length with necessary explanation.   2

$$CF_4, \ CH_3F, \ CH_2F_2, \ CHF_3$$

4. (a) (i) Explain why electron affinity of Mn^{3+} is greater than that of Fe^{3+}.   1+1

    (ii) Arrange N, O, N^+ and O^+ in order of increasing ionisation potential.

(b) The electronegativity of Ga is greater than that of Al. — Explain.   2

(c) Explain Pauling's approach for the determination of ionic radii. Determine the ionic radii of Na^+ and F^- ions by this method.   3

(Given internuclear distance $r_{Na^+ - F^-}$ is 231 pm).

(d) Mention the period and group for an element having atomic number 116.   1

Unit-III

5. (a) Explain why methyl mercury ion is taken as the standard for comparison of hard and soft characters of acids and bases?   2

(b) What are superacids? How the acidity of such solutions can be measured?   1+2

(c) Calculate the buffer capacity of a buffer medium when 0.05 mole of NaOH is added to 1.0 litre of the buffer solution and the change of pH is from 5.70 - 5.85.   2

(d) Calculate the change in pH at the end point, when 100 mL 0.1 (N) NaOH is titrated with 0.1 (N) CH_3COOH ignoring the change in volume.   3

[Given pK_a (CH_3COOH) = 4.73]

Hence, suggest suitable indicator(s) for the detection of end point.

6. (a) Predict which way the following reactions will proceed in gas phase. Justify your answer.   4

    (i) $HI + NaF = HF + NaI$

    (ii) $TiF_4 + 2TiI_2 = TiI_4 + 2TiF_2$

(b) Using Pauling's rule, identify the structural formulae that are nearly consistent with the actual pK_a values (i) 1.8 for H_3PO_3 and (ii) 9.0 for H_3AsO_3.   2

(c) HgO is added to an aqueous solution of KI. Comment on the change in acidity of the resulting solution.   2

(d) Arrange the following in the increasing order of Lewis acidity. Justify your answer.   2

$$SiF_4, \ SiCl_4, \ SiBr_4, \ SiI_4$$

Unit-IV

7. (a) What is formal potential? Explain why it is considered more important than standard electrode potential.   2

(b) Calculate the cell potential at 30°C from the following half-cell reactions: 3

$$Co^{2+}(aq)(0.1M) + 2e = Co(s) \qquad E^0_{Co^{2+}/Co} = -0.288 \text{ V}$$

$$Al(s) = Al^{3+}(aq)(0.1M) + 3e \qquad E^0_{Al/Al^{3+}} = +1.66 \text{ V}$$

Given Faraday constant (F) = 96500 C mol^{-1} and R = 8.314 J mol^{-1} K^{-1}.

(c) Construct a Frost diagram of oxygen in acidic solution from the following Latimer diagram: 3

$$O_2 \xrightarrow{\text{0.695 V}} H_2O_2 \xrightarrow{\text{+1.75 V}} 2H_2O$$
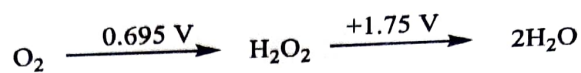
Hence, explain the disproportionation and / or comproportionation reaction.

(d) In qualitative group analysis, what is the role of $NH_4Cl + NH_4OH$ mixture in the precipitation of group IIIA cations? 3

2+2

8. (a) Will metallic tin (Sn) reduce Pb^{2+} if
   (i) concentration of Pb^{2+} is 0.5 M and that of Sn^{2+} being 0.01 M?
   (ii) concentration of Pb^{2+} is 0.01 M and that of Sn^{2+} being 0.5 M?

(b) Explain the effect of pH on the redox potential of the system 4

$$MnO^{4-} + 8H^+ + 5e \rightleftharpoons Mn^{2+} + 4H_2O$$
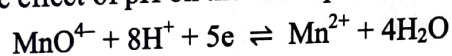
Explain why, chloride ion is oxidized by this system at low pH (< 1.5) and not in neutral medium.

Given E_0 values are $MnO_4^-/Mn^{2+} = 1.52$ volt, $Cl_2/Cl^- = 1.36$ volt.

(c) How the separation of CdS and ZnS in qualitative analysis can be explained by solubility product principle and common ion effect? 3

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.*

——×——