



WEST BENGAL STATE UNIVERSITY  
B.Sc. Honours 2nd Semester Examination, 2023

CEMACOR03T-CHEMISTRY (CC3)

INORGANIC CHEMISTRY-I

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 four questions taking one from each unit

Unit-I

1. (a) Compare the radial distribution plots for  $2s$  and  $2p$  orbitals and hence comment on their relative penetrating power. 3
- (b) Find out the ground state term symbol for  $\text{Co}^{2+}$  and  $\text{Cr}^{2+}$  ions. 2
- (c) Identify the possible Bohr-Sommerfeld orbits for  $n = 1$ . 2
- (d) In an atom the angular momentum of an electron is  $\sqrt{6} h/2\pi$ . What will be the minimum value of the principal quantum number of the electron? 2
- (e) Calculate the uncertainty in position of an electron whose velocity is  $3.0 \times 10^4 \text{ cm s}^{-1}$  and accuracy upto 0.001%. Mass of an electron =  $9.1 \times 10^{-28} \text{ g}$ . 2
2. (a) Apply Pauli's exclusion principle to predict the maximum capacity of  $p$ -subshell for accommodating electrons. 2
- (b) Why de Broglie's wave equation has no significance for a macroscopic particle? 1
- (c) Show that the de-Broglie wavelength of the electron in the first Bohr orbit of the hydrogen atom is  $2\pi a_0$  (where  $a_0$  = First Bohr radius). 2
- (d) "Though the  $(n+1)$  rule to determine the order of energy of different subshells is useful in most cases, there are some exceptions" — Justify the statement with an example. 2
- (e) Calculate the frequency of radiation emitted when an electron jumps from the third to the first Bohr orbit. [Rydberg Constant =  $109677 \text{ cm}^{-1}$ ]. 2
- (f) Deduce the expression for energy of a Hydrogen like atom in SI unit. 2

Unit-II

3. (a) Rationalize the electron affinity trend of C, N and O atoms: 2
- |     |       |     |                             |
|-----|-------|-----|-----------------------------|
| C   | N     | O   |                             |
| 122 | -20.3 | 141 | (in KJ mole <sup>-1</sup> ) |

- (b) Calculate the oxidation state of Tl in  $TlI_3$  and justify your answer. 2
- (c) Atomic radii of Nb and Ta are almost identical. Comment. 2
- (d) The Cl–O bond length in  $ClO_2^+$  is 141 pm while that in  $ClO_2$  is 148 pm. Explain. 2
4. (a) What is meant by ionic radius? Discuss with example the Pauling's method of determination of univalent radii applicable for isoelectronic ion pairs. 1+2
- (b) Rationalise the trends in ionization energy in the following cases: 2
- | Elements                     | Li   | Be   | B    |
|------------------------------|------|------|------|
| First ionisation energy (ev) | 5.39 | 9.32 | 8.30 |
- (c) The F–F bond distance in  $F_2$  is 141.3 pm. Calculate Allred-Rochow electronegativity of fluorine using Slater's rule. 3

### Unit-III

5. (a) What is Hammett acidity function,  $H_0$ ? How can you define super-acid on its basis? What happens when  $SbF_5$  is added to  $HSO_3F$ ? 3
- (b) What will be the pH of the solution obtained by mixing 10 ml of 0.2 (N) KOH with 30 ml of 0.1 (N)  $CH_3COOH$ ?  $K_a = 2 \times 10^{-5}$ . 3
- (c) Predict which way the reactions will go in the gas phase with explanation: 2
- (i)  $HI + NaF \rightarrow HF + NaI$
- (ii)  $TiF_4 + 2TiI_2 \rightarrow TiI_4 + 2TiF_2$
- (d) When 0.05 mole of NaOH was added to one litre of a buffer solution, its pH changed from 5.70 to 5.85. Find the buffer capacity. 2
6. (a) Draw the acid-base neutralization curves for the titration of 3
- (i) HCl Vs. NaOH
- (ii)  $CH_3COOH$  Vs. NaOH
- Explain your choice of indicators in each case.
- (b) What is the pH of  $10^{-3}$  M aqueous solution of  $NH_4OH$ ? Given  $K_b = 1.85 \times 10^{-5}$  M at  $25^\circ C$ . 2
- (c) Arrange  $BF_3$ ,  $BCl_3$ ,  $BBr_3$ ,  $BI_3$  in order of their Lewis acidity with justification. 3
- (d) Identify the structural difference between  $H_3PO_3$  and  $H_3AsO_3$  using Pauling's rule. [Given  $pK_a(H_3PO_3) \sim 2.0$  ;  $pK_a(H_3AsO_3) \sim 9.0$ ] 2

### Unit-IV

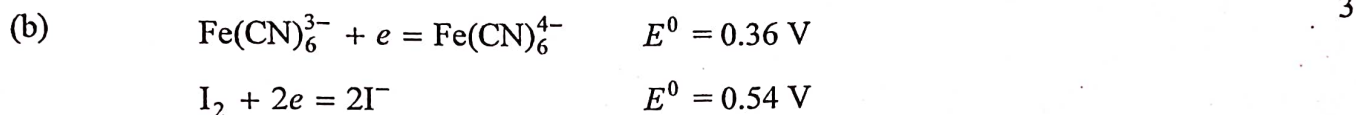
7. (a) What is comproportionation reaction? Give example. 1
- (b) "Addition of phosphoric acid is essential in the titration of  $Fe^{2+}$  ion with dichromate" — Comment. 2

(Given:  $E^0_{Cr_2O_7^{2-}/Cr^{3+}} = +1.33$  volt,  $E^0_{Fe^{3+}/Fe^{2+}} = +0.77$  volt,

$E^0$  for  $Ind_{ox}/Ind_{red} = +0.76$  V)

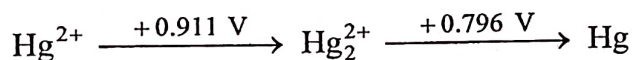
- (c) Discuss the role of Zimmerman-Reinhardt reagent in the titration of  $\text{Fe}^{2+}$  by  $\text{KMnO}_4$  in  $\text{HCl}$  medium. 2
- (d) Calculate the redox potential values at the following three stages of titration of 0.1 (N)  $\text{Fe}^{2+}$  and 0.1 (N)  $\text{KMnO}_4$  in 1 (N)  $\text{H}_2\text{SO}_4$  medium 3
- (i) 25 ml  $\text{Fe}^{2+}$  + 24.90 ml  $\text{KMnO}_4$
- (ii) 25 ml  $\text{Fe}^{2+}$  + 25 ml  $\text{KMnO}_4$
- (iii) 25 ml  $\text{Fe}^{2+}$  + 25.10 ml  $\text{KMnO}_4$
- Given:  $E_{\text{Fe}^{3+}/\text{Fe}^{2+}}^0 = 0.77 \text{ V}$  and  $E_{\text{MnO}_4^-/\text{Mn}^{2+}}^0 = 1.51 \text{ V}$
- (e) What do you mean by common ion effect? In qualitative group analysis,  $\text{Cu}^{2+}$  is precipitated as sulphide in Gr IIA but  $\text{Zn}^{2+}$  does not — Explain. 1+2

8. (a) What are redox indicators? Give one example with structure both in oxidised and reduced states. 2



A solution of potassium ferricyanide cannot oxidise iodide to iodine but it can do so in presence of  $\text{Zn}^{2+}$  ion — Explain.

(c) Construct a Frost diagram for mercury in acid solution from the following Latimer diagram: 3



Hence work out the possibility of disproportionation or comproportionation of  $\text{Hg}_2^{2+}$ .

(d) The solubility of  $\text{CaF}_2$  in water at  $18^\circ\text{C}$  is  $2.04 \times 10^{-4} \text{ mol/lit}$ . 3

Calculate:

- (i) Solubility product and
- (ii) The solubility of  $\text{CaF}_2$  in 0.01 M  $\text{NaF}$  solution.

—x—