



## WEST BENGAL STATE UNIVERSITY

B.Sc. Honours 2nd Semester Examination, 2022

### 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) What is the exchange energy? From the concept of exchange pair of electrons, how ground state electronic configuration of chromium can be determined? 1+3
- (b) What electronic transition in  $\text{He}^+$  spectrum would have the same wavelength as the first Lyman transition of hydrogen? 3
- (c) Explain the significance of different  $m_l$  (magnetic quantum number) values corresponding to Azimuthal quantum numbers ( $l$ ) = 1. 2
- (d) Determine the ground state term symbol of  $\text{Cu}^{2+}$  ion. 2
2. (a) Mention the limitation of Bohr's theory of atomic structure and discuss the Sommerfeld's extension on it. 3
- (b) State Hund's rule and hence find out the ground term for gaseous Cr atom. 3
- (c) How do the shapes of  $s$  and  $p$  orbitals can be obtained from angular functions? Give reasons. 3
- (d) Calculate the de-Broglie wavelength of  $6s$  electron of Hg moving with a speed nearly  $1/6^{\text{th}}$  that of light. Velocity of light =  $3.0 \times 10^8 \text{ ms}^{-1}$ . 2

#### Unit-II

3. (a) Explain the causes of Lanthanide-contraction. 2
- (b) The ionization energies follow the sequence in the following cases as shown — Justify. 3
  - (i)  $\text{IE}_1(\text{Cu}_{29}) < \text{IE}_1(\text{Zn}_{30}) > \text{IE}_1(\text{Ga}_{31})$
  - (ii)  $\text{IE}_1(\text{Au}_{79}) < \text{IE}_1(\text{Hg}_{80}) > \text{IE}_1(\text{Tl}_{81})$

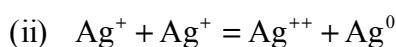
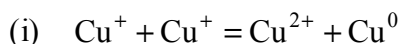
- (c) Calculate the electronegativity of hydrogen from the following data: 3  
 $E_{\text{H-H}} = 458 \text{ kJ/mol}$ ,  $E_{\text{F-F}} = 155 \text{ kJ/mol}$ ,  $E_{\text{H-F}} = 565 \text{ kJ/mol}$ ,  $\chi_p(\text{F}) = 4.0$
4. (a) Nitrogen is more electronegative than phosphorus but the electron affinity of phosphorus is more than that of Nitrogen — Explain. 2  
 (b) Explain the sequence of ionization energies. 3  
 $\text{kJmol}^{-1}$ : Cu (746), Zn (906), Ga (579)  
 (c) Calculate the electronegativity of As atom ( $Z = 33$ ) in the Allred-Rochow Scale having covalent radius 1.21 Å. 2  
 (d) Write the IUPAC names of the elements with atomic numbers 190 and 107. 1

### Unit-III

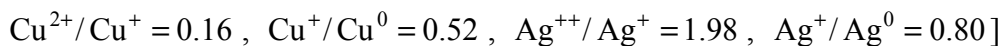
5. (a) Write Wayland-Drago equation and explain the terms involved in it. What is the utility of this equation? 1+2  
 (b) Predict the binding modes of CNS<sup>-</sup> with reasons in the following complex ions. 2  
 $[\text{Co}(\text{NH}_3)_5(\text{CNS})]^{2-}$  and  $[\text{Co}(\text{CN})_5(\text{CNS})]^{3-}$   
 (c) Can you develop a pH-like scale in liquid ammonia? What will be the span of that scale? 2  
 Given:  $K_{\text{H}_2\text{O}} = 10^{-14}$  at 25°C  
 $K_{\text{NH}_3} = 10^{-33}$  at -50°C  
 (d) Give the order of acidity of the following and rationalize the trend: 3  
 $[\text{Na}(\text{H}_2\text{O})_x]^+$ ,  $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$ ,  $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$ ,  $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$
6. (a) SO<sub>2</sub> can act both as a Lewis acid and as a Lewis base. Explain with suitable examples. 2  
 (b) Predict the direction of the following equilibria with explanation. 2  
 (i)  $2\text{CH}_3\text{MgF} + \text{HgF}_2 \rightleftharpoons (\text{CH}_3)_2\text{Hg} + 2\text{MgF}_2$   
 (ii)  $\text{BF}_3\text{H}^- + \text{BH}_3\text{F}^- \rightleftharpoons \text{BF}_4^- + \text{BH}_4^-$   
 (c) Addition of SbF<sub>5</sub> enhances the acidity of pure HF while the addition of NaF reduces its acidity — Explain. 2  
 (d) The B–F bond length in BF<sub>3</sub> is 130 pm. How will this bond length change in adducts H<sub>3</sub>NBF<sub>3</sub> and Me<sub>3</sub>NBF<sub>3</sub>? Justify your answer. 2  
 (e) What happens when bismuth nitride and ammonium chloride are allowed to react in liquid ammonia? 2

Unit-IV

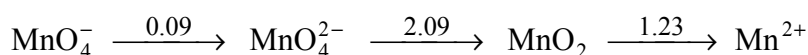
7. (a) Indicate the direction in which the following reactions spontaneously and assign them with appropriate name. 4



[  $E^0$  in Volt :



- (b) From the following standard reduction diagram calculate the  $E^0$  for  $\text{MnO}_4^-/\text{Mn}^{2+}$  redox system and hence its formal potential at pH = 4. 3

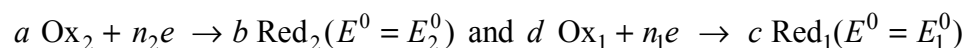


- (c) Balance the following redox reaction by ion electron method: 2

Oxidation of  $\text{Mn}^{2+}(\text{aq})$  to  $\text{MnO}_4^-$  by sodium bismuthate in nitric acid medium.

- (d) Explain the separation of group II cations in qualitative analysis by solubility product principle and common ion effect. 2

8. (a) Show that for two general redox couples: 4



the overall reaction:  $n_2 c \text{Red}_1 + n_1 a \text{Ox}_2 = n_2 d \text{Ox}_1 + n_1 b \text{Red}_2$  has the equilibrium constant  $K_{\text{eq}}$  where  $\log K_{\text{eq}} = (E_2^0 - E_1^0)/(0.059/n_1 n_2)$ .

- (b) Solutions containing cupric ions readily oxidize potassium iodide to iodine though  $E_{\text{Red}}^0$  of the  $\text{Cu}^{2+}/\text{Cu}^+$  system (- 0.15 V) is lower than that of the  $\text{I}_2/\text{I}^-$  system (0.54). — Explain. ( $K_{\text{sp}}$  of  $\text{CuI} = 10^{-12}$ ). 3

- (c) What is disproportionation reaction? Give an example. 2

- (d) Apply solubility product principle and common ion effect in separation of group IIIB metal sulphides in qualitative analysis. 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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