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 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 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 6*s* electron of Hg moving with a speed nearly $1/6^{th}$ that of light. Velocity of light $= 3.0\times10^8$ 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) $IE_1(Cu_{29}) < IE_1(Zn_{30}) > IE_1(Ga_{31})$

   (ii) $IE_1(Au_{79}) < IE_1(Hg_{80}) > IE_1(Tl_{81})$

(c) Calculate the electronegativity of hydrogen from the following data: 3

$E_{H\text{-}H} = 458$ kJ/mol , $E_{F\text{-}F} = 155$ kJ/mol , $E_{H\text{-}F} = 565$ kJ/mol , $\chi_p(F) = 4.0$

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

$kJmol^{-1}$: 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- with reasons in the following complex ions. 2

$[Co(NH_3)_5(CNS)]^{2-}$ and $[Co(CN)_5(CNS)]^{3-}$

(c) Can you develop a pH-like scale in liquid ammonia? What will be the span of that scale? 2

Given: $K_{H_2O} = 10^{-14}$ at 25°C

$K_{NH_3} = 10^{-33}$ at -50°C

(d) Give the order of acidity of the following and rationalize the trend: 3

$[Na(H_2O)_x]^+$, $[Fe(H_2O)_6]^{3+}$, $[A1(H_2O)_6]^{3+}$, $[Fe(H_2O)_6]^{2+}$

6. (a) SO_2 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) $2CH_3MgF + HgF_2 \rightleftharpoons (CH_3)_2Hg + 2MgF_2$

(ii) $BF_3H^- + BH_3F^- \rightleftharpoons BF_4^- + BH_4^-$

(c) Addition of SbF_5 enhances the acidity of pure HF while the addition of NaF reduces its acidity — Explain. 2

(d) The B–F bond length in BF_3 is 130 pm. How will this bond length change in adducts H_3NBF_3 and Me_3NBF_3? 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

(i) $Cu^{+} + Cu^{+} = Cu^{2+} + Cu^{0}$

(ii) $Ag^{+} + Ag^{+} = Ag^{++} + Ag^{0}$

[E^0 in Volt :

$Cu^{2+}/Cu^{+} = 0.16$, $Cu^{+}/Cu^{0} = 0.52$, $Ag^{++}/Ag^{+} = 1.98$, $Ag^{+}/Ag^{0} = 0.80$]

(b) From the following standard reduction diagram calculate the E^0 for MnO_4^-/Mn^{2+} redox system and hence its formal potential at $pH = 4$. 3

$$MnO_4^- \xrightarrow{0.09} MnO_4^{2-} \xrightarrow{2.09} MnO_2 \xrightarrow{1.23} Mn^{2+}$$

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

Oxidation of $Mn^{2+}(aq)$ to 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

$a\ Ox_2 + n_2e \rightarrow b\ Red_2 (E^0 = E_2^0)$ and $d\ Ox_1 + n_1e \rightarrow c\ Red_1 (E^0 = E_1^0)$

the overall reaction: $n_2c\ Red_1 + n_1a\ Ox_2 = n_2d\ Ox_1 + n_1b\ Red_2$ has the equilibrium constant K_{eq} where $\log K_{eq} = (E_2^0 - E_1^0)/(0.059/n_1 n_2)$.

(b) Solutions containing cupric ions readily oxidize potassium iodide to iodine though E_{Red}^0 of the Cu^{2+}/Cu^{+} system (– 0.15 V) is lower than that of the I_2/I^- system (0.54). — Explain. (K_{sp} of $CuI = 10^{-12}$). 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.*

——×——