WEST BENGAL STATE UNIVERSITY

B.Sc. Honours 2nd Semester Examination, 2020

CEMACOR03T-CHEMISTRY (CC3)

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) Write down possible arrangements of electrons in p^3 configuration and identify the arrangement with maximum exchange energy. 2

(b) What electronic transition in He^+ spectrum would have the same wavelength as the first Lyman transition of hydrogen? 3

(c) How do the shapes of s and p orbitals can be obtained from angular function? Give reasons. 3

(d) Show that frequency of revolution of an electron in Bohr orbit (quantum number n) is given by the expression 3

$$\nu_{orb} = (4\pi^2 m z^2 e^4)/n^3 h^3$$

(Terms have their usual meaning)

Hence show that the frequency ν of the emitted radiation for transition from n_1 to n_2, $(n_1 - n_2) = 1$ is intermediate between the frequencies of orbital revolution in these two orbits.

2. (a) Give the radial wave-function of the 3s hydrogenic orbital. How many radial nodes are there? 2+1

(b) The velocity of an electron is 2×10^8 cm/sec. Calculate its wave length. 2

(c) Stage the limitations of Aufbau principle with necessary illustrations. 3

(d) Find out the spectroscopic ground state term symbols for $Ti^{[illegible]}$ and $Co^{[illegible]}$ ions. 3

Unit-II

3. (a) After calcium, electrons enter the 4s orbital before going to the 3d-orbitals, but when a transition metal ionizes, the 4s electrons are removed first. Why? 3

(b) The electron affinity of Au is abnormally high and it may exist as auride — Justify. 2

(c) Using Pauling's method, calculate the radii of K^+ and Cl^- ions. The observed K^+–Cl^- distance in KCl crystal is 314 pm. 3

4. (a) Calculate Z* for the following electrons in a Scandium atom — 3
   (i) 3p (ii) 3d (iii) 4s

   (b) Explain the variation of the second IE (kJ/mole) of the elements given in the parenthesis: Mg (1450), Al (1817), Si (1576), P (1903), S (2251), Cl (2297). — 3

   (c) The atomic radii of Zr and Hf are almost identical — Explain. — 2

Unit-III

5. (a) State solvent-system concept of acids and bases. Give one example of each of an acid and a base in liquid ammonia as solvent. — 3

   (b) Why acidity in aqueous medium increases in the sequence — 2
   $$CH_4 < NH_3 < H_2O < HF?$$

   (c) Why do Ca, Al and Ni exist in nature respectively as carbonate, oxide and sulphide? — 3

   (d) $SnCl_2$ can act both as a Lewis acid and a Lewis base. Explain. — 2

6. (a) What will be the order of acidity of H_3PO_4, H_3PO_3 and H_3PO_2? Give reasons. — 3

   (b) State the theory by which the reaction — 2
   $$6CaO + P_4O_{10} \rightarrow 2Ca_3(PO_4)_2$$ may be regarded as acid-base reaction.

   (c) A buffer solution contains 0.10 mole of CH_3COOH and 0.10 mole of CH_3COO^- per litre. Calculate the pH of the buffer. [$Ka = 1.8 \times 10^{-5}$] — 3

   (d) Arrange the given ions in order of increasing acidity in aqueous medium with justification. — 2
   $$[Ni(H_2O)_6]^{2+},\ [Fe(H_2O)_6]^{3+},\ [Al(H_2O)_6]^{3+} \text{ and } [Mn(H_2O)_6]^{2+}$$

Unit-IV

7. (a) Balance the following equation by Ion-electron Method — 2
   $$Br_2 + NaOH \rightarrow NaBrO_3 + NaBr + H_2O$$

   (b) According to reduction potential value of Cu^{2+}/Cu^{+} $(E^0 = +0.15V)$ and $\frac{1}{2} I_2/I^-$ $(E^0 = +0.54V)$ system, Cu^{2+} should not oxidize I^-. Explain how can iodometric titration of Cu^+ be possible. [$K_{s(CuI)} \approx 1 \times 10^{-2}$ at 25°C] — 3

   (c) For a redox reaction — 3
   $$MnO_4^- + 5Fe^{2+} + 8H^+ \rightleftharpoons Mn^{2+} + 5Fe^{3+} + 4H_2O$$
   Calculate the equilibrium constant value
   (Given $E^0_{MnO_4^-/Mn^{2+}} = +1.52$ volt, $E^0_{Fe^{3+}/Fe^{2+}} = +0.77$ volt)

   (d) The solubility of AgCl is 0.0015 g dm^{-3}. Calculate its solubility product. — 3

8. (a) What are the characteristics of redox indicators? Give one example of a redox indicator. — 2+1

   (b) Give reason why Cl^- ion is oxidized to Cl_2 by $KMnO_4$ Solution at low pH. — 2
   (Given $E^0_{MnO_4^-/Mn^{2+}} = +1.52$ volt, $E^0_{\frac{1}{2}Cl_2/Cl^-} = +1.36$ volt)

(c) What are disproportionation and comproportionation reactions? Give one example of each. 2+1

(d) From the following Latimer diagram 3

$$Sn^{4+} \xrightarrow[+0.15\text{V}]{} Sn^{2+} \xrightarrow[-0.136\text{V}]{} Sn$$

(i) Calculate the reduction potential of the reaction $Sn^{4+} \rightarrow Sn$.

(ii) Comment on the case of reduction of Sn^{2+} to Sn and Sn^{4+} to Sn.

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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