WEST BENGAL STATE UNIVERSITY

B.Sc. Honours 2nd Semester Examination, 2019

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) Energy of an excited electron of He^+ ion is –6.04 eV. Calculate the angular momentum of that excited electron from Bohr's theory. 4

   [Given: Energy of 1st Bohr Orbit of Hydrogen $= -21.8\times10^{-19}$ J, $1\text{eV} = 1.6\times10^{-19}$ J, $h = 6.6203\times10^{-34}$ Js]

   (b) Calculate the wave length of spectral line when the electron jumps from the third to the second Bohr orbit in a hydrogen atom. 4

   [Given: Rydberg constant = 109677 cm^{-1}]

   (c) Using p^2 electronic configuration determine number of microstates. Write symbol of Ground state. 3

2. (a) Frame an equation for the energy of an electron revolving in a circular path around hydrogen atom. 4

   (b) Calculate the Principal quantum number where the electron is revolving in a H-atom, when its kinetic energy is 217.945×10^{-20} J. 2

   [Given: E_1 for $H = -871.78\times10^{-20}$ J]

   (c) Which set of orbitals is defined by the quantum numbers $n = 3$ and $l = 2$? How many orbitals will be there? 2

   (d) Find out the spectroscopic ground state term symbols for Cu^{2+} and Cr^{2+} ions. 3

Unit-II

3. (a) The ionisation potential of neon is 21.56 eV while that of the next element, sodium is only 5.14 eV. — Explain. 2

   (b) The atomic radii of Zr and Hf are almost same — Explain. 3

   (c) Which of the following reactions should proceed spontaneously in the gas phase? Explain with reason. 3

   (i) $Xe + He^+ \longrightarrow Xe^+ + He$

   (ii) $Si + Cl^+ \longrightarrow Si^+ + Cl$

   (iii) $F^- + I \longrightarrow F + I^-$

4. (a) Explain when third ionization energy (IE_3) of Mg (7732.8 kJ/mole) is about ten times higher than that of first ionization energy (IE_1, 737.7 kJ/mole). 3

(b) The second electron attachment enthalpy of oxygen is positive — yet it forms most compounds in – 2 oxidation state — Justify. 3

(c) $PbCl_4$ is very unstable and oxidising — Why? 2

Unit-III

5. (a) What is meant by buffer solution? Give an example of an acidic and a basic buffer solution. 2+2=4

(b) State Bronsted-Lowry concept of acids and bases. Write down the conjugate acid/base of the following: 2+2=4

H_2CO_3, SO_4^{2-}, NH_4^+ and CH_3COOH

(c) What are super acids? Give one example. 2

6. (a) Name the indicator you would select for the titration of aqueous solutions of Na_2CO_3 and H_2SO_4. Give reason in brief. 3

(b) Calculate the pH of an aqueous solution of ammonium acetate at 25°C. [Given: Dissociation constant of acetic acid, $K_a = 1.78 \times 10^{-5}$ and that of ammonium hydroxide is 1.8×10^{-5}.] 4

(c) Explain solvent levelling and differentiating effects. 3

Unit-IV

7. (a) Balance the following equations by ion-electron method: 2+2=4

(i) $NaBiO_3 + Mn(NO_3)_2 + HNO_3 \longrightarrow Bi(NO_3)_2 + NaNO_3 + H_2O + NaMnO_4$

(ii) $K_2Cr_2O_7 + KI + HCl \longrightarrow CrCl_3 + KCl + I_2 + H_2O$

(b) E^0 of Ce^{4+}/Ce^{3+} couple is 1.44 V. Find E at equivalence point in the titration of 0.1 N Fe^{2+} by 0.1 N Ce^{4+} in 1M acid medium (E^0 for Fe^{3+}/Fe^{2+} couple = 0.77 V). 3

(c) Calculate the solubility of CaF_2 in solutions of 4

(i) 10^{-3} M $Ca(NO_3)_2$ (ii) 10^{-1} M NaF [$K_s = 1.7 \times 10^{-10}$].

8. (a) Establish the Nernst equation for the couple VO_3^-/VO^{2+}. If the E^0 value for the couple in 1M acid medium at 25°C be 0.92 volt, calculate its formal potential at pH 7. 1+2=3

(b) From the reduction potentials of the following sequences of reactions predict whether MnO_4^- or MnO_4^{2-} is the better oxidant if the reduction product is Mn^{2+}. 2

$$MnO_4^- \xrightarrow{0.56\ \text{Volt}} MnO_4^{2-} \xrightarrow{2.26\ \text{Volt}} MnO_2 \xrightarrow{0.95\ \text{Volt}} Mn^{3+} \xrightarrow{1.51\ \text{Volt}} Mn^{2+}$$

(c) Cu^{2+} is unstable in aqueous medium and undergoes disproportionation reaction. — Explain. [Given: $E^0_{Cu^{2+}/Cu^+} = 0.15$ V, $E^0_{Cu^{2+}/Cu^0} = 0.34$ V] 3

(d) Discuss the solubility product principle. Explain how this principle is utilised in the precipitation of Gr-IIIB (Co^{++}, Ni^{++}, Mn^{++} and Zn^{++}) cations as sulphides in qualitative analysis. 3

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