



বিদ্যাসাগর বিশ্ববিদ্যালয়
VIDYASAGAR UNIVERSITY
Question Paper

B.Sc. Honours Examination 2023

(Under CBCS Pattern)

Semester — II

Subject : CHEMISTRY

Paper : C-3T

(Inorganic Chemistry—I)

Full Marks : 40

Time : 2 hours

*Candidates are required to give their answers
in their own words as far as practicable.*

The figures in the margin indicate full marks.

Answer from **all** the Groups as directed.

GROUP—A

1. Answer **any five** questions from the following :

2×5=10

- (a) How many radial nodes and nodal planes
do 4d and 5f orbitals each have?

(2)

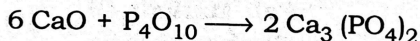
(b) Calculate the pH of 10^{-9} (M) NaOH solution.

(c) Why is the disproportionation of ClO^\ominus favoured in presence of Ag^+ ?

(d) Show that $e^{\alpha x}$ is an eigenfunction of the operator d^n/dx^n . What is the eigenvalue?

(e) The stabilisation of a half-filled d -subshell is even more pronounced than that of the p -subshell. Why?

(f) State the theory by which the reaction



may be regarded as an acid-base reaction.

(g) Ge(II) compounds are reducing agents, while Pb(IV) compounds are oxidising agents. Explain.

(h) State the role of NH_4HF_2 in the titration of Fe(II) ion with $\text{K}_2\text{Cr}_2\text{O}_7$.

(3)

GROUP—B

Answer any **four** questions from the following :

5×4=20

2. (a) When an excited nucleus decays, it emits a γ -ray. The lifetime of an excited state of a nucleus is of the order of 10^{-12} s. What is the uncertainty in the energy of the γ -ray produced? 3

- (b) The solubility product (K_{sp}) of MgF_2 is 7×10^{-10} . Find its solubility in 0.01 (M) NaF solution. 2

3. (a) Draw the acid-base neutralisation curve for CH_3COOH vs $NaOH$. Name the suitable indicator in this titration. 2

- (b) Calculate the electronegativity of Bromine (Br) in Mulliken's scale and hence, find out the electronegativity of Br in Pauling's scale.

Given : IE (Br) = $272.3 \text{ kcal mol}^{-1}$

EA (Br) = $77.7 \text{ kcal mol}^{-1}$

1 eV per atom = $23.06 \text{ kcal mol}^{-1}$ 3

(4)

4. (a) Draw the curves indicated below for the 3S-orbitals of hydrogenic systems. 3

(i) $R(r)$ vs r

(ii) $R(r)^2$ vs r

(iii) $4\pi r^2 R(r)^2$ vs r

- (b) Calculate the potential of the cell : 2

$\text{Zn}/\text{ZnCl}_2(\text{aq})(1.5 \text{ M}) \mid \text{AgCl(s)}/\text{Ag}$ at 25°C

Given : $E^\circ_{\text{Zn}^{2+}/\text{Zn}} = -0.76 \text{ V}$; $E^\circ_{\text{AgCl(s)}/\text{Ag}} = 0.24 \text{ V}$

5. (a) Give the order of acidity of the following and rationalize the trend : 2

$[\text{Na}(\text{H}_2\text{O})_x]^+$; $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$; $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$;
 $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$

- (b) By using the Slater's rule, calculate the first ionisation energy of Be atom. 3

6. (a) Write down the Schrödinger wave equation in Hamiltonian operator form in Cartesian coordinates. What is the significance of Hamiltonian operator? 3

- (b) What is auride ion? Why is it formed? 2

(5)

7. (a) Calculate the solubility product of $\text{Cu}(\text{OH})_2$ from the following data : 3

$$E^\circ_{\text{Cu}^{2+}/\text{Cu}} = 0.337 \text{ V} ; E^\circ_{\text{Cu}(\text{OH})_2/\text{Cu}, \text{OH}^-} = -0.224 \text{ V}$$

- (b) Why are the atomic radii of Zirconium (Zr) and Hafnium (Hf) almost same? 2

GROUP—C

Answer *any one* question from the following :

$$10 \times 1 = 10$$

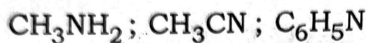
8. (a) What are the differences between ionisation potential and electrode potential of a metal? 2

- (b) A line in the Lyman series of hydrogen has a wavelength of $1.03 \times 10^{-7} \text{ m}$. Find the original energy level of the electron. 2

- (c) Using Slater's rules, determine Z^* for a 4f electron of Praseodymium (Pr) [$Z = 59$]. 2

(6)

- (d) Arrange the following in order of increasing basicity and explain : 2



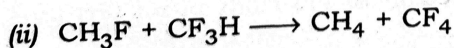
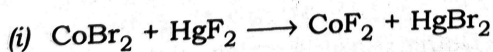
- (e) Deduce the ground state term symbol for Co^{2+} ion ($Z = 27$). 2

9. (a) Calculate the kinetic energy of an electron that has a de Broglie wavelength of 200 pm. 2

- (b) Calculate the potential of the solution at the equivalence point and at the $\pm 1\%$ stages of the equivalence point in the titration of 100 ml of 0.1 (N) Fe^{2+} with 0.1 (N) KMnO_4 in 1 (M) H_2SO_4 at 25 °C. 3

Given : $E^\circ_{\text{Fe}^{3+}/\text{Fe}^{2+}} = 0.77 \text{ V}$; $E^\circ_{\text{MnO}_4^-/\text{Mn}^{2+}} = 1.51 \text{ V}$

- (c) Justify the directions of the following reactions : 2



(7)

(d) In group IIIA for precipitation of Fe^{3+} , Al^{3+} , Cr^{3+} mixture of NH_4Cl + NH_4OH is used but not NaOH . Explain. 2

(e) Write down the structure of the oxidised form of BDS indicator. 1

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