

U.G. 3rd Semester Examination - 2024**CHEMISTRY****[MAJOR]****Course Code : CHEM-MAT-03****Group : IB (Inorganic & Physical)****[NEP-2020]****Full Marks : 40****Time : $2\frac{1}{2}$ Hours***The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.***GROUP-A****(Inorganic-IB)****[Marks : 20]**

1. Answer any one from the following questions:

 $1 \times 1 = 1$

- a) Why does silver nitrate solution turns bluish when copper rod is placed in it?
- b) What is buffer action? Explain with an example.

2. Answer any two from the following questions :

 $2 \times 2 = 4$

- a) Write down the name and structural formula of an acid-base indicator.
- b) Disproportionation of white P in NaOH solution – explain briefly.
- c) In presence of EDTA, Cu^{+2} cannot liberate I_2 from KI – explain.

[Turn over]

3. Answer any one from the following questions:

5×1=5

- a) i) A solution of potassium ferricyanide cannot oxidise iodide to iodine but it can do so in presence of Zn^{2+} ion – explain.

[Given: $\text{Fe}(\text{CN})_6^{3-}/\text{Fe}(\text{CN})_6^{4-} = +0.36$ volts;

$\frac{1}{2}\text{I}_2/\text{I}^- = 0.54$ volts.

- ii) Account for the following order of oxidising power $\text{VO}_2^+ < \text{Cr}_2\text{O}_7^{2-} < \text{MnO}_4^-$.

3+2=5

- b) i) Comment on relative acid strength of the following pairs:

$[\text{Co}(\text{H}_2\text{O})_6]^{2+}$, $[\text{Co}(\text{H}_2\text{O})_6]^{3+}$ and H_3PO_2 , H_3PO_4 .

- ii) Boric acid behaves as a Lewis acid rather than a Bronsted acid in aqueous solution – explain.

4+1=5

4. Answer any one from the following questions:

10×1=10

- a) i) What are hard and soft acids and bases? State their characteristics.

- ii) What do you mean by Common ion effect? Explain with an example.

- iii) Justify that alkali metals do not survive in aqueous solution but in liq NH_3 .

4+4+2=10

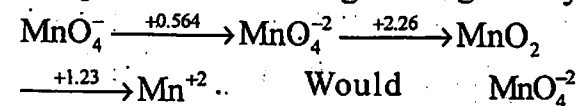
- b) i) A buffer solution contains 0.10 mole of CH_3COOH and 0.10 mole of CH_3COO^- per litre. Calculate the pH of the solution after the addition of 0.01 mole/lit of HCl .

[Given: $K_{\text{CH}_3\text{COOH}} = 1.8 \times 10^{-5}$].

- ii) Write a brief note on super acid.

- iii) Distinguish between formal and standard potential of redox couple.

- iv) The partial Latimer diagram is given by



disproportionate in solution?

2+2+4+2=10

GROUP-B
(Physical-IB)

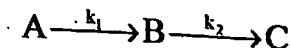
[Marks : 20]

1. Answer any one question: $1 \times 1 = 1$
- a) Write down the unit of rate constant of 2nd order reaction.
- b) Define entropy.
2. Answer any two questions: $2 \times 2 = 4$
- a) Define Inversion temperature.
- b) Show that for a first order reaction, the time required for decomposition of any fraction is constant.
- c) For a reaction with a rate law of $\text{Rate} = K[A]^2[B]$, if the concentration of A is doubled and the concentration of B is halved, by what factor does the rate of the reaction change?
3. Answer any one question: $5 \times 1 = 5$
- a) i) A first order reaction has a specific reaction rate of 10^{-2} sec^{-1} . How much will it take for 20g of reactant to reduce to 5 g ?

- ii) The rate of a reaction quadruples when temperature changes from 28°C to 57°C . Calculate the energy of activation.

$$2\frac{1}{2} + 2\frac{1}{2} = 5$$

- b) i) What is Clausius inequality? Give the expression for reversible and irreversible process.
- ii) What is Helmholtz free energy? $3 + 2 = 5$
4. Answer any one question: $10 \times 1 = 10$
- a) i) Derive the relation for the efficiency of a Carnot engine with diagram.
- ii) A Carnot engine operates between two temperature reservoirs at 600 K and 300 K. If the engine absorbs 200 J of heat from the high temperature reservoir, calculate: 1) The efficiency of the engine. 2) The work done by the engine.
- iii) How does entropy and enthalpy determine the spontaneity of a process? $4 + 4 + 2 = 10$
- b) i) Derive the rate equation for a consecutive reaction mechanism:



Discuss the conditions under which [B] reaches a maximum.

- ii) The turnover number of the enzyme fumarase that catalyzes the reaction,

$\text{Fumarate} + \text{H}_2\text{O} \longrightarrow \text{L-malate}$
is $2.5 \times 10^3 \text{ s}^{-1}$ and $K_m = 4.0 \times 10^{-6} \text{ mol/L}$.
Calculate the rate of conversion of fumarate to L-malate if the fumarase concentration is $1.0 \times 10^{-6} \text{ mol/L}$ and the fumarate concentration is $2.04 \times 10^{-4} \text{ mol/L}$.

- iii) Using the Lindemann mechanism, calculate the overall rate constant for a unimolecular reaction in the high-pressure limit.

$$4+3+3=10$$
