

## U.G. 3rd Semester Examination - 2024

## CHEMISTRY

[MAJOR]

Course Code : CHEM-MAT-03

Group : IB (Inorganic &amp; 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,  $\text{Cu}^{+2}$  cannot liberate  $\text{I}_2$  from KI – explain.

[Turn over]



3. Answer any **one** from the following questions:

$$5 \times 1 = 5$$

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

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

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

- 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  $\text{H}_3\text{PO}_2$ ,  $\text{H}_3\text{PO}_4$ .

- 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:

$$10 \times 1 = 10$$

- 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  $\text{NH}_3$ .

$$4 + 4 + 2 = 10$$

- b) i) A buffer solution contains 0.10 mole of  $\text{CH}_3\text{COOH}$  and 0.10 mole of  $\text{CH}_3\text{COO}^-$  per litre. Calculate the pH of the solution after the addition of 0.01 mole/ lit of  $\text{HCl}$ .

[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  
 $\text{MnO}_4^- \xrightarrow{+0.564} \text{MnO}_4^{2-} \xrightarrow{+2.26} \text{MnO}_2$   
 $\xrightarrow{+1.23} \text{Mn}^{+2}$ . Would  $\text{MnO}_4^{2-}$  disproportionate in solution?

$$2 + 2 + 4 + 2 = 10$$

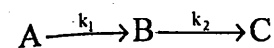
**GROUP-B**  
**(Physical-IB)**  
**[Marks : 20]**

1. Answer any **one** question: 1×1=1
  - a) Write down the unit of rate constant of 2nd order reaction.
  - b) Define entropy.
2. Answer any **two** questions: 2×2=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: 5×1=5
  - a) i) A first order reaction has a specific reaction rate of  $10^{-2} \text{ sec}^{-1}$ . 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  $28^\circ\text{C}$  to  $57^\circ\text{C}$ . 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?  $3+2=5$
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4. Answer any **one** question: 10×1=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.

$$4+3+3=10$$

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