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: $1\times1=1$

   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 : $2\times2=4$

   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.

3. Answer any **one** from the following questions: $5\times1=5$

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

$\frac{1}{2}I_2/I^-=0.54$ volts.

ii) Account for the following order of oxidising power $VO_2^+ < Cr_2O_7^{2-} < MnO_4^-$. $3+2=5$

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

$[Co(H_2O)_6]^{2+}$, $[Co(H_2O)_6]^{3+}$ 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: $10\times1=10$

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 $CH_3COO^{\ominus}$ per litre. Calculate the pH of the solution after the addition of 0.01 mole/ lit of HCl.

[Given : $K_{CH_3COOH}=1.8\times10^{-5}$].

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 $MnO_4^- \xrightarrow{+0.564} MnO_4^{-2} \xrightarrow{+2.26} MnO_2 \xrightarrow{+1.23} Mn^{+2}$. Would MnO_4^{-2} disproportionate in solution? $2+2+4+2=10$

GROUP-B

(Physical-IB)

[Marks : 20]

1. Answer any **one** question: $1\times1=1$

   a) Write down the unit of rate constant of 2nd order reaction.

   b) Define entropy.

2. Answer any **two** questions: $2\times2=4$

   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 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: $5\times1=5$

   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 quadrupoles 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: $10\times1=10$

   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:

$$A \xrightarrow{k_1} B \xrightarrow{k_2} C$$

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

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

$$\text{Fumarate} + H_2O \longrightarrow \text{L-malate}$$

is $2.5\times10^3\ S^{-1}$ and K_m, $= 4.0\times10^{-6}$ mol/L. Calculate the rate of conversion of fumarate to L-malate if the fumarase concentration is 1.0×10^{-6} mol/L and the fumarate concentration is 2.04×10^{-4} 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