U.G. 2nd Semester Examination - 2022

CHEMISTRY

[HONOURS]

Course Code : CHEM-H-CC-T-03

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

1. Answer any **one** from the following questions: 1×1=1

   a) Write down the structure of a redox indicator.

   b) What is common ion effect?

2. Answer any **two** from the following questions: 2×2=4

   a) Calculate the oxidation number of Cr in CrO_5 and O in F_2O.

   b) Write down the Nernst equation for MnO^{4-} / Mn^{2+} system.

   c) What is super acid? Give example.

   d) Does metallic copper dissolve in HCl? Give reason. $\left[E^0_{Cu^{2+}/Cu^+} = 0.4V\right]$

3. Answer any **one** from the following questions: 5×1=5

   a) i) Explain why Cu^{2+} ion readily liberates iodine from iodide but in presence of ethylenediamine it does not.

   $\left[E^0_{Cu^{2+}/Cu^+} = 0.15V,\ E^0_{1/2}\ I_2/I^- = 0.54V\right]$

   ii) What will be the solubility of AgCl in a solution of 0.1(M) NaCl solution? (K_{sp} of AgCl = 1×10^{-10})

   iii) Define standard hydrogen electrode. 2+2+1=5

   b) i) 100 ml of buffer solution of pH = 9 is to be prepared by mixing 0.1 (N) HCl and 0.1 (N) NH_4OH. Calculate the volume of each solution required to prepare the buffer ($K_b = 2\times10^{-5}$).

   ii) Calculate the pH of 0.1 (M) CH_3COONa solution. (Given $K_a = 1.8\times10^{-5}$). 3+2=5

4. Answer any **one** from the following questions: $10\times1=10$

a) i) Show that the equilibrium constant (K) of a redox reaction is given by the equation $\log K = n/0.0591\left(E_1^0 - E_2^0\right)$

ii) Draw the Frost Diagram for mercury in acid solution from the given Latimer diagram.:

$$Hg^{2+} \xrightarrow{0.911V} Hg_2^{2+} \xrightarrow{0.796V} Hg$$

Determine the slope of each line and comment on the tendency of any of the species to undergo disproportionation.

iii) Explain the role of Zimmermann-Reinhardt solution during the titration of Fe^{2+} *vs* MnO^{4-} in HCl medium.

$3+(1+1+3)+2=10$

b) i) What do you mean by buffer capacity? Show that the buffer capacity is maximum at the half-neutralization point and then prove that for an acidic buffer, pH at the half-neutralization point is equal to pKa.

ii) What is the condition of precipitation of a salt from a solution?

iii) Derive the Henderson equation for the calculation of pOH of a basic buffer.

iv) State and explain the Ostwald dilution law.

$(1+2+1)+2+2+2=10$

GROUP-B

5. Answer any **one** question from the following: $1\times1=1$

a) What is meant by the efficiency of a heat engine?

b) What is temperature co-efficient of reaction?

6. Answer any **two** questions from the following: $2\times2=4$

a) Show that $(\partial A/\partial V)T = p$ and $(\partial A/\partial T)V = -S$.

b) Why is the half-life for a first-order reaction independent of the initial concentration?

c) "Entropy of the universe is always increasing." Comment on this.

d) How does rate of a reaction vary with temperature?

7. Answer any **one** question from the following: $5\times1=5$

a) Derive the Gibbs-Helmholtz equation for a process at constant pressure and constant

volume. What does the Clausius Inequality signify in thermodynamics? 4+1=5

b) "Two Carnot engines working between the same temperature domains have the same efficiency."—Explain. Write the importance of Joule-Thomson co-efficient. Prove that this co-efficient is zero for an ideal gas.

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

c) Write three important features of homogeneous catalysis. What is Lineweaver-Burk plot in enzyme catalysis? What is acid-base catalyst?

2+2+1=5

8. Answer any **one** question from the following:

10×1=10

a) i) Discuss the primary kinetic salt effect with a suitable example.

ii) Discuss Mechanism and Kinetics of Enzyme-catalyzed Reactions.

iii) The boiling point of water at a pressure of 50 atmospheres is 265ºC. Assume the temperature of the sink to be 35ºC in this case. Calculate theoretical efficiency of a steam engine operating under these temperatures. 3+5+2=10

b) i) The 50% of a first-order reaction is complete in 23 minutes. Calculate k and the time required to complete 90% of this reaction.

ii) Briefly discuss the collision theory for a bimolecular reaction.

iii) Explain the equivalence of Kelvin–Planck and Clausius's statements.

(1+2)+3+4=10

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