RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FIRST SEMESTER EXAMINATION, MARCH 2021

FIRST YEAR [BATCH 2020-23]

Date : 26/03/2021

INDUSTRIAL CHEMISTRY (HONOURS)

Time : 11 am - 1 pm

Paper : II [CC 2]

Full Marks : 50

Answer **any five** questions: [10× 5]

Given Constants: F = 96484.56 coul mole^{-1} , T = (273.15 + 25) K, R = 8.31441 joule mole^{-1}K^{-1}

1. a) What is rate of a reaction? What is its unit?

   b) What is rate constant? What is the unit of rate constant for nth order reaction?

   c) What is order of a reaction? Give an example of fractional order reaction.

   d) What is molecularity of a reaction? [2+3+3+2]

2. a) What is pseudo unimolecular reaction?

   b) Show that the specific reaction rate of a pseudo unimolecular reaction follows first order kinetics.

   c) A reaction is found to be zero order. Will its molecularity be zero? Write down the Arrhenius equation. Explain the each term.

   d) Is a first order or a second order reaction completed? [2+3+(1+2)+2]

3. a) At 25◦C the half-life period for the decomposition of N_2O_5 is 5.7 hr. and is independent of the initial pressure of N_2O_5. Calculate (i) the specific rate constant (ii) the time required to go to 90% completion.

   b) Calculate the cell potential and free energy available for the following electrochemical systems:

   i) Ag (*s*)| Ag1+ (*aq* 1.0 M) || Cu2+ (*aq* 1.0 M) | Cu(*s*)

   Given: E_{anode} = 0.7996 volt, $E_{cathode}$ = 0.3402 volt

   ii) Cu(*s*) | Cu2+ (*aq* 0.1 M) || Ag1+ (*aq* 0.1 M) | Ag (*s*)

   c) Explain with reason which of the above cells can act as Voltaic Cell and Electrolytic Cell. [5+(2+2)+1]

4. a) Briefly describe the principle of conductometric titration.

   b) Illustrate with example how conductometric titration can be used to determine the end-point of titration of *Strong Acid with a Strong Base, Strong Acid with a Weak Base and Weak Acid with a Strong Base*

   c) Define Molar conductivity of a substance and describe how weak and strong electrolytes' molar conductivity changes with concentration of solute. How is such change explained?

   d) Calculate the Equilibrium constant for the reaction:

$$Fe(s) + Cd^{2+}(aq) \rightleftharpoons Fe^{2+}(aq) + Cd(s)$$

$$(\text{Given}: E^{\circ}_{Cd^{2+}|Cd} = -0.40\,V,\ E^{\circ}_{Fe^{2+}|Fe} - 0.44\,V).$$

[2+3+3+2]

5. a) Write down four main differences between thermal and photochemical reactions.

   b) State Lambert–Beer law and derive the expression between absorbance and concentration of the medium.

   c) Define molar extinction coefficient.

   d) Explain the Photochemical decomposition of Hydrogen Iodide and determine the quantum yield of the reaction.

   e) Give an example of a naturally occurring Photo-sensitized reaction. [2+2+1+4+1]

6. a) Distinguish between 'state function' and 'path function' with example. Explain why 'Adiabatic work' is a 'state function'.

   b) Derive the expression for efficiency of a Carnot cycle. Involving ideal gas as the working substance.

   c) Categorize the following properties of a thermodynamic system extensive or intensive? Specific heat capacity, internal energy, molar volume & chemical potential. [3+3+4]

7. a) State “Zeroth law” of thermodynamics. From this derive the idea of “empirical temperature”.

   b) Write down the operational principle of a “Carnot engine” with a schematic indicator diagram

   c) Heat capacity at constant pressure is greater than heat capacity at constant volume. Why? [3+4+3]

8. a) Entropy of a system cannot be negative, justify.

   b) Prove that for an ideal gas adiabatic slope is steeper than isothermal for P vs. V diagram.

   c) Isothermal reversible work of expansion for an ideal gas is greater than that for an irreversible process between the same initial and final state – Explain. [3+3+4]

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