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**St. Aloysius College (Autonomous)**

**Mangaluru**

**SEMESTER I- P.G. Examination – M.Sc. Analytical Chemistry**

**November/December-2023**

**INORGANIC CHEMISTRY**

**Time: 3 Hrs**

**Max. Marks: 70**

**PART – A**

1. Answer any **FIVE** sub-divisions of the following **(5x2= 10)**

- a. Write the resonance structures for Ozone and show its formal charges?
- b. Give the geometry of  $\text{ClF}_3$  molecule using VSEPR theory and justify the geometry.
- c. Among  $\text{AsH}_3$  and  $\text{H}_2\text{Se}$ , which is a strong acid? Why?
- d. Among  $\text{SbH}_2^-$  and  $\text{TeH}^-$ , which is stronger base? Why?
- e. Draw the structure of the ortho isomer of dicarboclosodecacarborane( $\text{C}_2\text{B}_{10}\text{H}_{12}$ )
- f. In the following equations  $\text{Na}_2\text{O}$  is a Usanovich base and  $\text{Sb}_2\text{S}_5$  is Usanovich acid. Justify  
$$\text{Na}_2\text{O} + \text{SO}_3 \rightarrow 2\text{Na} + \text{SO}_4^{2-}$$
$$3(\text{NH}_4)_2\text{S} + \text{Sb}_2\text{S}_5 \rightarrow 6\text{NH}_4^+ + 2\text{SbS}_4^{3-}$$
- g. Give reason: Lewis acid strength of  $\text{BBR}_3$  is greater than  $\text{BCl}_3$  and  $\text{BF}_3$ .
- h. What is Wij's reagent? Mention its significance.

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**PART – B**

Answer any **FIVE** of the following choosing at least one **(5x12= 60)**  
full question from each unit

**UNIT-I**

2. a. Explain the significance of the following:  
i) Hund's rule      ii) Pauli's exclusion principle. **(4)**
- b. State and explain Fajan's rules. Identify the most covalent and most ionic alkali metal halides. **(4)**
- c. Explain the Molecular orbital description of CO molecule. **(4)**
3. a. Write a short note on the following.  
i) Slater's rules    ii) London forces **(4)**
- b. Sketch the structures of crystal lattices of CsCl and Rutile and explain their salient features. **(4)**
- c. Construct the molecular orbital energy level diagram for  $\text{N}_2$  molecule and predict its bond order and magnetic property. **(4)**

## UNIT-II

4. a. With illustrative examples, explain levelling and differentiating solvents. (4)  
b. Write a note on Super acids based on arsenic and antimony. (4)  
c. Explain the terms: i) Lux-Flood Theory ii) Symbiosis (4)
5. a. Discuss briefly the reactions in anhydrous Sulphuric acid. (4)  
b. Outline the applications of HSAB concept. (4)  
c. Explain the complex formation reactions in liquid ammonia and liquid Sulphur dioxide. (4)

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## UNIT-III

6. a. Calculate the number of framework electrons in (i)  $B_5H_9$  (ii)  $B_5H_{11}$  (iii)  $B_6H_{10}$  (iv)  $B_{10}H_{14}$  (4)  
b. Differentiate between borazine and benzene with respect to their chemical properties. (4)  
c. Discuss the MO theory of B-H-B bonding in boranes. (4)
7. a. Explain the terms: i) Zeolites ii) STYX number (4)  
b. Classify the following carboranes and justify (4)  
(i)  $C_2B_6H_9^-$  (ii)  $C_2B_4H_7^-$  (iii)  $C_2B_2H_7^-$  (iv)  $C_2B_9H_{11}$   
c. What are Silicates? Discuss their Classification. (4)

## UNIT-IV

8. a. Discuss the allotropes of Sulphur in detail. (4)  
b. Describe the structure and properties of  $XY_7$  type of Interhalogen with a suitable example. (4)  
c. Describe the structure and bonding in  $XeO_3$  and list any two of its properties. (4)
9. a. Comment on the stability and acidic strength of oxoacids of halogens. (4)  
b. Explain the structure of Triiodide ion. (4)  
c. Discuss the preparation and applications of Linear Phosphazenes. (4)

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St Aloysius College (Autonomous), Mangaluru

SEMESTER I- P.G Examination – M.Sc. Analytical Chemistry

November/December -2023

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ORGANIC CHEMISTRY

Max. Marks: 70

Time: 3 Hours

**PART-A**

1. Answer any **FIVE** subdivisions of the following (5x2=10)
- What is a polar covalent bond? How does it differ from a nonpolar covalent bond?
  - How does resonance contribute to the stability of certain organic molecules?
  - Write a note on product analysis
  - How do you detect the detection of reaction of intermediates using isotopic labelling technique
  - Describe the E-Z notation and how it helps in determining the configuration of geometrical isomers.
  - Provide an example of a molecule with multiple chiral centers and explain how to determine its overall absolute configuration.
  - Describe the role of the base in the Hofmann-Löffler-Fretag reaction and its significance.
  - Define the Gattermann-Koch reaction and its significance in organic synthesis.

**PART-B**

Answer any **FIVE** of the following choosing at least one full question from each unit: (5x12=60)

**UNIT- I**

- Explain the concept of electronegativity as it applies to covalent bonds. Provide examples of molecules with polar and nonpolar bonds, and discuss how this influence their behavior in different environments. (4)
  - Describe the factors that influence the acidity of organic compounds. Discuss how inductive effect can be used to rationalize the observed trends in acid strength. (4)
  - Discuss the concept of relative basicity in organic chemistry. How can one predict which of two organic compounds is more acidic or basic, and what factors are considered in this prediction? (4)
- Define homo-aromatic and anti-aromatic systems. Provide an example of each and explain why they are classified as such. (4)
  - Explain the concept of tautomerism. Provide examples and discuss the conditions under which tautomeric shifts occur. (4)
  - Define inclusion compounds and discuss their significance in host-guest chemistry. Provide an example of any well-known inclusion compound and explain its structural features. (4)

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**UNIT II**

4. a) Discuss reactivity and detection of free radicals (4)  
 b) Design a synthetic pathway to prepare a carbanion and explain its reactions (4)  
 c) Describe cross-over experiment and product analysis with examples. (4)
5. a) Discuss the stability and structure of carbocation (4)  
 b) Explain the following i) isotopic labelling techniques (4)  
     ii) kinetic studies  
 c) Discuss formation and reactivity of nitrene (4)

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**UNIT III**

6. a) Discuss the importance of conformational analysis of cyclic compounds. (4)  
 b) Choose a complex organic molecule with multiple stereocenters. Using Fischer projections, determine its absolute configuration and discuss the implications of its stereochemistry on its reactivity (4)  
 c) Investigate the effect of conformation on the reactivity of biphenyl compounds in a specific chemical transformation. How to assign the nomenclature for the conformations of biphenyls? (4)
7. a) Examine the role of conformational analysis in understanding the stereochemistry of fused ring systems and spiro systems. Discuss how the arrangement of rings affects the overall structure. (4)  
 b) Explain how the configuration of a molecule can be determined using the Cahn-Ingold-Prelog priority rules. (4)  
 c) Investigate the concept of diastereomers in molecules with multiple chiral centers. Provide examples and analyze the differences in physical and chemical properties between diastereomers and enantiomers (4)

**UNIT IV**

8. a) What are Duff reaction? Give its mechanism (4)  
 b) Explain Stephen reaction and its applications (4)  
 c) Describe the structural elucidation of fructose (4)
9. a) Write a note on deoxy sugar and its synthesis (4)  
 b) Explain the mechanism of Darzen reaction (4)  
 c) Discuss the general reaction mechanism of Chichibabin reaction (4)

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**St Aloysius College (Autonomous), Mangaluru**

**SEMESTER I- P.G Examination – M.Sc. Analytical Chemistry**

**November/December -2023**

**PHYSICAL CHEMISTRY**

Time: 3 Hours

Max. Marks: 70

**PART A**

1. Answer any **FIVE** sub divisions of the following (5x2=10)
- What does the Gibbs-Duhem equation describe in terms of thermodynamics?
  - Write the equation for combined form of first and second law of thermodynamics.
  - Why conventional methods cannot be employed to the study of fast reactions?
  - What is a pseudo-first order rate constant? How do its dimensions differ from those of a second-order rate constant?
  - Give two reactions where acid catalyst is employed.
  - List any two assumptions of BET theory.
  - Give the assumptions of DHO equation.
  - Using the Phase Rule, determine the number of phases present and their composition at the eutectic composition in the zinc-cadmium system.

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**PART B**

Answer any **FIVE** of the following choosing at least one full question from each unit: (5x12=60)

**UNIT-I**

- What is cryoscopy, and how does it work to determine the molecular weight of a solute in a solvent? (4)
  - Explain the concept of free energy and its significance in predicting the spontaneity of chemical processes. (4)
  - Derive any two fundamental equations of Thermodynamics (4)
- Show that Net Entropy change in a Reversible process is Zero (4)
  - Derive Gibbs-Duhem equation and discuss its significance. (4)
  - Deduce an Expression for osmotic pressure (4)

**UNIT-II**

- Obtain the expression for rate constant of reversible reactions which are first order in both directions (4)
  - Discuss the kinetics of branched chain reactions. Obtain the condition for explosion limits. (4)
  - Discuss the Hinshelwood modification of unimolecular theory (4)
- Explain how flow methods are useful to study fast reactions (4)
  - Explain the mechanism of oscillatory reactions with a suitable example. (4)
  - Differentiate between substituent constant and reaction constant (4)

**Contd...2**

**UNIT-III**

6. a. Differentiate between chemisorption and physisorption (4)  
b. Explain how changes in temperature can affect enzyme activity. What happens to enzyme activity at high temperatures, and why? (4)  
c. Discuss the  $E_a$  of Arrhenius & vant Hoff intermediates. (4)
7. a. Differentiate between protolytic and prototropic mechanism of acid catalysis. (4)  
b. How does semiconductor catalysis work. (4)  
c. Derive Michaelis - Menten equation. (4)

**UNIT-IV**

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8. a. Explain ionic Atmosphere, Electrophoretic effect and relaxation time (4)  
b. Derive Debye Huckel Onsagur Equation (4)  
c. What are the Different modifications done to DHLL Equation? (4)
9. a. Explain Phase Rule, Component, Phase and Degrees of Freedom (4)  
b. Detail the different methods used to study three component Systems? (4)  
c. Explain the purpose and construction of triangular phase diagrams in representing three-component systems. Use the water-chloroform-acetic acid system to illustrate the key features and their significance. (4)

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**PRINCIPLES OF ANALYTICAL CHEMISTRY AND SEPARATION  
TECHNIQUES**

Time: 3 Hours

Max. Marks: 70

**PART - A**

1. Answer any **SEVEN** sub-divisions of the following: (7 x 2 = 14)
- Define co-precipitation in gravimetric analysis in one or two sentences.
  - Define the normal error curve (bell curve) and its significance in statistical analysis. How does it relate to the distribution of random errors?
  - What is port-precipitation? How it can affect the accuracy of gravimetric measurements.
  - Name one experimental technique used to determine complex stability constants.
  - What is the role of buffer in complexometric titrations.
  - Provide an example of a specific redox indicator and the type of reaction it's suitable for.
  - How does gas chromatography assist in the detection of illegal drugs in law enforcement and drug testing?
  - What is the connection between IEC and the "puzzle-solving" aspect of chemistry during purification?
  - Mention one industry where HPLC is extensively applied for analytical purposes.

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**PART - B**

Answer any **FOUR** of the following choosing at least (4 x 14 = 56)  
one full question from each unit

**UNIT - I**

- Describe the Q-test and its purpose in identifying outliers or anomalous data points. What criteria are used to decide whether to reject an observation using the Q-test? (4)
  - Explain the term "selective precipitation" and provide an example of a situation where selective precipitation is used for separation and purification. (5)
  - What experiments can be designed to separate metal ions in a solution of mixtures of metals? (5)
- Evaluate the potential sources of errors and the steps taken to ensure accuracy and precision. Suggest improvements if necessary. (4)
  - Explain the methods of sampling of liquids. (5)
  - Compare and contrast the means and standard deviations of two samples. (5)

**UNIT - II**

4. a) How does a weak acid-strong base titration curve differ from a strong acid-strong base titration curve? (4)
- b) Describe the advantages and limitations of EDTA titrations in the context of determining various metal ions in complex matrices. (5)
- c) What is the Nernst equation, and how is it used in potentiometric titration? (5)
5. a) Write a note on applications of acid base titrations. (4)
- b) Derive a typical redox titration curve and explain its different regions. (5)
- c) Explain what conditional formation constants are and how they are used in complexometric titrations to consider the influence of pH on complex stability. (5)

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**UNIT-III**

6. a) How does the choice of stationary phase affect separation in GC? (5)
- b) Explain the principle of HPLC and how it differs from low-pressure column chromatography. What are the advantages of using high pressure in liquid chromatography? (5)
- c) What is a theoretical plate in chromatography, and how does it relate to column efficiency? (4)
7. a) Discuss the importance of measuring and optimizing the ion-exchange capacity for efficient chromatographic separations. (5)
- b) Compare and contrast batch and continuous extraction techniques in terms of their advantages, limitations, and applications in analytical chemistry. (5)
- c) Explain the factors affecting solvent extraction. (4)

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**St Aloysius College (Autonomus)**  
**Mangaluru**

**SEMESTER I –PG Examination –M.Sc. Analytical Chemistry**  
**November/December -2023**  
**RESEARCH METHODOLOGY**

Time: 3 hours

Max.Marks: 70

**PART – A**

1. Answer any **SEVEN** sub-divisions of the following: (7 x 2 = 14)
- Explain the difference between qualitative and quantitative research methods.
  - Explain the importance of formulating a concise and specific research problem statement.
  - Explain the importance of proper labelling and identification of laboratory waste containers.
  - Why is proper ventilation important when handling gases at above atmospheric pressure?
  - Describe one benefit of adhering to publication ethics for researchers and the broader scientific community
  - Explain the nature of moral judgments in a few words.
  - Distinguish between ontological and epistemological aspects of research philosophy?
  - Name one type of hazardous waste that is commonly disposed of through incineration and explain why this method is suitable for such waste.
  - Name two examples of products or objects that can be protected by geographical indication.

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**PART – B**

Answer any **FOUR** of the following choosing at least one (4x14=56)  
full question from each unit:

**UNIT – I**

- What is research strategy? Explain the basis of research strategy. (4)
  - How can you improve your H-index as a researcher? (5)
  - Discuss the role of the literature review in research methodology. How does a comprehensive literature review contribute to the quality and credibility of research findings? (5)
- Write a note on deduction and induction. (4)
  - How can you compare the quality and impact of different e-journals? (5)
  - Compare and contrast the strengths and limitations of using online databases versus physical libraries for gathering research materials. (5)

Contd...2

**UNIT – II**

4. a) Explain the method of land treatment and sanitary landfills for the treatment of hazardous chemical wastes? (5)
- b) Discuss the environmental impact of improper laboratory waste disposal. (4)
- c) Discuss the importance of emergency eyewash and safety shower facilities in laboratories working with hazardous materials, and describe their proper use and maintenance. (5)
5. a) Give some examples for different types of personal protective equipment's (PPE)? Explain the purpose of each of the PPE with appropriate examples. (5)
- b) What are the basic requirements for disposing chemical wastes? (5)
- c) What are some typical emergency scenarios that might arise in a laboratory? (4)

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**UNIT – III**

6. a) How do intellectual property rights impact innovation for sustainable development? Can you give examples of how they can help or hinder progress? (5)
- b) Discuss consequences of text plagiarism with real-world cases. (4)
- c) Present a case study involving a research dilemma, and critically evaluate the ethical principles and considerations that should guide researchers in resolving the dilemma. (5)
7. a) Examine the consequences and factors in patent infringement cases. (5)
- b) Analyze the impact of industrial design protection in industries like fashion and automotive design. (4)
- c) Define data falsification and fabrication in research, and describe the potential consequences of these unethical practices for both researchers and the scientific community (5)

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