FD-305

M.Sc. 1st Semester
Examination, Dec.-Jan., 2021-22

CHEMISTRY

Paper - I

Group Theory and Chemistry of
Metal Complexes

Time : Three Hours] [*Maximum Marks* : 80
[*Minimum Pass Marks* : 16

Note : Answer **all** questions. The figures in the right-hand margin indicate marks.

Unit-I

1. (*a*) Write the postulates of great orthogonality theorem. 6

(*b*) Write down the multiplication table for C_{2v} point group. 8

(*c*) Define proper and improper axes of symmetry with suitable example. 6

OR

(*a*) Explain reducible and irreducible representation. 6

(*b*) Find out point group for the following compounds : 8

(*i*) P-dichlorobenzene

(*ii*) ClF_3

(*iii*) NH_3

(*c*) Write a note on conjugacy relation and classes. 6

Unit-II

2. (*a*) Explain the formation of σ bonds in any octahedral complex using MOT. 6

(*b*) Write chemical reactions of sodium nitropruside. 6

(*c*) Describe molecular configuration of CO molecule as suggested by Coulson. 8

OR

(*a*) Discuss the structure of mononuclear dioxygen complex. 6

(*b*) $Fe(CO)_5$ is known while $[Fe(CO)_6]^{3+}$ is not known. Why ? 6

(*c*) Write the effects of π bonding on the value of Δ_0. 8

Unit-III

3. (*a*) How does chelation affects stability of complexes ? 6

(*b*) Describe the experimental determination of stability constant by spectrophotometric method. 8

(*c*) Explain the types of Isopolytungstate. 6

OR

(*a*) Write a note on properties and uses of aluminosilicates. 6

(*b*) Write a note on synthesis and properties of silicones fluids and silicones rubber. 8

(*c*) Give classification of heteropoly molybdate. 6

Unit-IV

4. (*a*) What are phosphazines ? Discuss nature of bond in triphosphazines. 6

(*b*) What are carboranes ? Write their preparation properties and structure. 8

(*c*) Write a note on Borazines. 6

OR

(*a*) Write Wade's rule to explain the structure of closo, nido and arachno boranes. 6

(*b*) Write a note on heterocatenation. 6

(*c*) What are metal carbonyl culster ? Describe with suitable examples. 8

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Paper - II

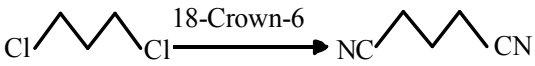
Concepts in Organic Chemistry

Time : Three Hours] [*Maximum Marks* : 80

Note : Answer **all** questions. The figures in the right-hand margin indicate marks.

Unit-I

1. (*a*) Define crown ethers with suitable example. Explain the role of 18-crown-6 in conversion of 1, 3-dichloro propane to 1, 3-dinitrile propane (Glutaronitrile) 10



(*b*) Discuss bonding in Fullerenes. 5

(*c*) Explain the criterion for Homoaromaticity in Tropylium cation $(C_8H_9)+$. 5

OR

(*a*) Explain in detail Aromaticity and Antiaromaticity on the basis of perturbation molecular orbital theory. 12

(*b*) Give brief account on the following : 4×2

(*i*) Cyclodextrins

(*ii*) Catenanes

Unit-II

2. (*a*) What are stereospecific and stereo selective reactions ? Explain them with the help of two examples of each. 8

(*b*) Discuss conformational analysis of 1, 4-disubstituted cyclohexane. Comment on their stability on the basis their energy. 8

(*c*) Explain with suitable example Threo and Erythro isomers. 4

OR

(*a*) Write a Fisher projection, staggered sawhorse and Newmann formulae of threo-2, 3-dichloro-3-phenyl-propanoic acid (Ph — CH — Cl — CH — Cl — COOH). 10

(*b*) Explain asymmetric synthesis with example. 5

(*c*) Discuss the optical activity of biphenyles and allenes. 5

Unit-III

3. (*a*) Discuss the structure and generation of carbocation. Give the order of stability of the following carbocation Ethyl, Benzyl, Tert-butyl, Allyl. 10

(*b*) Explain E2 elimination reaction with suitable example. Discuss effect of substrate and leaving group on E2 elimination. 6

(*c*) Explain Hunsdiecker reaction. 4

OR

(*a*) Why are carbanions considered as reactive intermediates ? Discuss their generation, stability and reactions. 10

(*b*) Explain why singlet carbenes are electrophilic and triplet carbenes are diradical in nature. 6

(*c*) Explain E1cB reaction with mechanism. 4

Unit-IV

4. (*a*) Explain thermal and photo induced [4+2] cyclo-addition reaction. State which is symmetry allowed and which is symmetry forbidden. 8

(*b*) Write notes on the following : 4×3

(*i*) Ene reaction

(*ii*) Suprafacial and Antarafacial shifts

(*iii*) Aza-Cope rearrangement

OR

(*a*) Explain why cis-3, 4-dimethyl cyclo-butene on heating gives cis-trans-2, 4-hexadiene, while on photochemical reaction the product is trans-trans-2, 4-hexadiene. 10

(*b*) Explain the following with suitable example : 5×2

(*i*) Sigmatropic rearrangement

(*ii*) Electrocyclic reaction

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CHEMISTRY

Paper - III

Quantum Chemistry
(Thermodynamics and Chemical Dynamics-I)

Time : Three Hours] [*Maximum Marks* : 80

Note : Answer **all** questions. The figures in the right-hand margin indicate marks.

Unit-I

1. (*a*) Transform the complex number, $z = -3 + 2i$ into polar form. 5

(*b*) If $\vec{r}$ is the radius vector and $\vec{p}$ is the momentum vector and $\vec{L} = i\vec{L}_x + j\vec{L}_y + k\vec{L}_z$ where, $\vec{L}$ is the total angular momentum, then find the values of $\vec{L}_x$, $\vec{L}_y$ and $\vec{L}_z$. 5

(*c*) Give the application of Schrodinger wave equation to find out energy and spherical harmonics of a rigid rotator. 10

OR

(*a*) If $z_1 = 2 - 3i$ and $z_2 = -5 + 2i$, then find the values of $|z_1|$, $|z_2|$ and the arguments of z_1 and z_2. 5

(*b*) Write the postulates of quantum mechanics. Derive time independent equation on the basis of postulates of quantum mechanics. 10

(*c*) Find

$$\int e^{3x} \cos(3x)\, dx$$ 5

Unit-II

2. (*a*) Using Maxwell relations, show that for van der Waal's gas $\frac{\delta Cp}{\delta p} = \frac{2a}{RT^2}$. 10

(*b*) Derive Gibb's-Duhem equation. 5

(*c*) What is Fugacity ? How it vary with pressure ? 5

OR

(*a*) Show that chemical potential of a component in the gaseous mixture is always less than its chemical potential in the pure state. 10

(*b*) Give the method of determination of partial molar volume. 5

(*c*) What is activity ? Discuss activity of an ideal gas and that of a real gas. 5

Unit-III

3. (*a*) Discuss briefly Debye-Huckel theory of strong electrolytes and give Debye-Huckel Onsager equation. 10

(*b*) How the mean activity coefficients of electrolytes can be determined by emf measurement ? 5

(*c*) Calculate the mean activity coefficient of a 0.02 molar aqueous solution of zinc chloride. (Given A = 0.509) 5

OR

(*a*) Derive Lipmann equation. 10

(*b*) Give the brief discussion of Debye-Huckel limiting law. 5

(*c*) Explain Stern model of electrified interface. 5

Unit-IV

4. (*a*) What are consecutive reactions ? Give the kinetics of consecutive reactions and explain transient equilibrium and secular equilibrium of reactions. 10

(*b*) What is Salt effect ? Explain the salt effect involved in catalytic reactions ? 5

(*c*) Give the application of steady state kinetics to the thermal reaction between hydrogen and bromine. 5

OR

(*a*) What are the postulates of transition state theory ? Derive Eyring equation on the basis of transition state theory. 10

(*b*) Discuss integral and differential methods of determining rate law. 5

(*c*) Write a note on Belousov-Zhabotinsky reaction. 5

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Paper - IV

Theory and Application of Spectroscopy

Time : Three Hours] [*Maximum Marks* : 80

Note : Answer **all** questions. All parts of answer of each question should be written in one place. Be precise and to the point in your answer. All questions carry equal marks.

Unit-I

1. (*a*) Explain intensity of spectral lines.

(*b*) Explain factor affecting line width.

OR

(*a*) Explain interaction of IR radiation with vibrating molecules.

(*b*) Explain interaction of microwave radiation with rotating molecules.

Unit-II

2. (*a*) Classify rotating molecules on the basis of moment of inertia.

(*b*) Explain interaction of microwave radiation with linear, symmetric top, assymetric top and spherical top molecules.

OR

(*a*) Show that microwave spectra are observed at constant spacing.

(*b*) Rotational constant of $H^{35}Cl$ is 10.5909 cm^{-1}. Calculate rotational constants for $H^{37}Cl$.

Unit-III

3. Explain theory and application of electron diffraction spectroscopy.

OR

Describe principle and application of Turbidimetry.

Unit-IV

4. (*a*) How will you explain different lines of rotating molecules by colliding microwave radiations ?

(*b*) Explain Raman activity of symmetric top and spherical top molecules.

OR

(*a*) How will you explain rotational vibrational Raman spectroscopy ?

(*b*) Explain Raman activity of H_2 and H_2O molecules.

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