

**NORTH MAHARASHTRA UNIVERSITY,  
JALGAON**



**FACULTY OF SCIENCE**

**SYLLABUS FOR  
M.Sc. Part-1  
(Chemistry)  
SEMESTER-I and II**

**To Be Implemented From  
Academic Year 2017-18**

**NORTH MAHARASHTRA UNIVERSITY, JALGAON**

**M.Sc. (Part-I) Chemistry**  
**Semester I and II**  
**Syllabus w.e.f. 2017-2018**

**SEMESTER – I**

CH-110:- Physical Chemistry – I

CH- 130:- Inorganic Chemistry – I

CH- 150:- Basic Organic Chemistry

CH-P-1:- Physical Chemistry Practical (Annual)

CH-I-1:- Inorganic Chemistry Practical (Annual)

CH-O-1:- Organic Chemistry Practical (Annual)

**SEMESTER – II**

CH-210:- Physical Chemistry – II

CH- 230:- Inorganic Chemistry – II

CH-250:- Name Reactions, Synthetic Organic Chemistry & Spectroscopy

CH-290:- General Chemistry

**Practical Courses (Annual)**

**Course Title Semester Periods Marks**

CH-P-1:-Physical Chemistry Practical Annual 60:40Pattern

CH-O-1:- Organic Chemistry Practical Annual 60:40, Pattern

CH-I-1:-Inorganic Chemistry Practical Annual 60:40, Pattern

**Note:**

1. There are in all three theory courses for first semester, four theory courses for second semester and three annual practical courses.
  2. The marks for each paper are distributed as external (60 marks) and internal (40 marks) examinations. For internal assessment of each theory course 02 written test will be taken of 15 marks and seminar or home assignment of 10 marks.
  3. Each theory course to be completed in 60 lectures of 60 min duration each.
  4. Practical courses to be conducted during the whole year. The examination of practical courses will be conducted only once, at the end of academic year (annually). Each practical course will carry 100 Marks out of which 20 Marks will be allotted for internal assessment and University Examination will be conducted for 80 Marks.
  5. Each practical course is having weightage Six Hours per week. The annual examination for the practical courses CH-P-1, CH-I-1, CH-O-1 will be held at the end of semester II. The internal examination of 40 Marks for practical courses will be held before the annual practical examination.
- A student will not be permitted to appear at the practical examination unless he / she produce a certified journal. If the journal is lost, the student should produce a certificate from Head of the department / Head of the Institution stating that he / she has satisfactorily completed the practical work.

**Rules for personal safety:**

- 1) For eye protection, safety goggles must be worn in the laboratory at all times. If the student wears contact lenses, full protection goggles, which provide total seal around eyes, must be worn. All students are expected to wear safety goggles.
- 2) A long sleeved, knee length laboratory coat is recommended. Long pants and closed toed shoes must be worn for individual safety. Loose clothing, open style shoes and sandals are prohibited. Long hair must be tied up. Each student will have to get his / her own necessary protection items.
- 3) Prior to the practical examination, the teacher-in-charge will check all protective equipment to ensure that they are in order.
- 4) Pipetting by mouth should be avoided. Use of pro-pipette bulbs is recommended.
- 5) All laboratories should be equipped with safety chart, adequate first aid requirements and fire extinguishers.

**M. Sc. Part-I (60:40 Pattern) - Physical Chemistry Syllabus.****SEM - I CH-110****1. QUANTUM CHEMISTRY (22 L)**

Recapitulation of Quantum Chemistry, Schrodinger equation (time independent, derivation expected), wave function, its interpretation and properties, eigenfunctions and eigenvalues, Schrodinger equation in eigenvalue form, normalization, orthogonality and orthonormality of wavefunction. Operators: algebra of operators, commutative property, linear operators, Hermitian operator and its theorems, linear momentum, kinetic energy and total energy operators, postulates of quantum mechanics, free particle, particle in one, two and three dimensional box, wavefunction and probability density plots, degeneracy, simple harmonic oscillator, energy eigenvalues,  $\Psi$  and  $\Psi^2$  plots, even and odd functions, rigid rotator, spherical polar coordinates, separation of variables, energy eigenvalues, LCAO-MO,  $H_2^+$  molecular ion, HMO theory and its application to ethylene and butadiene.

Ref. 8, 9, 10, 11 and 12

**2. NUCLEAR AND RADIATION CHEMISTRY (20 L)**

Parent-daughter decay-growth relationships: daughter nucleus stable, general expression for activity of daughter, parent shorter and longer lived than daughter, parent and daughter of nearly the same half life, secular and transient equilibrium. Applications of radioactivity: Szilard - Chalmer's reaction, Isotope dilution and neutron activation analysis.

Elements of radiation chemistry: primary effects of interaction of radiation with matter, LET, Bremsstrahlung. Interaction of gamma radiation with matter: photoelectric effect, Compton scattering and pair production, units of measuring radiation absorption. Radiation dosimetry: units of dose, Fricke and Ceric sulphate dosimeters, conversion of measured dose values.

Ref: 7 and 12

**3. ELECTROCHEMISTRY (10 L)**

Strong electrolytes, ionic strength, activity and activity coefficients of strong electrolytes, Debye-Huckel theory of conductivity (mathematical derivations not expected), ionic atmosphere, relaxation and electrophoretic effects, DHO equation (mathematical derivation not expected),

its validity and deviations, Debye-Huckel theory of activity coefficients: Debye-Huckel limiting law (derivation expected), its testing and deviations. Transport number: definition and its relation to ionic mobility, Moving boundary and Hittorf's theoretical and experimental method.

Ref: 2, 3, 5, 6 and 12

#### **4. ADSORPTION**

**(08L)**

Adsorption, Adsorption of gases by solid, Types of adsorption isotherm, Langmuir adsorption isotherm (derivation expected), BET theory, derivation of BET equation and its application to determine surface area of adsorbent, derivation of Gibbs adsorption isotherm.

Ref.: 2, 3, 5, 12

### **SEM -II CH-210**

#### **1. THERMODYNAMICS**

**(17 L)**

State functions, exact and inexact differentials, test of exactness, internal energy change in terms of internal pressure and  $C_v$ , change in internal energy at constant pressure, expansion coefficient, temperature dependence of enthalpy, isothermal compressibility. Joule-Thomson effect: J-T experiment, J-T coefficient, inversion temperature, difference between heat capacities. Thermodynamic description of mixtures: partial molar quantities, Gibbs-Duhem equation, determination of partial molar volume by intercept and slope methods, chemical potential, thermodynamics of mixing of gases.

**Colligative properties of solutions:** Depression in freezing point, elevation in boiling point, Solubility (Non colligative property), Osmotic pressure (Explanation on the basis of chemical potential). Third law of thermodynamics, determination of absolute entropies for solids, liquids and gases, residual entropies.

Ref. : 1, 2, 3, 6 and 13

#### **2. STATISTICAL THERMODYNAMICS**

**(8 L)**

Concept of Boltzmann Ensemble, Thermodynamic probability, Stirling approximation, Boltzmann distribution law, partition function and its significance, energy and entropy in terms of partition function, separation of partition functions, translational partition function, translation energy and entropy from it, rotational partition function, rotational energy and entropy from it, vibrational partition function, vibrational energy and entropy from it.

Ref.: 1, 2, 3, 5, 6 and 13

#### **3. CHEMICAL KINETICS**

**(15 L)**

Rate of reaction- rate, rate law, rate constant, reaction order, Accounting for the rate laws: reactions approaching equilibrium, consecutive elementary reactions, rate determining steps, steady state approximation, pre-equilibria, Michaelis-Menten mechanism, Lindemann-Hinshelwood mechanism, chain reactions, rate laws of chain reactions, explosions. Polymerization kinetics: chain and stepwise polymerization and their rate laws, chain length and average number of units in each chain.

Molecular reaction dynamics: Diffusion controlled reactions, activated complex theory, Eyring equation, thermodynamic aspects, Hammett and Taft equation.

Fast reactions: Flash photolysis, flow methods, relaxation methods and magnetic resonance methods.

Ref: 1, 2, 3 and 13

#### 4. MOLECULAR SPECTROSCOPY

(20 L)

**Infrared spectroscopy:** Simple harmonic oscillator, vibrational spectra of diatomic molecules, anharmonic oscillator, diatomic vibrating rotator, vibration-rotation spectrum of diatomic molecule applying Born-Oppenheimer approximation, vibration-rotation spectra of linear polyatomic molecules and symmetric top molecules, influence of nuclear spin, breakdown of Born-Oppenheimer approximation, vibrations of polyatomic molecules, fundamental vibrations and infrared activity.

**Raman spectroscopy:** Rayleigh and Raman scattering, quantum and classical theories of Raman effect, pure rotational Raman spectra of linear and symmetric top molecules, Raman activity of vibrations, rule of mutual exclusion, vibrational Raman spectra, and rotational fine structure

**Electronic spectroscopy:** Electronic vibrational spectra, intensity of vibrational-electronic spectra, Franck-Condon principle, rotational fine structure, Fortrat diagram, dissociation energy, pre-dissociation.

**Mossbauer spectroscopy:** Introduction and application

Ref: 2, 4 and 13

#### REFERENCE

1. Physical Chemistry 5th or 6th edition  
P. W. Atkins, J. D. Paula, Oxford University Press
2. Physical Chemistry 2nd Edition  
K. J. Laidler, J. H. Meiser (CBS Publications)
3. Principles of Physical Chemistry, 41st Millennium edition  
Sharma, Puri and Pathaniya
4. Fundamentals of Molecular Spectroscopy, 4th edition  
C. N. Banwell and McCash, Tata Mac-Graw Hill
5. Principles of Physical Chemistry, 4th edition  
S. H. Maron and C.F. Prutton, Oxford and IBH Publishing Co.
6. Thermodynamics for Chemists  
S. Glasstone
7. Essentials of Nuclear Chemistry, 4th edition  
H. J. Arnikar
8. Quantum Chemistry  
R. K. Prasad, New Age International
9. Physical Chemistry: A molecular approach  
Donald, McQuarrie, J. D. Simon Viva books
10. Quantum Chemistry  
Donald, McQuarrie
11. Quantum Chemistry  
Levine
12. Physical Chemistry, Shree Book Co.  
Dr. L. S. Patil
13. Physical Chemistry - II, Shree Book Co. Dr. L. S. Patil

### Skeleton for question paper

CH-110 (Physical Chemistry-I) and CH-210 (Physical Chemistry-II)

**Time allowed: 03 Hrs**

**Marks 60**

Course	Periods	Marks	Marks with Option
CH-110	60	60	90
CH-210	60	60	90

### Marking Scheme (Internal Exam of 40 Marks)

Two internal Tests of 15 marks each : 30 Marks

Seminar / Home Assignment : 05 Marks

Attendance and Behavior : 05 Marks

-----  
**Total : 40 Marks**

### M. Sc (I) Semester I

#### Subject Physical Chemistry (CH-110)

Chapter	Lectures	Total Marks	Total Marks with internal options
Quantum	22	22	32
Nuclear Chemistry	20	20	30
Electrochemistry	10	10	16
Adsorption	08	08	12
<b>Total</b>	<b>60</b>	<b>60</b>	<b>90</b>

Chapter	Q1	Q2	Q3	Q4	Q5	Total Marks with internal options
Quantum	6	8	8	4	6	32
Nuclear Chemistry	4	8	8	4	6	30
Electrochemistry	4	4	4	4	--	16
Adsorption	2	--	--	4	6	12
<b>Total</b>	<b>16</b>	<b>20</b>	<b>20</b>	<b>16</b>	<b>18</b>	<b>90</b>

Question	Compulsory Marks
1	12
2	12
3	12
4	12
5	12
<b>Total</b>	<b>60</b>

**Question paper pattern  
(New Syllabus from June 17)**

**M.Sc (I) semester I  
Physical Chemistry(CH-110)**

**Q1) Attempt any Six of the following.** **12**

- i) Quantum
- ii) Nuclear
- iii) Electrochemistry
- iv) Adsorption
- v) Quantum
- vi) Quantum
- vii) Nuclear
- viii) Electrochemistry

**Q2) A) Attempt any Two of the following.** **08**

- i) Quantum
- ii) Nuclear
- iii) Electrochemistry

**B) Solve any One of the following** **04**

- i) Quantum
- ii) Nuclear

**Q3) A) Attempt any Two of the following.** **08**

- i) Quantum
- ii) Nuclear
- iii) Electrochemistry

**B) Solve any One of the following** **04**

- i) Quantum
- ii) Nuclear

**Q4) A) Attempt any Two of the following.** **08**

- i) Quantum
- ii) Nuclear

iii) Adsorption

**B) Solve the following**

**04**

i) Electrochemistry

**Q5) A) Attempt any Two of the following.**

**12**

i) Quantum

ii) Nuclear

iii) Adsorption

-----

**M.Sc (I) Semester II**

**Subject Physical Chemistry (CH-210)**

Chapter	Lectures	Total Marks	Total Marks with internal options
Thermodynamics	17	16	24
Statistical Thermodynamics	08	08	12
Chemical Kinetics	15	16	24
Molecular Spectroscopy	20	20	30
<b>Total</b>	<b>60</b>	<b>60</b>	<b>90</b>

Chapter	Q1	Q2	Q3	Q4	Q5	Total Marks with internal options
Thermodynamics	6	8	--	4	6	24
Statistical Thermodynamics	4	4	--	4	--	12
Chemical Kinetics	2	4	8	4	6	24
Molecular Spectroscopy	4	4	12	4	6	30
<b>Total</b>	<b>16</b>	<b>20</b>	<b>20</b>	<b>16</b>	<b>18</b>	<b>90</b>

Question	Compulsory Marks
<b>1</b>	12
<b>2</b>	12
<b>3</b>	12
<b>4</b>	12
<b>5</b>	12



**Question Paper pattern**  
**(New Syllabus w e f from June 17)**  
**M.Sc (I) Semester II**  
**Physical Chemistry(CH-210)**

<b>Q1) Attempt any Six of the following.</b>	<b>12</b>
i) Thermodynamics	
ii) Statistical Thermodynamics	
iii) Chemical Kinetics	
iv) Molecular Spectroscopy	
v) Thermodynamics	
vi) Thermodynamics	
vii) Molecular Spectroscopy	
viii) Statistical Thermodynamics	
<b>Q2) A) Attempt any Two of the following.</b>	<b>08</b>
i) Thermodynamics	
ii) Chemical Kinetics	
iii) Molecular Spectroscopy	
<b>B) Solve any One of the following</b>	<b>04</b>
i) Thermodynamics	
ii) Statistical Thermodynamics	
<b>Q3) A) Attempt any Two of the following.</b>	<b>08</b>
i) ) Molecular Spectroscopy	
ii) Chemical Kinetics	
iii) Molecular Spectroscopy	
<b>B) Solve any One of the following</b>	<b>04</b>
i) Chemical Kinetics	
ii) Molecular Spectroscopy	
<b>Q4) A) Attempt any Two of the following.</b>	<b>08</b>
i) Thermodynamics	
ii) Statistical Thermodynamics	
iii) Molecular Spectroscopy	
<b>B) Solve the following</b>	<b>04</b>
i) Chemical Kinetics	
<b>Q5) A) Attempt any Two of the following.</b>	<b>12</b>
i) Thermodynamics	
ii) Chemical Kinetics	
iii) Molecular Spectroscopy	

---

**Suggested as per old pattern**

<b>Q 1) A) Attempt any Three of the following.</b>	<b>15</b>
i)	
ii)	
iii)	
iv)	
v)	
vi)	
<b>Q 2) A) Attempt any Two of the following.</b>	<b>10</b>
i)	
ii)	
iii)	
<b>B) Problem</b>	<b>05</b>
<b>Q 3) A) Attempt any Two of the following.</b>	<b>10</b>
i)	
ii)	
iii)	
<b>B) Problem</b>	<b>05</b>
<b>Q 4) A) Attempt any Two of the following.</b>	<b>10</b>
i)	
ii)	
iii)	
<b>B) Problem</b>	<b>05</b>

-----

**M. Sc. - Chemistry (Part- I) Physical Chemistry Practical CH-P-1**

The student should perform minimum of **09** experiments from each Semester that is 18 experiments annually. It is expected to perform at least one experiment from each technique.

**SEM -I (INSTRUMENTAL)**

**Conductometry:-**

- 1) Determine the conductance of strong electrolyte (KCl/ NaCl/ AgNO<sub>3</sub>/HCl) at various concentrations and verify the applicability of DHO equation.
- 2) Determination of degree of hydrolysis and hydrolysis constant of sodium acetate conductometrically.
- 3) Determine the amount of trichloroacetic acid, monochloroacetic acid and acetic acid in the given solution by conductometric titration against sodium hydroxide solution.

**Potentiometry:-**

- 1) To determine the stability constant of a complex ion  $[\text{Ag}_2(\text{S}_2\text{O}_3)]^{-3}$  potentiometrically.
- 2) To determine standard free energy change  $\Delta G^0$  and equilibrium constant for the reaction  $\text{Cu} + 2\text{Ag}^+ = \text{Cu}^{+2} + 2\text{Ag}$  Potentiometrically.

**pH -metry:-**

- 1) Determination of Hammett constant of a given substituted benzoic acid by pH measurements.
- 2) To determine the amount of aspirin in the given tablet.

**Colorimetry/ Spectrophotometry:-**

- 1) To determine pKa and Ka of given indicator by colorimetry/ spectrophotometry.
- 2) To determine the empirical formula of Ferric salicylate complex by Job's method and verify by slope ratio method.

**Surface Chemistry:**

- 1) To determine the critical micelle concentration of soap by surface tension by drop number method.

**(NON INSTRUMENTAL)****Chemical kinetics:-**

- 1) To determine the rate constant for depolymerization of diacetone alcohol catalyzed by sodium hydroxide using dilatometer.
- 2) To determine the order of the reaction between potassium persulphate and potassium iodide by fractional change method.

**Non instrumental:-**

- 1) Determine the transport number of  $\text{H}^+$  and  $\text{Cl}^-$  ions by moving boundary method.
- 2) To obtain solubility curve for liquid say water-acetic acid-chloroform system
- 3) Investigate the adsorption of acetic acid in aqueous solution by using activated charcoal and verify Freundlich's adsorption isotherm

**SEM -II (INSTRUMENTAL)****Conductometry:-**

- 1) Study the second order velocity constant of hydrolysis of ethyl acetate by sodium hydroxide using conductance measurement.

- 2) Determination of critical micellar concentration (CMC) of sodium lauryl sulphate from the measurement of conductivities at different concentrations.

#### **Potentiometry:-**

- 1) To determine the amount of each halide in a mixture of halides containing
  - a) KI and KBr/KCl or b) KI/KBr and KCl Potentiometrically.
- 2) To titrate ferrous ammonium sulphate solution with potassium dichromate solution potentiometrically using bimetallic electrode pair.

#### **pH -Metry:-**

- 1) To determine acidic and basic dissociation constants of an amino acid and hence the iso-electric point of the acid.
- 2) To determine the three dissociation constants of polybasic acid such as  $\text{H}_3\text{PO}_4$  by pH measurements.

#### **Colorimetry/ Spectrophotometry:-**

- 1) Determination of iron in water using a colorimeter.
- 2) Simultaneous determination of  $\text{Cr}_2\text{O}_7^{2-}$  and  $\text{MnO}_4^-$  ions or  $\text{Co}^{2+}$  and  $\text{Ni}^{2+}$  in the solution by Spectrophotometry.
- 3) Record the UV spectrum of Benzene, Pyridine and Pyrimidine in methanol. Compare and discuss the various transition involved in terms of MO theory.

#### **Polarimetry:-**

- 1) Polarimetric determination of the specific rotation of camphor in benzene and carbon tetrachloride.
- 2) Determine the percentage of two optically active substances (d-glucose and d-tartaric acid) in a mixture polarimetrically.

### **(NON INSTRUMENTAL)**

#### **Chemical kinetics:-**

- 1) To investigate the kinetics of iodination of acetone.
- 2) To determine energy of activation of the hydrolysis of methyl acetate in presence of hydrochloric acid (Calculations and graphs expected from excel programming).

#### **Non instrumental:-**

- 1) Determination of partial molar volume of ethanol in dilute aqueous solutions.
- 2) To study the effect of addition of an electrolyte (KCl /NaCl / $\text{NH}_4\text{Cl}$  /  $\text{Na}_2\text{SO}_4$ /  $\text{K}_2\text{SO}_4$ ) on solubility of an organic acid(benzoic acid or salicylic acid).

**References:-**

- 1) Findley's Practical Physical Chemistry (9th edition), Edited By B.P.Levitt, Longman group Ltd.
- 2) Systematic Experimental Physical Chemistry (3rd edition), By S.W.Rajbhoj and Dr. T.K.Chondekar, Anjali Publication, Aurangabad.
- 3) Experimental physical Chemistry, By V.D.Athawale P.Mathur New age International Ltd, New Delhi.
- 3) Advanced Practical Physical Chemistry, 19th edition or latest edition, By J.B.Yadav, Goel Publishing House, Meerut
- 4) Advanced Practicals in Physical Chemistry (4th revised edition or latest 13<sup>th</sup> Edition). By Dr.Pande, Dr.Mrs. Datar Dr.Mrs. Bhadane, Manali Publication, Pune.
- 6) University Practical Chemistry By P.C.Kamboj Vishal Publishing Co. Jalandhar, Panjab.
- 7) Practical Physical Chemistry, A.M. James and F.F. Prichard, Longman Group Ltd.

---

**Practical Marking Scheme (Internal Exam. of 40 marks)**

One experiment	:	30 Marks
Oral	:	05 Marks
General Behavior and Attendance	:	05 Marks

---

**Total: 40 Marks****Practical Marking Scheme (University External Exam of 60 Marks)**

One experiment	:	40 Marks
Certified Journal	:	10 Marks
Oral	:	10 Marks

---

**Total: 60 Marks**

## INORGANIC CHEMISTRY-I (CH- 130)(60:40 Pattern)

### CHAPTER -1: Molecular Orbital Theory: - (L16, M-24)

Molecular term symbol for homonuclear diatomic molecules  $H_2, B_2, C_2, N_2, O_2$  and  $F_2$  molecules  
Linear tri-atomic molecules –  $BeH_2, CO_2$ . Trigonal planar molecule-  $BF_3$ , Tetrahedral Molecule –  $CH_4$ , Trigonal pyramidal molecule  $NH_3$ , Angular Tri-atomic molecules  $H_2O, NO_2$ . MOT as applied to octahedral complexes.

Ref 6: - Relevant pages.

### CHAPTER -2: Organometallic compounds of transition metals:- (L-14, M-21)

The 18 electron rule, Molecule orbital theory and 18 electron rule, Counting electrons in complexes. Alkyl & aryl complexes, Alkene complexes, Allyl and butadiene complexes, Complexes containing delocalized cyclic systems, carbenes (alkylidene) and carbene (alkylidyne) complexes, Organometallic compounds in homogeneous catalysis.

Ref 1, 2, 4, 5,8,10 - Relevant pages.

### CHAPTER -3: Molecular symmetry:- (L-16, M-24)

Symmetry elements and operations, Symmetry planes, reflections, inversion centre, proper / improper axes of rotation, equivalent symmetry elements and atoms, symmetry elements and optical isomerism, Classification of point groups and procedure to determine the point group, with at least one example of each point group.

Ref: - 3, 5, 7, 9 - Relevant pages.

### CHAPTER -4: Transition Metal Carbonyls and Related Compounds (L-14, M-21)

Introduction, The preparation and properties of transition metal carbonyls, The structure of transition metal carbonyls, Carbonyl hydrides, Carbonylate anions and cations, Carbonyl halides, Phosphine and Phosphorous trihalide complexes, Dinitrogen complexes, Nitric oxide complexes, Cyano complexes.

Ref.2: Relevant pages.

### References:-

- 1) Inorganic Chemistry Principles of Structures and Reactivity, 4th edition;  
James E. Huheey, Ellen A. Keiter, Richard L. Keiter.
- 2) Inorganic chemistry, 3rd edition Alan G. Sharpe.
- 3) Chemical Applications of Group Theory, F.A. Cotton.
- 4) Inorganic Chemistry, Fourth Edition; Shriver & Atkins Intern.student edition.

- 5) Principles of Inorganic Chemistry; Late B.R. Puri, L.R. Sharma & K.C. Kalia.
- 6) Electrons and Chemical bonding By H.B. Gray.
- 7) Group Theory and its Chemical applications, P.K. Bhattacharya, Himalaya Publishing House.
- 8) Advance Inorganic Chemistry , Cotton &Wilkinson.
- 9) Concept and Applications of Group Theory, Dr. KishorArora, Anmol Publication Pvt.Ltd., New Delhi.
- 10) Modern Inorganic Chemistry by William L.Jolly, 2nd edition, Tata McGraw Hill Co.

**Skeleton for question paper**

**CH - 130 (Inorganic Chemistry-I)**

**Time Allowed: – 3 hours. Marks: - 60**

<b>Periods</b>	<b>Marks</b>	<b>Marks with Option</b>
<b>60</b>	<b>60</b>	<b>90</b>

**Questions:–There are total three questions.**

**1. Answer any four of the following:**

**(16)**

- a)
- b)
- c)
- d)
- e)
- f)

**2. Attempt any four of the following:**

**(20)**

a)

b)

c)

d)

e)

f)

**3. Answer any four of the following:**

**(24)**

a)

b)

c)

d)

e)

f)



## INORGANIC CHEMISTRY – SEM -II (CH- 230)(60:40 Pattern)

### CHAPTER -1: Reaction mechanism in transition metal complexes:- (P-10,M-15)

Ligand substitution reaction, The classification of mechanism, The substitution of square planar complexes, the nucleophilicity of entering group, the shape of activated 18 complexes, K1 pathway, Substitution in Octahedral complexes, Rate law and their interpretation.

Ref 1,5,6,15 - Relevant pages

### CHAPTER -2: The Ionic bond:- (P-12,M-16)

Structures of ionic solids, radius ratio rules, calculation of limiting radius ratio Values of coordination no.3, 4, 6, close packing, classification of ionic structures – Ionic compounds of the type AX (ZnS, NaCl, CsCl), Ionic compounds of the type AX<sub>2</sub> (CaF<sub>2</sub>, TiO<sub>2</sub>, SiO<sub>2</sub>) ; Layer structures (CdI<sub>2</sub>, [NiAs]) Structures containing polyatomic ions. Lattice energy. The Born - Haber cycle, Applications of lattice energetics.

Ref :-2,3,6 - Relevant pages

### CHAPTER -3: Catalysis:- (P-12,M-16)

Catalysis, Description of catalyst, Properties of catalyst, Homogeneous catalyst, Catalytic steps, Hydrogenation of alkenes, Hydroformylation, Monsanto acetic acid synthesis, Wacker oxidation of alkenes, Alkene polymerization, Heterogeneous catalysis, Nature of heterogeneous catalyst.

Ref-1,5,6. - Relevant pages.

### CHAPTER -4: Spectra:- (P-14,M-21)

Energy levels in an atom, coupling of orbital angular momenta, coupling of spin angular momenta, spin orbit coupling. Determining the ground state terms – Hund's rule, Hole formulation, Derivation of the terms for a P<sub>2</sub> & P<sub>3</sub> configuration, calculation of the number of microstates, Electronic spectra of transition metal complexes – Laporte 'orbital' selection rule, spin selection rule, splitting of electronic energy levels and spectroscopic states. Spectra of d<sub>1</sub> & d<sub>9</sub> ions, d<sub>2</sub> & d<sub>8</sub> ions

Ref :2,6 - Relevant pages.

### CHAPTER-5: Preparation & Application of Complexes (P-12,M- 18)

Preparation of complexes, Application of complexes in analytical chemistry, complexometric titration, Application of complexes in metallurgy, Application of complexes in industry, Application of complexes in medical field. Presence of metal complexes in biological system, Hemoglobin, Chlorophyll, Vitamin B<sub>12</sub>.

Ref :18,pages-554 to 569.

References:-

1) Inorganic Chemistry Principles of Structures and Reactivity, 4th edition; James E. Huheey, Ellen A. Keiter, Richard L. Keiter.

- 2) Concise Inorganic Chemistry, 5th edition J. D. Lee.
- 3) Inorganic chemistry, 3rd edition Alan G. Sharpe.
- 4) Chemical Applications of Group Theory, F.A. Cotton.
- 5) Inorganic Chemistry, Fourth Edition; Shriver & Atkins Intern.student edition.
- 6) Principles of Inorganic Chemistry; Late B.R. Puri, L.R. Sharma & K.C. Kalia.
- 7) Principles of Physical Chemistry; Late B.R. Puri, L.R. Sharma & Pathania.
- 8) Electrons and Chemical bonding By H.B. Gray.
- 9) Modern Aspects of Inorganic Chemistry, By H. J. Emeleus and A.G. Sharpe; Universal Book Stall, New Delhi – 2.19
- 10) Advanced Inorganic Chemistry; Dr. S.K. Agarwala, Dr. Keemtilal, Pragati Prakashan, Meerut.
- 11) Theoretical Principles of Inorganic Chemistry, G.S. Manku, Tata McGraw-Hill Ed.
- 12) Concepts and Models of Inorganic Chemistry, 2nd edition, B. Douglas, D.H. Mc. Daniel, J.J. Alexander.
- 13) General & Inorg. Chem. (Part one), R. Sarkar, New Central Book Agency ; Kolkata.
- 14) Group Theory and its Chemical applications, P.K. Bhattacharya, Himalaya Publishing House.
- 15) Advance Inorganic Chemistry, Cotton & Wilkinson. 1
- 6) Concept and Applications of Group Theory, Dr. Kishor Arora, Anmol Publication Pvt. Ltd., New Delhi.
- 17) Modern Inorganic Chemistry by William Jolly, 2nd edition, Tata McGraw Hill Co.
- 18) Selected topics in inorganic chemistry – By Dr. W. U. Malik, Dr. G. D. Tuli, Dr. R. D. Madan.

## Inorganic Chemistry Practical Syllabus

### CH-I-1

---

- 1) The student should perform minimum of 18 experiments.
  - 2) Draw Flow chart all experiments except for thermochemistry, Chromatography and instrumental method
  - 3) Use of double method is compulsory for all volumetric analysis except instrumental method
- 
1. Analysis of ore (**Any two**)
    - a) Pyrolusite ore - Estimation of silica gravimetrically and Manganese volumetrically.
    - b) Haematite - Estimation of copper volumetrically and Iron gravimetrically.
    - c) Chromite ore – Estimation of Iron gravimetrically and chromium volumetrically.
    - d) Dolomite ore- Estimation of Calcium volumetrically and Mg gravimetrically.
  2. Analysis of binary mixtures by gravimetric and volumetric method(**Any three**)
    - a) Copper- Nickel
    - b) Copper -Magnesium
    - c) Copper-Zinc
    - d) Iron-Magnesium
    - e) Nickel-Zinc
    - f) Lead-Tin
  3. Preparation of the following complexes and determination of its purity:(**Any three**)
    - a) Potassium trioxalatoferate(III)trihydrate
    - b) Tris(acetylacetonato)iron(III)
    - c) Potassium di aqua bis(oxalato) chromate (III)
    - d) Prussian Blue (Potassium Ferric Ferro cyanide)
    - e) Chloropenta-amminecobalt (III) chloride
  4. Drug Analysis (**Any one**)
    - a) Determination of iron from given drug sample.
    - b) Determination of Magnesium from given Milk powder.
  5. Thermochemistry (**Any two salts**)

To determine the lattice energy of binary salts ( NaCl, KCl, CaCl<sub>2</sub>).
  - 6 Chromatography ( **any two**)
    - a) Determination of the R<sub>f</sub> value of Pb,Cu,Cd ions by using paperchromatographic technique.
    - b) Determination of the R<sub>f</sub> value of Fe, Al, Cr ions by using paper chromatographictechnique.
    - c) Determination of the R<sub>f</sub> value of Ba, Sr, Ca ions by using paper chromatographictechnique.
  8. Instrumental method of Analysis( **Five Experiment**)
    - A) To determine the strength of given mixture of carbonate and bicarbonate by pH metric method
    - B) To determine Ca in the given solution by flame photometrically, by calibration curve Method.

C) Spectrophotometry (**any one experiments**)

- a) Estimation of phosphate from waste water by calibration curve method
- b) Estimation of Manganese from steel.

D) To determine the amount of copper present by iodometric method (potentiometrically)

E) Estimation of Boric acid using  $\text{NH}_4\text{OH}$  by conductometric method.

**References:-**

1. A Text book of Quantitative Analysis by A.I.Vogel , 4th edition
2. Advanced Practical Inorganic Chemistry By Gurdeep Raj Goel Publishing House.
3. Post Graduate Practical Chemistry (Part – 1) by H.N. Patel, S.P. Turakhia, S.S. Kelkar, S.R. Puniyani, Himalaya Publishing House.
4. Applied Analytical Chemistry: Vermani.
5. University Practical Chemistry by P.C.Kamboj
6. Commercial Methods of Analysis: Shell & Biffen

**Organic Chemistry Syllabus**

**SEM -I**

**CH-150 Basic Organic Chemistry(60:40 Pattern)**

**1. Stereochemistry (14 L, 14M)**

- a) Stereochemical principles, enantiomeric relationship, diastereomeric relationship, R and S, E and Z nomenclature in C, N, S, P containing compounds, Prochiral relationship, stereospecific and stereoselective reactions, optical activity in biphenyls, spiranes, allenes..
- b) Conformational analysis of cyclic mono substituted and acyclic compounds.

**2. Nucleophilic Substitution reaction (14 L, 14M)**

Aliphatic nucleophilic substitution

- a)  $\text{S}_{\text{N}}1$ ,  $\text{S}_{\text{N}}2$  and  $\text{S}_{\text{N}}\text{i}$  mechanism and stereochemistry (regioselectivity and stereospecificity of substitution reaction).
- b) NGP by pi and sigma bonds, classical and non-classical carbocations.
- c) Nucleophilic substitution at an allylic, aliphatic and vinylic carbon.
- d) Effect of substrate structure, nucleophile, leaving group and solvent on rate of  $\text{S}_{\text{N}}1$  and  $\text{S}_{\text{N}}2$  reactions, ambident nucleophile.

Aromatic nucleophilic substitution

- a)  $\text{S}_{\text{N}}\text{Ar}$ ,  $\text{S}_{\text{N}}1$ , Benzyne and  $\text{S}_{\text{N}}\text{R}1$  reactions, effect of substrate structure, leaving group, solvent and attacking nucleophile.

**3. Electrophilic Substitution reaction (12 L, 12M)**

- a) Arenium ion mechanism, orientation and reactivity, energy profile diagram, ortho, para, ipso attack, orientation in other ring systems, six and five membered heterocycles with one hetero atom.

- b) Important reactions like Friedel crafts alkylation and acylation, nitration, halogenation, formylation, chloromethylation, sulphonation, diazo coupling.

**4. Addition reaction (10 L, 10M)**

- a) Addition to carbon-carbon multiple bonds and carbonheteroatom multiple bonds- Mechanism and stereochemical aspects of additionreaction involving electrophile.  
b) Structural effects and reactivity:Halogenations, Hydrohalogenation, Hydration,Hydroxylation, Hydroboration, Epoxidation, Carbene addition, Hydrogenation, Ozonolysis.

**5. Elimination reaction (10 L, 10M)**

- a) E1, E2, E1CB mechanisms, Stereo chemistry of elimination, Elimination versus substitution, anti and syn elimination.  
b) Dehydrohalogenation, Dehalogenation, Dehydration, Hoffmann and Saytzeffselimination,Pyrolytic elimination.

**References:**

1. Organic Chemistry – by J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford)
2. Advanced Organic Chemistry – by J. March (Latest Edition)
3. Advance Organic Chemistry (Part A ) –by A. Carey and R.J. Sundberg
4. Stereochemistry of carbon compound-by E.L.Eliel
5. Guide book to Reaction Mechanism –Peter Sykes.
6. Organic Chemistry: A Brief Course by Robert C. Atkins , Francis A Carey
7. Stereochemistry of carbon compound-by E.L.Eliel
8. Stereochemistry of organic compound-by Nasipuri
9. Stereochemistry conformations and mechanism by P.S. Kalsi

**SEM –IICH-250(60:40 Pattern)**

**Name Reactions, Synthetic Organic Chemistry & Spectroscopy.**

**1. :NameReactions (14 L, 14M)**

Bayer- Villiger Oxidation, Stobbe condensation, Dieckmann condensation, Reimer Tiemann, reformatsky and Grignard reaction, Diels Alder Reaction, Robinson annulation, Michael, Mannich, Stork enamine, Sharpless asymmetric epoxidation, Ene, Barton, Hell-Volhard- Zelinsky reaction, Shapiro reaction, Chichibabin reaction, Cannizaro's reaction, Bylis-Hilman reaction, Darzen reaction, Knovenagel reaction, Biginelli reaction.

**2. Synthetic Reagents (14 L, 14M)**

- e) Oxidation reactions:  
CrO<sub>3</sub>, PDC, PCC(Corey's reagent), KMnO<sub>4</sub>, MnO<sub>2</sub>, Swern oxidation, SeO<sub>2</sub>, Pb(OAc)<sub>4</sub>, Pd-C, OsO<sub>4</sub>, m-CPBA, O<sub>3</sub>,NaIO<sub>4</sub>, HIO<sub>4</sub>, chloranil, DDQ, Oppenauer oxidation

f) Reduction reactions:

LiAlH<sub>4</sub>, NaBH<sub>4</sub>, NaCNBH<sub>3</sub>, MPV reduction, Na/liquor NH<sub>3</sub>, H<sub>2</sub>/Pd-C, Willkinsons catalyst, DIBALH and WolffKishner reduction, Zn-Hg/H<sub>2</sub>O/HCL, Catalytic Reduction, Bu<sub>3</sub>SnH.

**3. Rearrangements: (08 L, 08M)**

Hofmann, Curtius, Smith, Wolff, Lossen, Sommelet, Favorskii, Benzil-benzilic acid, Fries, Claisen, Cope.

**4. Spectroscopy: (24 L, 24M)**

a) UV: Factors affecting UV absorption and interpretation of UV spectra

b) IR: Basic ideas about IR frequencies, interpretation of IR spectra

c) PMR: Fundamentals of PMR, factors affecting chemical shift, integration coupling (1st order analysis)

d) Introduction to CMR and mass spectrometry

e) Problems on UV, IR and PMR

**References:**

1. Organic reaction mechanism- V. K. Ahluwalia 3<sup>rd</sup> Ed.
2. Organic Chemistry– J. Clayden, N. Greeves, S. Warren and P. Wothers (Oxford)
3. Modern Synthetic reactions- H.O. House
4. Reaction Rearrangement and ReagrntsBy S.N. Sanyal.
5. Guide book to Reaction Mechanism –Peter Sykes.
6. Introduction to spectroscopy – D.I. Pavia, G.M. Lampman, G.S. Kriz, 3rd Edition
7. Spectroscopic methods in organic melecules – D.H. William & I FlemmingMcGraw Hill
8. Mechanism and Structure in Organic Chemistry - E.S. Gould

**CH-O-1Organic Chemistry Practical**

**1. Use of Chemistry software's like, ISI draw, Chem Draw, Chem Sketch**

- a) Draw the structure of simple aliphatic and aromatic compounds, heterocyclic compounds with different substituent. (Minimum TenCompounds).
- b) IUPAC name and predict the NMR Signals.
- c) Sketch Design reaction mechanism scheme of any two addition and two substitution reactions.
- d) Literature Search and references.

**2. Single Stage Preparation Monitored by TLC (any 6)**

- a) Acetophenone to Benzalacetophenone.
- b) Resorcinol to 7-hydroxy, 4-methyl coumarin.
- c) Camphor to Borneol.
- d) Benzophenone to Benzhydrol.
- e) Acetoaceticester to Pyrazolone.

- f) Paramino Benzoic Acid to Parachloro Benzoic Acid.
  - g) 2-methoxy naphthalene to 1-formyl-2-methoxy naphthalene.
  - h) Glycine to Benzoylglycine.
  - i) Cyclohexanone to Adipic acid
  - j) Cyclohexanone to Oxime
  - k) P-nitrotoluene to p-nitrobenzoic acid
- 3. Two Stage Preparation Monitored by TLC (any 2)**
- a) Phthalic acid - phthalic anhydride - phthalimide.
  - b) Chlorobenzene- 2,4-dinitrochlorobenzene - 2,4-dinitrophenol.
  - c) Acetophenone - Oxime - Acetanilide.
  - d) Nitrobenzene - m-Dinitrobenzene - m-Nitroaniline.
  - e) Acetophenone- Benzalacetophenone - Epoxide.
- 4. Green Chemistry Preparations (any 3)**
- a) Bromination of acetanilide using Ferric ammonium nitrate.
  - b) Preparation of Benzilic Acid using NaOH /KOH under Solvent-free Conditions.
  - c) Photo reduction of benzophenone to benzopinacol in presence of sun light using isopropanol and acetic acid.
  - d) Synthesis of Dibenzalpropanone from Benzaldehyde and Acetone(Aldol Condensation).
  - e) Synthesis of Dihydropyrimidinone from Ethyl acetoacetate, Benzaldehyde and Urea.
- 5. Purification Techniques (Demonstrations) (any 1)**
- a) Solvent extraction using Soxhlet extractor.
  - b) Steam distillation.
  - c) Column Chromatography.

## References:

1. Practical Organic Chemistry by Vogel's.
2. Monograph on Green Chemistry Laboratory Experiments.

**M.Sc. Part –I (Semester- II)(60:40 Pattern)**

**Course - CH-290-General Chemistry**

**Solve any two sections in the same answer sheet.**

**SECTION –I: CHEMICAL MATHS**

<b>Sr. No</b>	<b>Name of the chapter</b>	<b>No. of periods</b>	<b>Weightage without option</b>	<b>Weightage with option</b>
1	Units	<b>02</b>	<b>03</b>	<b>04</b>
2	Differential Calculus	<b>06</b>	<b>07</b>	<b>12</b>
3	Integral Calculus	<b>06</b>	<b>07</b>	<b>12</b>
4	Partial differentiation	<b>04</b>	<b>05</b>	<b>08</b>
5	Differential equation	<b>02</b>	<b>03</b>	<b>04</b>
6	Probability and errors	<b>02</b>	<b>03</b>	<b>04</b>
7	Graphical methods in physical chemistry	<b>02</b>	<b>03</b>	<b>04</b>
8	Computer application in chemistry	<b>02</b>	<b>03</b>	<b>04</b>
9	Vector, Matrices and Determinant	<b>02</b>	<b>03</b>	<b>04</b>
10	Problem in Physical chemistry	<b>02</b>	<b>03</b>	<b>04</b>
	<b>TOTAL</b>	<b>30</b>	<b>40</b>	<b>60</b>

**SECTION –II: ANALYTICAL CHEMISTRY**

<b>Sr. No</b>	<b>Name of the chapter</b>	<b>No. of periods</b>	<b>Weightage without option</b>	<b>Weightage with option</b>
1	Statistics	<b>10</b>	<b>10</b>	<b>15</b>
2	Electrogravimetric Analysis	<b>10</b>	<b>10</b>	<b>15</b>
3	High Performance Liquid Chromatography	<b>10</b>	<b>10</b>	<b>15</b>
	<b>TOTAL</b>	<b>30</b>	<b>30</b>	<b>45</b>

**SECTION-III: INSTRUMENTAL METHODS OF ANALYSIS**

<b>Sr. No</b>	<b>Name of the chapter</b>	<b>No. of periods</b>	<b>Weightage without option</b>	<b>Weightage with option</b>
1	Potentiometry	<b>10</b>	<b>10</b>	<b>15</b>
2	Voltammetry	<b>10</b>	<b>10</b>	<b>15</b>
3	Fluorescence and Phosphorescence	<b>10</b>	<b>10</b>	<b>15</b>
	<b>TOTAL</b>	<b>30</b>	<b>30</b>	<b>45</b>



**SECTION-I: CHEMICAL MATHS (30 L)**

(No Derivations. Only essential formulae and their applications for solving the problems in Chemistry is expected.)

**1. Units (02L)**

- a) Basic & Derived CGS & SI Units: Pressure, volume, density, force, energy, Gas Constant(R).
- b) Non conventional units: Pressure, volume, density, force, energy, R.

**2. Differential Calculus (06L)**

- a) Derivative, Basic rules.
- b) Differentiation of functions of function, logarithmic functions.
- c) Algebraic simplification.
- d) Graphical significance of differentiation, Applications of Maxima & Minima.
- e) The differential.

Ref:-1 Pages 70-113

**3. Integral Calculus (06L)**

- a) Basic rules, definite & indefinite integral, “e” and its significance, compound interest low, exponential equations.
- b) Integration of trigonometric functions.
- c) Algebraic simplification, Integration- by substitution & by partial fractions.

Ref:-1 Pages 114- 156

**4. Partial Differentiation (04L)**

- a) The fundamental theorem - special cases, Successive Partial Differentiation.

Ref:-1 Pages 174-186

**5. Differential Equations (02L)**

Simple differential equations in Chemistry, Homogeneous differential equations, Exact and Inexact differential equations, linear differential equations.

Ref:-1 Pages 187-199

**6. Probability And Errors (02L)**

Ref:-1 Pages 210-216, 220-225

**7. Graphical Methods In Physical Chemistry (02L)**

Ref:-1 Pages 225-239

**8. Computer: Applications In Chemistry (02L)**

Introduction, Components of Computer, Hardware, Software, binary arithmetic, Softwares in chemistry - MOPAC, GAMESS, GAUSSION, MOLDRAW, etc. Internet surfing, e-journals, literature Search (Project on Specific topics on Recent Advances in

Chemistry).

Ref:-2 Pages 36-68

Ref:-3 Relevant pages

### **9. Vector, Matrices, & Determinant: - (02L)**

Ref: - 4 Pages 1048-1070

### **10. Problems In Physical Chemistry (02L)**

To be referred for Problems on the respective chapters in the syllabus.

Ref.-1 Pages 247-259 Appendix-I

#### **References:-**

Ref. 1. Mathematical Preparation for physical chemistry-Farrington Daniels McGraw Hill.

Ref. 2.Principal of Physical Chemistry- Puri, Sharma &Pathania.ISBN-81-8646-00-8  
Millennium Ed.

Ref. 3. Physical Chemistry- Thomas Engel, Philip Reid, Pearson- 2006, LPE Ed.

Ref. 4. Physical Chemistry- P.W Atkins, 7th Ed.

## **SECTION-II: ANALYTICAL CHEMISTRY**

**(30 L)**

### **1.Statistics:-**

**(10L)**

Introduction to Chemometrics Mean and Standard deviation, distribution of random errors, reliability of results, comparing of means of two samples, paired t-test, the number of replicate determinations, correlation and regression, linear regression, errors in slope and intercept, errors in the estimate of concentration, standard additions, comparison of more than two means, experimental design, two way analysis of variance, chemometrics and experimental design, factorial design.

Ref:-1, Pages 123 to 149

### **2. Electrogravimetric Analysis: -**

**(10L)**

Theory of electrogravimetric analysis, Terms used in electrogravimetric analysis, Completeness of deposition, Electrolytic separation of metals, Character of the deposit, Electrolytic separation of metals with controlled cathode potential, Apparatus, Determination of copper ( constant current procedure ) , Determination of antimony, copper, lead and tin in bearing metal ( controlled current procedure)

Ref. 1. Pages From 503 to 518

### **3. High Performance Liquid Chromatography:**

**(10L)**

Instrumentation: Mobile Phase Reservoirs and Solvent Treatment systems, Pumping systems, Sample injection systems, Columns for High Performance Liquid Chromatography, Detectors.

Ref. 2. Pages From 971-980

#### **References:-**

**Ref. 1.** Vogel's Text Book of Quantitative Chemical analysis (Fifth Edition) By- J.

Mendham, R.C.Denny, J.D. Barnes, M.J.K. Thomas (Pearson Education- Low Price Edition).

**Ref. 2.** Fundamentals of Analytical Chemistry, Eighth Edition, D. A. Skoog, D. M. West, F.

**SECTION-III: INSTRUMENTAL METHODS OF ANALYSIS**

**(30 L)**

**1. Potentiometry:**

**(10L)**

Potentiometer and pH meter, The Cell for Potential Measurements, The Glass pH Electrode Principle, Combination Electrode, Theory of Glass Membrane Potential, The Alkaline Error, The Acid Error, Standard Buffers, Accuracy of pH Measurements, Measurements with the pH-meter, Ion-selective Electrodes - Glass Membrane Electrodes, Precipitate Electrodes, Solid-State Electrodes, Liquid-Liquid Electrodes, Plastic Membrane/Ionophore Electrodes, Coated Wire electrodes, Enzyme Electrodes,  
Ref. 3. Pages 380-399

**2. Voltammetry:**

**(10L)**

Excitation signals Linear-sweep Voltammetry- Voltammetric Instruments, Voltammetric Electrodes, Voltammograms, Hydrodynamic voltammetry, Voltammetric Detectors Amperometric Sensors, Amperometric Titrations  
Ref. 1. Pages 665-684

**2. Fluorescence and Phosphorescence:**

**(10L)**

Fluorescence, Photoluminescent Theory, Electron Transitions During Photoluminescence, Factors That Affect Photoluminescence, Luminescent Apparatus, Optical Excitatory Sources, Wavelength selectors, Cells, Detector and Readout, Photoluminescent spectra, Photoluminescent Analysis, Analysis of Nonluminescing Compounds, Determination of Mixtures, Phosphorescence.  
Ref. 2. Pages. 316-343

**References:**

- Ref. 1. Fundamentals of Analytical Chemistry, Eighth Edition, D. A. Skoog, D. M. West, F. J. Holler, S. R. Croch  
Ref. 2. Introduction to Instrumental Analysis, Robert D. Braun, Mc. Graw Hill (1987)  
Ref. 3. Analytical Chemistry (Sixth Edition) Wiley International Edition. By- Gary D. Christian, John Wiley and Sons INC.

## **Job/Career Opportunities after M.Sc. in Chemistry**

There exist enormous career opportunities for aspirants who have completed their master degree in Chemistry. M.Sc. course allows candidates to get specialized in diverse areas of Chemistry (Polymer chemistry, Organic Chemistry etc.). Both public as well as private sector firms recruit candidates for their varied operations. Those who are interested to work out side India, can work with better compensation packages.

Candidates who have completed their post graduation in Chemistry can pursue their career in both public and private sector organizations. Candidates can join organizations such as Advanced Centre for Treatment Research and Education in Cancer and Indian Institute of Chemical Technology as Junior Research Fellow or Project Assistant. Petroleum Industry is another major field that offers plenty of job opportunities for candidates who have completed post graduation in Chemistry. Apart from this, candidates can seek job opportunities in private firms such as Dabur, Glaxo Smith Kline etc as Junior Chemist with attractive pay packages. Experienced professional can apply for job opportunities available in various industries abroad.

### **Job opportunities in Public sector after M. Sc in Chemistry:**

Candidates can seek employment in various job positions such as Biochemist, Industrial Research Scientist, Laboratory Assistant and Quality Controller etc in public sector companies. They can find ample career openings with government owned pharmaceutical companies or with other public sector undertaking chemical factories. Candidates having industrial experience of a minimum of 2 to 3 years can apply for jobs abroad. Candidates who have first class marks in post graduation can join as Junior Research Fellow in research institutes. Candidates who qualify the NET exam are eligible to apply for the post of faculty in Government and Private Colleges. Apart from these jobs, candidates can apply for faculty post in private [engineering](#) colleges.

### **Government jobs after M.Sc.:**

M.Sc Applied Chemistry graduates can find lots of job opportunities in various fields of government sector. Most popular field among them is research field. Teaching profession is

yet another popular field in the government sector. Details of jobs available in government sector for M.Sc Applied Chemistry graduates are given below.

### **Jobs in Government Sector:**

Lots of job opportunities are arising for the graduates due to the growth of several public sector undertakings. Candidates who have completed M.Sc. Applied Chemistry can thus find jobs in these public sector undertakings. Hindustan Petroleum Corporation Limited (HPCL) is one among them. Governmental research organizations also recruit these graduates for various posts. Several exams are conducted for the graduates to recruit them for various vacancies available in different departments of State and Central government. M.Sc. Applied Chemistry graduates can also attend those exams to get such jobs in government sector. These graduates can also pursue their career in teaching as there are several educational institutions run by state and central government.

### **Central Government Jobs after M.Sc. Applied Chemistry:**

M.Sc. Applied Chemistry graduates can work as Research Manager or Scientist in various government research organizations such as Indian Space Research Organization (ISRO), Bhabha Atomic Research Centre (BARC) and Defense Research and Development Organization laboratories. These graduates can attend the various exams conducted by Union Public Service Commission (UPSC), CSIR – UGC and Staff Selection Committee (SSC) to get jobs in various departments in central government. Candidates who secure any government job can write the concerned departmental exams to get promotion to higher positions. Civil Service Exams like IFS, IAS and IES are another alternative for these graduates.

### **Teaching Profession in Government Sector after M.Sc Applied Chemistry:**

M.Sc Applied Chemistry graduates who have good teaching aptitude can find teaching jobs in various universities offering applied chemistry courses. They should need to qualify the NET exam to apply for the lecture post available in various colleges or universities. Apart from qualifying the NET exam, candidates should also possess M.Ed degree to get a teaching job in any university or college.

### **Career abroad after M.Sc.:**

Foreign nations are also in need of qualified candidates in Chemistry. Those candidates with enough job experience are highly proffered by international firms. Chemical firms and Pharmaceutical firms in European nations often recruit candidates with proven experience. They also offer good remuneration to deserving professional.

