SCHEME OF EXAMINATION

RULES & REGULATIONS

AND

SYLLABUS

(Effective from Academic Session 2025-2026)

B.Sc. Chemistry

Fifth Semester Examination, December 2025
Sixth Semester Examination, June 2026

under

Choice Based Credit System (CBCS)

Faculty of Science

UNIVERSITY OF KOTA

MBS Marg, KOTA (Rajasthan)-324 005

INDIA

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Bachelor of Science (B.Sc.): Mathematics Group

Subject Combination: Physics, Chemistry, Mathematics (PCM)

Semester Scheme of Examination

Year / Semester	Serial Number, Code and Nomenclature of Paper			Duration of Examination	Teaching (Hrs./Week) and Credits			Distribution of Maximum Marks			Minimum Pass Marks	
	Number	Code	Nomenclature		Lecture (L)	Practical (P)	Credit (C)	Internal Assess.	Sem. Assess.	Total Marks	Internal Assess.	Sem. Assess.
1st Year I Semester	1.1	PHY-------	Physics-I	3 Hrs.	4	--	4	30	70	100	12	28
	1.2	PHY-------	Physics Practical-I	6 Hrs.	--	4	2	--	50	50	--	25
	1.3	CHE ---- T	Chemistry-I	3 Hrs.	4	--	4	30	70	100	12	28
	1.4	CHE ---- P	Chemistry Practical-I	6 Hrs.	--	4	2	--	50	50	--	25
	1.5	MAT------	Mathematics-I	3 Hrs.	4	--	4	30	70	100	12	28
	1.6	MAT------	Mathematics Practical-I	6 Hrs.	--	4	2	--	50	50	--	25
	1.9/1.10	AEC------	General Hindi / General English	1.5 Hrs.	2	--	2	--	50	50	--	20
			Total (I Semester)	**28.5 Hrs.**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
1st Year II Semester	2.1	PHY-------	Physics-II	3 Hrs.	4	--	4	30	70	100	12	28
	2.2	PHY-------	Physics Practical-II	6 Hrs.	--	4	2	--	50	50	--	25
	2.3	CHE ---- T	Chemistry-II	3 Hrs.	4	--	4	30	70	100	12	28
	2.4	CHE ---- P	Chemistry Practical-II	6 Hrs.	--	4	2	--	50	50	--	25
	2.5	MAT------	Mathematics-II	3 Hrs.	4	--	4	30	70	100	12	28
	2.6	MAT------	Mathematics Practical-II	6 Hrs.	--	4	2	--	50	50	--	25
	1.10/1.9	AEC------	General English / General Hindi	1.5 Hrs.	2	--	2	--	50	50	--	20
			Total (II Semester)	**28.5 Hrs.**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
			Total (I and II Semesters)	**57.0 Hrs.**	**28**	**24**	**40**	**180**	**820**	**1000**	**72**	**358**
2nd Year III Semester	3.1	PHY-------	Physics-III	3 Hrs.	4	--	4	30	70	100	12	28
	3.2	PHY-------	Physics Practical-III	6 Hrs.	--	4	2	--	50	50	--	25
	3.3	CHE ---- T	Chemistry-III	3 Hrs.	4	--	4	30	70	100	12	28
	3.4	CHE ---- P	Chemistry Practical-III	6 Hrs.	--	4	2	--	50	50	--	25
	3.5	MAT------	Mathematics-III	3 Hrs.	4	--	4	30	70	100	12	28
	3.6	MAT------	Mathematics Practical-III	6 Hrs.	--	4	2	--	50	50	--	25
	3.7	GEC------	Environmental Studies	1.5 Hrs.	2	--	2	--	50	50	--	20
			Total (III Semester)	**28.5 Hrs.**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
2nd Year IV Semester	4.1	PHY-------	Physics-IV	3 Hrs.	4	--	4	30	70	100	12	28
	4.2	PHY-------	Physics Practical-IV	6 Hrs.	--	4	2	--	50	50	--	25
	4.3	CHE ---- T	Chemistry-IV	3 Hrs.	4	--	4	30	70	100	12	28
	4.4	CHE ---- P	Chemistry Practical-IV	6 Hrs.	--	4	2	--	50	50	--	25
	4.5	MAT------	Mathematics-IV	3 Hrs.	4	--	4	30	70	100	12	28
	4.6	MAT------	Mathematics Practical-IV	6 Hrs.	--	4	2	--	50	50	--	25
	4.7	GEC------	Elementary Computer Applications	1.5 Hrs.	2	--	2	--	50	50	--	20
			Total (IV Semester)	**28.5 Hrs.**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
			Total (III and IV Semesters)	**57.0 Hrs.**	**28**	**24**	**40**	**180**	**820**	**1000**	**72**	**358**

Year / Semester	Serial Number, Code and Nomenclature of Paper			Duration of Examination	Teaching (Hrs./Week) and Credits			Distribution of Maximum Marks			Minimum Pass Marks	
	Number	Code	Nomenclature		Lecture (L)	Practical (P)	Credit (C)	Int. Assess.	Sem. Assess.	Total	Int. Assess.	Sem. Assess.
3rd Year V Semester	5.1(a)	PHY-------	Physics-V(a): Elective	3 Hrs.	4	--	4	30	70	100	12	28
	5.1(b)	PHY-------	Physics-V(b): Elective									
	5.1(c)	PHY-------	Physics-V(c): Elective									
	5.2(a)	PHY-------	Physics Practical-V(a): Elective	6 Hrs.	--	4	2	--	50	50	--	25
	5.2(b)	PHY-------	Physics Practical-V(b): Elective									
	5.2(c)	PHY-------	Physics Practical-V(c): Elective									
	5.3(a)	CHE ---- T(a)	Chemistry-V(a): Inorganic Chemistry	3 Hrs.	4	--	4	30	70	100	12	28
	5.3(b)	CHE ---- T(b)	Chemistry-V(b): Organic Chemistry									
	5.3(c)	CHE ---- T(c)	Chemistry-V(c): Physical Chemistry									
	5.4(a)	CHE ---- P(a)	Chemistry Practical-V(a): Inorganic Chemistry Practical	6 Hrs.	--	4	2	--	50	50	--	25
	5.4(b)	CHE ---- P(b)	Chemistry Practical-V(b): Organic Chemistry Practical									
	5.4(c)	CHE ---- P(c)	Chemistry Practical-V(c): Physical Chemistry Practical									
	5.5(a)	MAT------	Mathematics-V(a): Elective	3 Hrs.	4	--	4	30	70	100	12	28
	5.5(b)	MAT------	Mathematics-V(b): Elective									
	5.5(c)	MAT------	Mathematics-V(c): Elective									
	5.6(a)	MAT------	Mathematics Practical-V(a):	6 Hrs.	--	4	2	--	50	50	--	25
	5.6(b)	MAT------	Mathematics Practical-V(b):									
	5.6(c)	MAT------	Mathematics Practical-V(c):									
	5.7	VAC------	Value Added Course	1.5 Hrs.	2	--	2	--	50	50	--	20
	Total (V Semester)			**28.5 Hrs.**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
3rd Year VI Semester	6.1(a)	PHY-------	Physics-VI(a): Elective	3 Hrs.	4	--	4	30	70	100	12	28
	6.1(b)	PHY-------	Physics-VI(b): Elective									
	6.1(c)	PHY-------	Physics-VI(c): Elective									
	6.2(a)	PHY-------	Physics Practical-VI(a): Elective	6 Hrs.	--	4	2	--	50	50	--	25
	6.2(b)	PHY-------	Physics Practical-VI(b): Elective									
	6.2(c)	PHY-------	Physics Practical-VI(c): Elective									
	6.3(a)	CHE ---- T(a)	Chemistry-VI(a): Inorganic Chemistry	3 Hrs.	4	--	4	30	70	100	12	28
	6.3(b)	CHE ---- T(b)	Chemistry-VI(b): Organic Chemistry									
	6.3(c)	CHE ---- T(c)	Chemistry-VI(c): Physical Chemistry									
	6.4(a)	CHE ---- P(a)	Chemistry Practical-VI(a): Inorganic Chemistry Practical	6 Hrs.	--	4	2	--	50	50	--	25
	6.4(b)	CHE ---- P(b)	Chemistry Practical-VI(b): Organic Chemistry Practical									
	6.4(c)	CHE ---- P(c)	Chemistry Practical-VI(c): Physical Chemistry Practical									
	6.5(a)	MAT------	Mathematics-VI(a): Elective	3 Hrs.	4	--	4	30	70	100	12	28
	6.5(b)	MAT------	Mathematics-VI(b): Elective									
	6.5(c)	MAT------	Mathematics-VI(c): Elective									
	6.6(a)	MAT------	Mathematics Practical-VI(a): Elective	6 Hrs.	--	4	2	--	50	50	--	25
	6.6(b)	MAT------	Mathematics Practical-VI(b): Elective									
	6.6(c)	MAT------	Mathematics Practical-VI(c): Elective									
	6.7	SEC------	Skill Enhancement Course	1.5 Hrs.	2	--	2	--	50	50	--	20
	Total (VI Semester)			**28.5 Hrs.**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
Total (V and VI Semesters)				**57.0 Hrs.**	**28**	**24**	**40**	**180**	**820**	**1000**	**72**	**358**

Grand Total of Three-Year B.Sc. Degree Programme (I to VI Semesters)	**171.0 Hrs.**	**84**	**72**	**120**	**540**	**2460**	**3000**	**216**	**1074**

Bachelor of Science (B.Sc.): Biology Group

Subject Combination: Botany, Chemistry, Zoology (BCZ)

Semester Scheme of Examination

Year / Semester	Serial Number, Code and Nomenclature of Paper			Duration of Examination	Teaching (Hrs./Week) and Credits			Distribution of Maximum Marks			Minimum Pass Marks	
	Number	Code	Nomenclature		Lecture (L)	Practical (P)	Credit (C)	Internal Assess.	Sem. Assess.	Total Marks	Internal Assess.	Sem. Assess.
1st Year I Semester	1.1	BOT-------	Botany-I	3 Hrs.	4	--	4	30	70	100	12	28
	1.2	BOT-------	Botany Practical-I	6 Hrs.	--	4	2	--	50	50	--	25
	1.3	CHE ---- T	Chemistry-I	3 Hrs.	4	--	4	30	70	100	12	28
	1.4	CHE ---- P	Chemistry Practical-I	6 Hrs.	--	4	2	--	50	50	--	25
	1.5	ZOO------	Zoology-I	3 Hrs.	4	--	4	30	70	100	12	28
	1.6	ZOO------	Zoology Practical-I	6 Hrs.	--	4	2	--	50	50	--	25
	1.9/1.10	AEC------	General Hindi / General English	1.5 Hrs.	2	--	2	--	50	50	--	20
	Total (I Semester)			**28.5 Hrs.**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
1st Year II Semester	2.1	BOT-------	Botany -II	3 Hrs.	4	--	4	30	70	100	12	28
	2.2	BOT-------	Botany Practical-II	6 Hrs.	--	4	2	--	50	50	--	25
	2.3	CHE ---- T	Chemistry-II	3 Hrs.	4	--	4	30	70	100	12	28
	2.4	CHE ---- P	Chemistry Practical-II	6 Hrs.	--	4	2	--	50	50	--	25
	2.5	ZOO------	Zoology-II	3 Hrs.	4	--	4	30	70	100	12	28
	2.6	ZOO------	Zoology Practical-II	6 Hrs.	--	4	2	--	50	50	--	25
	1.10/1.9	AEC------	General English / General Hindi	1.5 Hrs.	2	--	2	--	50	50	--	20
	Total (II Semester)			**28.5 Hrs.**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
Total (I and II Semesters)				**57.0 Hrs.**	**28**	**24**	**40**	**180**	**820**	**1000**	**72**	**358**
2nd Year III Semester	3.1	BOT-------	Botany-III	3 Hrs.	4	--	4	30	70	100	12	28
	3.2	BOT-------	Botany Practical-III	6 Hrs.	--	4	2	--	50	50	--	25
	3.3	CHE ---- T	Chemistry-III	3 Hrs.	4	--	4	30	70	100	12	28
	3.4	CHE ---- P	Chemistry Practical-III	6 Hrs.	--	4	2	--	50	50	--	25
	3.5	ZOO------	Zoology-III	3 Hrs.	4	--	4	30	70	100	12	28
	3.6	ZOO------	Zoology Practical-III	6 Hrs.	--	4	2	--	50	50	--	25
	3.7	GEC------	Environmental Studies	1.5 Hrs.	2	--	2	--	50	50	--	20
	Total (III Semester)			**28.5 Hrs.**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
2nd Year IV Semester	4.1	BOT-------	Botany-IV	3 Hrs.	4	--	4	30	70	100	12	28
	4.2	BOT-------	Botany Practical-IV	6 Hrs.	--	4	2	--	50	50	--	25
	4.3	CHE ---- T	Chemistry-IV	3 Hrs.	4	--	4	30	70	100	12	28
	4.4	CHE ---- P	Chemistry Practical-IV	6 Hrs.	--	4	2	--	50	50	--	25
	4.5	ZOO------	Zoology-IV	3 Hrs.	4	--	4	30	70	100	12	28
	4.6	ZOO------	Zoology Practical-IV	6 Hrs.	--	4	2	--	50	50	--	25
	4.7	GEC------	Elementary Computer Applications	1.5 Hrs.	2	--	2	--	50	50	--	20
	Total (IV Semester)			**28.5 Hrs.**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
Total (III and IV Semesters)				**57.0 Hrs.**	**28**	**24**	**40**	**180**	**820**	**1000**	**72**	**358**

Year / Semester	Serial Number, Code and Nomenclature of Paper			Duration of Examination	Teaching (Hrs./Week) and Credits			Distribution of Maximum Marks			Minimum Pass Marks	
	Number	Code	Nomenclature		Lecture (L)	Practical (P)	Credit (C)	Int. Assess.	Sem. Assess.	Total	Int. Assess.	Sem. Assess.
3rd Year V Semester	5.1(a)	BOT-------	Botany-V(a): Elective	3 Hrs.	4	--	4	30	70	100	12	28
	5.1(b)	BOT-------	Botany-V(b): Elective									
	5.1(c)	BOT-------	Botany-V(c): Elective									
	5.2(a)	BOT-------	Botany Practical-V(a)	6 Hrs.	--	4	2	--	50	50	--	25
	5.2(b)	BOT-------	Botany Practical-V(b)									
	5.2(c)	BOT-------	Botany Practical-V(c)									
	5.3(a)	CHE ---- T(a)	Chemistry-V(a): Inorganic Chemistry	3 Hrs.	4	--	4	30	70	100	12	28
	5.3(b)	CHE ---- T(b)	Chemistry-V(b): Organic Chemistry									
	5.3(c)	CHE ---- T(c)	Chemistry-V(c): Physical Chemistry									
	5.4(a)	CHE ---- P(a)	Chemistry Practical-V(a): Inorganic Chemistry Practical	6 Hrs.	--	4	2	--	50	50	--	25
	5.4(b)	CHE ---- P(b)	Chemistry Practical-V(b): Organic Chemistry Practical									
	5.4(c)	CHE ---- P(c)	Chemistry Practical-V(c): Physical Chemistry Practical									
	5.5(a)	ZOO------	Zoology-V(a): Elective	3 Hrs.	4	--	4	30	70	100	12	28
	5.5(b)	ZOO------	Zoology-V(b): Elective									
	5.5(c)	ZOO------	Zoology-V(c): Elective									
	5.6(a)	ZOO------	Zoology Practical-V(a)	6 Hrs.	--	4	2	--	50	50	--	25
	5.6(b)	ZOO------	Zoology Practical-V(b)									
	5.6(c)	ZOO------	Zoology Practical-V(c)									
	5.7	VAC------	Value Added Course	1.5 Hrs.	2	--	2	--	50	50	--	20
	Total (V Semester)			**28.5 Hrs.**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
3rd Year VI Semester	6.1(a)	BOT-------	Botany-VI(a): Elective	3 Hrs.	4	--	4	30	70	100	12	28
	6.1(b)	BOT-------	Botany-VI(b): Elective									
	6.1(c)	BOT-------	Botany-VI(c): Elective									
	6.2(a)	BOT-------	Botany Practical-VI(a)	6 Hrs.	--	4	2	--	50	50	--	25
	6.2(b)	BOT-------	Botany Practical-VI(b)									
	6.2(c)	BOT-------	Botany Practical-VI(c)									
	6.3(a)	CHE ---- T(a)	Chemistry-VI(a): Inorganic Chemistry	3 Hrs.	4	--	4	30	70	100	12	28
	6.3(b)	CHE ---- T(b)	Chemistry-VI(b): Organic Chemistry									
	6.3(c)	CHE ---- T(c)	Chemistry-VI(c): Physical Chemistry									
	6.4(a)	CHE ---- P(a)	Chemistry Practical-VI(a): Inorganic Chemistry Practical	6 Hrs.	--	4	2	--	50	50	--	25
	6.4(b)	CHE ---- P(b)	Chemistry Practical-VI(b): Organic Chemistry Practical									
	6.4(c)	CHE ---- P(c)	Chemistry Practical-VI(c): Physical Chemistry Practical									
	6.5(a)	ZOO------	Zoology-VI(a): Elective	3 Hrs.	4	--	4	30	70	100	12	28
	6.5(b)	ZOO------	Zoology-VI(b): Elective									
	6.5(c)	ZOO------	Zoology-VI(c): Elective									
	6.6(a)	ZOO------	Zoology Practical-VI(a)	6 Hrs.	--	4	2	--	50	50	--	25
	6.6(b)	ZOO------	Zoology Practical-VI(b)									
	6.6(c)	ZOO------	Zoology Practical-VI(c)									
	6.7	SEC------	Skill Enhancement Course	1.5 Hrs.	2	--	2	--	50	50	--	20
	Total (VI Semester)			**28.5 Hrs.**	**14**	**12**	**20**	**90**	**410**	**500**	**36**	**179**
Total (V and VI Semesters)				**57.0 Hrs.**	**28**	**24**	**40**	**180**	**820**	**1000**	**72**	**358**

Grand Total of Three-Year B.Sc. Degree Programme (I to VI Semesters)	**171.0 Hrs.**	**84**	**72**	**120**	**540**	**2460**	**3000**	**216**	**1074**

University of Kota, Kota

Bachelor of Science (B.Sc.): Mathematics (PCM) and Biology (BCZ) Groups

B.Sc. Chemistry

Semester Scheme of Examination

Year / Semester	Serial Number, Code and Nomenclature of Paper			Duration of Examination	Teaching (Hrs./Week) and Credits			Distribution of Maximum Marks			Minimum Pass Marks	
	Number	Code	Nomenclature		Lecture (L)	Practical (P)	Credit (C)	Internal Assess.	Sem. Assess.	Total Marks	Internal Assess.	Sem. Assess.
1st Year I Semester	1.3	CHE ---- T	Chemistry-I	3 Hrs.	4	--	4	30	70	100	12	28
	1.4	CHE ---- P	Chemistry Practical-I	6 Hrs.	--	4	2	--	50	50	--	25
1st Year II Semester	2.3	CHE ---- T	Chemistry-II	3 Hrs.	4	--	4	30	70	100	12	28
	2.4	CHE ---- P	Chemistry Practical-II	6 Hrs.	--	4	2	--	50	50	--	25
2nd Year III Semester	3.3	CHE ---- T	Chemistry-III	3 Hrs.	4	--	4	30	70	100	12	28
	3.4	CHE ---- P	Chemistry Practical-III	6 Hrs.	--	4	2	--	50	50	--	25
2nd Year IV Semester	4.3	CHE ---- T	Chemistry-IV	3 Hrs.	4	--	4	30	70	100	12	28
	4.4	CHE ---- P	Chemistry Practical-IV	6 Hrs.	--	4	2	--	50	50	--	25
3rd Year V Semester	5.3(a)	CHE ---- T(a)	Chemistry-V(a): Inorganic Chemistry	3 Hrs.	4	--	4	30	70	100	12	28
	5.3(b)	CHE ---- T(b)	Chemistry-V(b): Organic Chemistry									
	5.3(c)	CHE ---- T(c)	Chemistry-V(c): Physical Chemistry									
	5.4(a)	CHE ---- P(a)	Chemistry Practical-V(a): Inorganic Chemistry Practical	6 Hrs.	--	4	2	--	50	50	--	25
	5.4(b)	CHE ---- P(b)	Chemistry Practical-V(b): Organic Chemistry Practical									
	5.4(c)	CHE ---- P(c)	Chemistry Practical-V(c): Physical Chemistry Practical									
3rd Year VI Semester	6.3(a)	CHE ---- T(a)	Chemistry-VI(a): Inorganic Chemistry	3 Hrs.	4	--	4	30	70	100	12	28
	6.3(b)	CHE ---- T(b)	Chemistry-VI(b): Organic Chemistry									
	6.3(c)	CHE ---- T(c)	Chemistry-VI(c): Physical Chemistry									
	6.4(a)	CHE ---- P(a)	Chemistry Practical-VI(a): Inorganic Chemistry Practical	6 Hrs.	--	4	2	--	50	50	--	25
	6.4(b)	CHE ---- P(b)	Chemistry Practical-VI(b): Organic Chemistry Practical									
	6.4(c)	CHE ---- P(c)	Chemistry Practical-VI(c): Physical Chemistry Practical									

B.Sc. Chemistry (Biology and Mathematics Groups): Semester Wise Summary of Theory and Practical Contents

Sem	Course Type	Unit	Contents Inorganic Chemistry + Organic Chemistry + Physical Chemistry	Sem	Course Type	Unit	Contents Inorganic Chemistry + Organic Chemistry + Physical Chemistry
I	Discipline Centric Core (DCC) Course	I	Atomic Structure, Electronic Configuration	II	Discipline Centric Core (DCC) Course	I	Ionic Bonding, Metallic Bonding, Weak Interaction Forces
		II	Periodic Table, Periodic Properties			II	Covalent Bonding
		III	Basics of Organic Chemistry			III	Alkanes, Cycloalkanes
		IV	Stereochemistry			IV	Liquid State, Solid State
		V	Gaseous State			V	Chemical Kinetics, Catalysis
		Practical	Laboratory Safety and Working. Inorganic Chemistry: Semimicro Analysis Organic Chemistry: MPs and BPs, Purifications, Stereochemistry, Qualitative Analysis Physical Chemistry: Calibration and use of apparatus, Solution Preparation, Surface Tension, Viscosity			Practical	Inorganic Chemistry: Semimicro Analysis Organic Chemistry: Qualitative Analysis, Paper Chromatography Physical Chemistry: Chemical Kinetics, Volumetric Analysis
Sem	**Course Type**	**Unit**	**Contents Inorganic Chemistry + Organic Chemistry + Physical Chemistry**	**Sem**	**Course Type**	**Unit**	**Contents Inorganic Chemistry + Organic Chemistry + Physical Chemistry**
III	Discipline Centric Core (DCC) Course	I	Chemistry of *s*-Block Elements	IV	Discipline Centric Core (DCC) Course	I	Chemistry of *p*-Block Elements
		II	Alkenes, Dienes, Alkynes			II	Coordination Compounds
		III	Arenes and Aromaticity, Alkyl and Aryl Halides			III	Nitroalkanes and Nitroarenes, Alkyl and Aryl Amines
		IV	Chemical Thermodynamics			IV	Alcohols and Phenols, Ethers and Epoxides
		V	Solutions, Colligative Properties			V	Chemical Equilibrium, Ionic Equilibrium
		Practical	Inorganic Chemistry: Quantitative Analysis, Chromatography Organic Chemistry: Qualitative Analysis, Thin Layer Chromatography Physical Chemistry: Thermochemistry, Transition Temperature			Practical	Inorganic Chemistry: Gravimetric Analysis, Inorganic Preparations Organic Chemistry: Organic Synthesis, Column Chromatography Physical Chemistry: Ionic Equilibrium, Molecular Weight Determination

Sem	Course Type	Unit	Elective: V(a): Inorganic Chemistry	Elective: V(b): Organic Chemistry	Elective: V(c): Physical Chemistry
V	Discipline Specific Elective (DSE) Course	I	Chemistry of *d*-Block Elements, Part-I: • Chemistry of I, II and III Transition Series	Carbonyl Compounds	Phase Equilibrium
		II	Chemistry of *d*-Block Elements, Part-II: • Metal-Ligand Bonding in Transition Metal Complexes • Thermodynamic & Kinetic Aspects of Metal Complexes	Carboxylic Acids & their Derivatives, Organic Synthesis via Enolates	Electrochemistry-I
		III	Chemistry of *d*-Block Elements, Part-III: • Magnetic & Electronic Properties of Transition Metal Complexes	Synthetic Polymers, Synthetic Dyes, Fats and Lipids	Electrochemistry-II
		IV	Chemistry of *f*-Block Elements • Chemistry of Lanthanides, Chemistry of Actinides	Amino Acids, Peptides, Proteins	Surface Chemistry, Micelles
		V	Chemistry of Noble Gases, Inorganic Polymers	Enzymes	Photochemistry
		Practical	Complexometric Titrations, Iodo/Iodimetric Titrations, Acid-Base Titrations, Redox Titrations	Oils and Fats, Amino acids and Proteins, Organic Synthesis	Distribution Law, Phase Equilibrium, Conductometry, Electrochemistry
Sem	**Course Type**	**Unit**	**Elective: VI(a): Inorganic Chemistry**	**Elective: VI(b): Organic Chemistry**	**Elective: VI(c): Physical Chemistry**
VI	Discipline Specific Elective (DSE) Course	I	Acids and Bases, Hard and Soft Acids and Bases, Non-aqueous Solvents, Oxidation-Reduction	Heterocyclic Compounds	Quantum Chemistry-I
		II	Organometallic Compounds-I	Carbohydrates, Nucleic Acids	Quantum Chemistry-II
		III	Organometallic Compounds-II	Ultraviolet Spectroscopy, Infrared Spectroscopy	Principles of Spectroscopy, Rotational Spectroscopy
		IV	Nuclear Chemistry	NMR Spectroscopy	Vibrational Spectroscopy, Raman Spectroscopy
		V	Bioinorganic Chemistry	Mass Spectrometry, Structure Elucidation	Electronic Spectroscopy, Atomic Spectroscopy
		Practical	Instrumentation, Colorimetry, Spectrophotometry, Flame Photometry	Estimation, Carbohydrates, Enzymes, Spectroscopy	Potentiometry, Refractometry & Polarimetry, Adsorption, UV-VIS.

Note: If a student opts any one paper out of Inorganic Chemistry, Organic Chemistry and Physical Chemistry in the V semester then it is mandatory that student will opt the same paper only in the VI semester, it means, if a student opts Inorganic Chemistry in the V semester, then he/she will opt Inorganic Chemistry only in the VI semester or if a student opt Organic Chemistry in the V semester, then he/she will opt Organic Chemistry only in the VI semester or if a student opt Physical Chemistry in the V semester, then he/she will opt Physical Chemistry only in the VI semester.

Rules & Regulations

Objectives of the Course:

Bachelor of Science (B.Sc.) programme of the university is a pioneering model in science. The course shall provide the thorough knowledge of all the branches of the chemistry. The course also emphasizes on the communication & presentation skills of the students. After completing the course, the students shall be eligible to take admission for higher studies in different branches of the chemical sciences and able to do research in the different areas of chemical sciences or allied fields and shall be placed in different organizations / institutions where skilled chemical science professionals are required.

Duration of the Course:

The course Bachelor of Science (B.Sc.) Pass Course shall consist of three academic years divided in to the six semesters. B.Sc. (Pass Course) degree shall be awarded to the candidates after successful completion of the six-semester programme of study.

Eligibility for Admission:

- **B.Sc. (Pass Course) Biology Group:**
  A candidate who has passed qualifying examination *i.e.* 10+2 or equivalent examination with Physics, Chemistry and Biology or Physics, Chemistry and Mathematics with Biology as additional subject from any recognized board shall be permitted to take admission in B.Sc. First Semester to award B.Sc. (Pass Course) degree in Biology group from this University.

- **B.Sc. (Pass Course) Mathematics Group:**
  A candidate who has passed qualifying examination *i.e.* 10+2 or equivalent examination with Physics, Chemistry and Mathematics or Physics, Chemistry and Biology with Mathematics as additional subject from any recognized board shall be permitted to take admission in B.Sc. First Semester to award B.Sc. (Pass Course) degree in Mathematics group from this University.

Minimum Marks required in the Qualifying Examination:

- Qualifying examination passed from Rajasthan State or Bonafide Resident of Rajasthan:
  - General Category = 48%.
  - SC/ST/OBC/SBC or MBC = Min. Pass Marks
- Qualifying examination passed from other state than Rajasthan or not a Bonafide Resident of Rajasthan:
  - All Categories = 60%.

Attendance:

Every teaching faculty, handling a course, shall be responsible for the maintenance of Attendance Register for candidates who have registered for the course. The teacher of the course must intimate the Head of the Department at least seven calendar days before the last instruction day in the semester about the attendance particulars of all students. Each student should earn 75% attendance in the courses of the particular semester failing which he or she will not be permitted to sit in the End-Semester Examinations. However, it shall be open to the authorities to grant exemption to a candidate who has failed to obtain the prescribed 75% attendance for valid reasons and such exemptions should not under any circumstance be granted for attendance below 65%.

Course Number, Course Code or ID and Nomenclature:

The course code for UG course may be fixed by taking the first three alphabets of the subject, following by the four numerical digits of examination paper code and T/P. T and P correspond to theoretical nature and practical nature of the subject respectively. For example, if the course is B.Sc. Chemistry theory paper, then the course code will be CHE9604T and if the course is B.Sc. Chemistry practical paper, then the course code will be CHE9604P.

Maximum Marks and Credit Points:

Maximum marks of a theory and practical paper shall be decided on the basis of their contact hours / per week. One teaching hour per week shall equal to one credit and carry 25 maximum marks. Therefore, 4 teaching hours/week having 4 credit points shall carry 100 maximum marks for each theory paper/course. While two contact hours per week for a laboratory or practical work shall be equal to one credit point. Therefore, 4 contact hours / week shall equal to 2 credit points and shall carry 50 maximum marks.

Structure of the Programme:

The B.Sc. (Pass Course) programme consists of discipline centric core, discipline specific electives along with ability enhancement course, generic elective course, value aided course and skill enhancement course under Choice Based Credit System (CBCS) as per the details of the course structure given below:

S. No.	Nature of Paper / Course	Semesters Wise Papers/Course along with Credits of Theory and Practical Components						Total Credits
		I	II	III	IV	V	VI	
1.	Discipline Centric Core (DCC) Course	Subject-I (4T+2P = 6Cr) Subject-II (4T+2P = 6Cr) Subject-III (4T+2P = 6Cr)	Subject-I (4T+2P = 6Cr) Subject-II (4T+2P = 6Cr) Subject-III (4T+2P = 6Cr)	Subject-I (4T+2P = 6Cr) Subject-II (4T+2P = 6Cr) Subject-III (4T+2P = 6Cr)	Subject-I (4T+2P = 6Cr) Subject-II (4T+2P = 6Cr) Subject-III (4T+2P = 6Cr)	--	--	**24** **24** **24** **.....** **72**
2.	Discipline Specific Elective (DSE) Course	--	--	--	--	Subject-I (4T+2P = 6Cr) Subject-II (4T+2P = 6Cr) Subject-III (4T+2P = 6Cr)	Subject-I (4T+2P = 6Cr) Subject-II (4T+2P = 6Cr) Subject-III (4T+2P = 6Cr)	**12** **12** **12** **.....** **36**
3.	Ability Enhancement Compulsory (AEC) Course	General Hindi / General English (2 Cr)	General English / General Hindi (2 Cr)	--	--	--	--	**04**
4.	Generic Elective Course (GEC)	--	--	Environmental Science (2 Cr)	Elementary Computer Applications (2 Cr)	--	--	**04**
5.	Value Added Course (VAC)	--	--	--	--	Mulya Pravah (2 Cr)	--	**02**
6.	Skill Enhancement Course (SEC)	--	--	--	--	--	Skill Enhancement Course (2 Cr)	**02**
Total Credits		**20**	**20**	**20**	**20**	**20**	**20**	**120**

Teaching Methodologies:

The classroom teaching would be through conventional lectures by using blackboards or use of OHPs or LCDs for power point presentations (PPT). The lecture would be such that the student should participate actively in the discussion. Student seminars would be

conducted and scientific discussions would be arranged to improve their communicative skill. In the laboratory, instruction would be given for the experiments followed by demonstration and finally the students have to do the experiments individually. For the students of slow learners, special attention would be given.

Assessment Pattern:

The assessment of the students shall be divided into two parts in which first part is continuous or mid-term or internal assessment (30% weightage of the maximum marks) and second part is semester or end-term or external assessment (70% weightage of the maximum marks).

(i) Continuous / Mid-Term / Internal Assessment:

(a) The continuous or mid-term or internal assessment for each theory paper shall be taken by the faculty members in the Department during each semester. Internal assessment part is further divided in two parts of equal weightage of marks as per the details given below:

Continuous Assessment	Modes of Assessments		Max. Marks
	Collegiate (Regular) Students	Non-collegiate (Private) Students	
Cont. Assess-I	Written Examination	Report Writing	20
Cont. Assess-II	Seminar / Presentation / Project Report / Quiz / GD / Viva-voce	Viva-voce	10

Note: *In the Continuous/Mid-Term/Internal Assessment-I, written examination shall be of one hour duration for each theory paper and shall be taken according to the academic calendar which will be notified by the Department. Time duration for Continuous/Mid-Term/Internal Assessment-II is not allotted. It will be decided by the faculty member which will be taking second internal assessment.*

(b) For practical papers, there will not be continuous or mid-term or internal assessment. There will be only one external or end-term or semester assessment having 100% weightage of maximum marks.

(c) A student, who remains absent (defaulter) or fails or wants to improve the marks in the continuous or mid-term or internal assessment, may be permitted to appear in the desired paper(s) in same semester and one time only with the permission of the concern Head of the Department. Defaulter/improvement fee of Rupees 250/- per paper shall be taken from such candidates. Duly forwarded application of such student by the Head of the Department, who may permit the such candidates to appear in the continuous or mid-term or internal assessment after production of satisfactory evidence about the reason of his/her absence in the test(s) and deposition of the defaulter/improvement fee, shall be sent to the concerned teacher to take the continuous or mid-term or internal assessment of such candidates. A record of such candidates shall be kept in the Department.

(d) Regular attendance of the student shall be considered in the internal assessment. Marks (equal to 10% of internal assessment) may be given to the student(s) for regularity who is/are taken classes regularly. If the attendance/regularity factor is similar for all the students, then weightage marks for regularity may be merged in the weightage of second internal assessment (seminar / presentation / assignment / dissertation / quiz / group discussion / viva-voce, *etc.*).

(e) Paper wise consolidated marks for each theory paper and dissertation / seminar (*i.e.* total marks obtained during various modes of internal assessment) obtained by the students (out of the 30% weightage of the maximum marks of the each paper) shall be forwarded by the Head of the Department (in two copies) to the Controller of Examinations of the University within a week from the date of last internal assessment test for incorporation in the tabulation register.

(f) The consolidated marks obtained by the students be also made known to them before being communicated by the concerned Head of the Department to the University for final incorporation in the tabulation register. If any discrepancies are discovered or pointed out by the students, the same shall be looked into by the concerned faculty member and corrections made, wherever necessary. The decision of the Head of the Department before the communication of marks to the University shall be final. No corrections shall be made in the internal assessment marks after the declaration of the result by the University.

(g) Consolidated marks of internal assessment obtained out of the 30% weightage of maximum marks of each theory paper which will be communicated to the University shall be in whole number and not in fraction. Marks awarded for the various internal assessments in each paper shall be added up and then round off to the next whole number to avoid any fraction.

(h) All test copies and other material related to the internal assessment shall also be sent to the Controller of Examinations of the University to keep in record as per the University guidelines.

(i) The concerned Head of the Department shall be responsible for proper conduct of internal assessment tests and for communication of the consolidated marks to the University within the prescribed time.

(j) The Head of the Department shall keep a record of the marks and also notify the same to the candidates immediately so that if any candidate is not satisfied with the award in any test or seasonal work, he / she should represent the matter to the higher authority.

(ii) Semester / End-Term / External Assessment:

(a) The semester or end-term or external assessment (70% weightage of the maximum marks) shall be 03 hours duration to each theory paper and 06 hours duration for each practical paper and shall be taken by the University at the end of each semester.

(b) The syllabus for each theory paper is divided into five independent units.

Question Paper Pattern:

(A) Continuous / Mid-Term / Internal Assessment:

30% weightage of Maximum Marks (30 Marks out of 100 Maximum Marks).

For Collegiate (Regular) Students

(i) Continuous / Mid-Term / Internal Assessment-I (Max. Marks: 20):

Department of .....
University / College: .....
Address: .....

First Internal Assessment Test 20… - 20….
(Written Examination)

Name of Class/Course :	Max. Marks : 20 Marks
Name of Semester :	Duration of Exam. : 1.00 Hr
No. & Name of Paper :	Date of Exam. :

Q. No. 1. …… 05 Marks
or
……

Q. No. 2. …… 05 Marks
or
……

Q. No. 3. …… 05 Marks
or
……

Q. No. 4. …… 05 Marks
or
……

(ii) Continuous / Mid-Term / Internal Assessment-II (Max. Marks: 10):

Department of .....
University / College: .....
Address .....

Second Internal Assessment Test 20… - 20….
(Seminar / Presentation / Project Report / Quiz / GD / Viva-voce)

Name of Class/Course:	Max. Marks : 10 Marks
Name of Semester :	Mode of Assessment:
No. & Name of Paper:	Date of Assessment:

Format for Compilation of Marks/Awards of Continuous/Mid-Term/Internal Assessment-I & II for Collegiate (Regular) Students

Department of .....
University / College: .....
Address .....

Name of Class/Course: .....
Name of Semester : .....
No. & Name of Paper: .....
Max. Marks : .....

S. No.	Name of Student	Father's Name	Marks Obtained			
			Internal Assess. - I	Internal Assess. - II	Total Marks (In Figure)	Total Marks (In Words)
1.						

Name & Signature of the Faculty Member

For Non-collegiate (Private) Students

(i) Continuous / Mid-Term / Internal Assessment-I (Max. Marks: 20):

Report Writing

Each private student of UG program will prepare a report on any topic of each course in minimum 1000 words from the prescribed syllabus of the concerned theory paper/course. The student needs to report the Concerned Department / College at the time prescribed by the College/University to submit the report and the College will arrange a Viva-voce on that report. It is proposed that the engaged teacher will be paid at the rate of per answer book per student charges. The examination section will generate an option of bill when the teacher fills the continuous assessment marks on examination portal (same as for external answer book evaluation). The various components of the report may be:

- Name of Course/Class:
- Name of Student:
- Father's/Husband Name:
- Examination Form No:
- Enrollment No:
- Name of College (Center):
- Name of Paper:
- Title of Topic:
- No. of Unit of Topic (as per prescribed syllabus):
- Introduction about the Topic:
- Details/Analysis about the Topic
- Conclusion of the Topic:
- References:

(ii) Continuous / Mid-Term / Internal Assessment-II (Max. Marks: 10):

Only Viva-voce will be taken by the concerned faculty member at Department level.

Format for Compilation of Marks/Awards of Continuous/Mid-Term/Internal Assessment-I & II for Non-collegiate (Private) Students

Department of .....
University / College: .....
Address .....

Name of Class/Course: .....
Name of Semester : .....
No. & Name of Paper: .....
Max. Marks : .....

S. No.	Name of Student	Father's Name	Marks Obtained			
			Internal Assess. - I (Report Writing)	Internal Assess. - II (Viva voce)	Total Marks (In Figure)	Total Marks (In Words)
1.						

Name & Signature of the Faculty Member

(B) Semester / End-Term / External / Assessment:

70% weightage of Maximum Marks (70 Marks out of 100 Maximum Marks).

Question Paper Pattern for Semester Examination

[Common for Collegiate (Regular) and Non-collegiate (Private) Students]

Duration of Examination: 3 Hours **Max. Marks: 70**

Note: *The syllabus is divided into five independent units and question paper will be divided into following two sections:*

- ***Section-A*** *will carry one compulsory question comprising 10 short answer type questions (answer about in 10-20 words) by taking two questions from each unit with no internal choice. Each short answer type question will have 2 marks and hence Section-A will carry total 20 marks.*
- ***Section-B*** *will carry 50 marks equally divided into five long answer type questions (answer about in 400-500 words) with one question from each unit with internal choice (another question will be given in option or question may be divided in to sub-divisions). Paper setter shall be advised to set one question from each unit along with one option of each question and students are instructed to attempt total five questions by selecting one question from each unit. Each long answer type question will have 10 marks and hence Section-B will carry total 50 marks.*

Section-A

Q. No. 1: Comprising 10 Short Answer Type Questions

Unit-I

(i) …… 02 Marks
(ii) …… 02 Marks

Unit-II

(iii) …… 02 Marks
(iv) …… 02 Marks

Unit-III

(v) …… 02 Marks
(vi) …… 02 Marks

Unit-IV

(vii) …… 02 Marks
(viii) …… 02 Marks

Unit-V

(ix) …… 02 Marks
(x) …… 02 Marks

Section-B

Unit-I

Q. No. 2: …….. 10 Marks

Or

……

Unit-II

Q. No. 3: …….. 10 Marks

Or

……

Unit-III

Q. No. 4: …….. 10 Marks

Or

……

Unit-IV

Q. No. 5: …….. 10 Marks

Or

……

Unit-V

Q. No. 6: …….. 10 Marks

Or

……

Practical Examinations:

Continuous / Mid-Term / Internal Assessment:

Not applicable in Practical Examinations.

Semester / End-Term / External Assessment:

Common for Collegiate (Regular) and Non-collegiate (Private) Students

Duration of Exam: 6 Hours **Maximum Marks: 50**

Distribution of Maximum Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: ……..	10
2.	Exercise No. 2: ……..	10
3.	Exercise No. 3: ……..	10
4.	Practical Record	10
5.	Viva-voce	10
	Total Marks	**50**

Minimum Pass Marks and Rules regarding Determination of Results:

Each semester shall be regarded as a unit for working out the result of the candidates. The result of each semester examination shall be worked out separately (even if he/she has appeared at the paper of the lower semester along with the papers of higher semester) in accordance with the following conditions:

(a) The candidate shall be declared as pass in a semester examination, if he/she secures at least 40% marks in each theory paper separately in continuous/internal and semester / external examinations and 50% marks in each practical paper/project/dissertation with 40% aggregate marks in that semester.

(b) A candidate declared as fail/absent in one or more papers at any odd semester examination shall be permitted to take admission in the next higher semester (even semester) of the same academic session.

(c) A candidate may be promoted in the next academic session (odd semester), if he/she has cleared collectively at least 50% of the papers of both semesters of previous academic session. The candidate who does not fulfill the above condition will remain as an ex-student and will re-appear in the due papers' examinations along with next odd/even semester examinations.

(d) If any student who is provisionally admitted in higher odd semester but could not secure prescribed minimum marks in previous semesters will be treated as ex-student and his/her admission fee will be carry forwarded to the next odd semester of forthcoming academic session.

(e) If a candidate, who is declared as pass, wants to improve his/her performance in the theory papers of just previous semester, he/she may re-appear only one time in these theory papers in next odd/even semester examinations.

(f) Candidate shall not be permitted to re-appear or improve the marks obtained in the external examination of practical/dissertation in any condition.

(g) If the number of papers prescribed in a semester examination is an odd number, it shall be increased by one for the purpose of reckoning 50% of the papers for considering the student pass/fail.

(h) A candidate may be given only two additional chances for passing the semester thus maximum tenure for completing for three years undergraduate programme up to five years and so on.

(i) The marks secured in the General Hindi, General English, Computer Applications and Environment Science shall not be counted in awarding the division to a candidate. The candidate shall have to clear the compulsory papers/subjects in the additional three chances and non-appearance or absence in the examination of compulsory papers/subjects shall be counted as chance and shall be declared fail in that examination.

(j) The grace marks scheme shall be applicable as per the University norms.

Classification of Successful Candidates:

(a) Each student shall be awarded a final letter grade at the end of the semester of the particular course. The letter grades and their corresponding grade points are given as:

Percentage of Marks Obtained	Performance	Grade Letter	Grade Point
90.00 – 100.00	Outstanding	O	10
80.00 – 89.99	Excellent	A^+	9
70.00 – 79.99	Very Good	A	8
60.00 – 69.99	Good	B^+	7
50.00 – 59.99	Above Average	B	6
45.00 – 49.99	Average	C	5
40.00 – 45.99	Below Average / Pass	P	4
00.00 – 39.99	Fail	F	0
--	Absent	AB	0
--	Unfair Means	UM	0
--	Withdrawn	W	0

(b) A candidate who remains absent for any semester examination shall be assigned a letter grade AB along with corresponding grade point zero. He/she will have to re-appear for the said examination in due paper/course.

(c) Semester Grade Point Average (SGPA): Performance of a student in a semester is indicated by a number called 'Semester Grade Point Average' (SGPA). The SGPA is the weighted average of the grade points obtained in all the courses by the student during the semester. For example, if a student takes five papers (theory/practical) in a semester with credits C_1, C_2, C_3, C_4 and C_5 and the student's grade points in these courses are P_1, P_2, P_3, P_4 and P_5 respectively, then students' SGPA is calculated as:

$$\text{SGPA} = \frac{C_1P_1 + C_2P_2 + C_3P_3 + C_4P_4 + C_5P_5}{C_1 + C_2 + C_3 + C_4 + C_5} = \frac{\sum_{i=1}^{n} C_iP_i}{\sum_{i=1}^{n} C_i}$$

Where:

C_i: Number of credits earned in the i^{th} paper/course of semester for which SGPA is to be calculated.

P_i: Grade point earned in i^{th} paper/course.

i = 1, 2, 3, 4,……..n : Represents the number of papers/courses in which a student has appeared in End of Semester Evaluation (EoSE).

The SGPA is calculated, as per example given below, up to two decimal points:

Paper/Course	Credit (C)	Grade Letter	Grade Point (P)	Credit Point (CP)	SGPA
Physics-I	4	A	8	4 x 8 = 32	ΣCP
Physics Practical-I	2	B^+	7	2 x 7 = 14	= ---------
Chemistry-I	4	A	8	4 x 8 = 32	ΣC
Chemistry Practical-I	2	B^+	7	2 x 7 = 14	146
Mathematics-I	4	A	8	4 x 8 = 32	= ------
Mathematics Practical-I	2	B	6	2 x 6 = 12	20
General Hindi	2	C	5	2 x 5 = 10	
Total	**20**	**--**	**--**	**146**	= **7.30**

It should be noted that, the SGPA for any semester shall take into consideration the F and AB grade awarded in that semester. For example, if a student has a F or AB grade in paper/course 4, the SGPA shall then be computed as:

$$SGPA = \frac{C_1P_1 + C_2P_2 + C_3P_3 + C_4 \times ZERO + C_5P_5}{C_1 + C_2 + C_3 + C_4 + C_5}$$

(d) Cumulative Grade Point Average (CGPA): The CGPA is calculated with the SGPA of all the semesters up to two decimal points and is indicated in final grade report card / final transcript showing the grades of all the semesters and their papers/courses. The CGPA shall reflect the failed status in case of F grade(s), till the paper(s)/course(s) is/are passed. When the paper(s)/course(s) is/are passed by obtaining a pass grade on subsequent examination(s), the CGPA shall only reflect the new grade and not the fail grades earned earlier. The CGPA is calculated as:

$$CGPA = \frac{C_1S_1 + C_2S_2 + C_3S_3 + C_4S_4 + C_5S_5 + C_6S_6}{C_1 + C_2 + C_3 + C_4 + C_5 + C_6} = \frac{\sum_{i=1}^{n} C_i S_i}{\sum_{i=1}^{n} C_i}$$

Where:

C_1, C_2, C_3, … is the total number of credits for I, II, III, …. Semesters and S_1, S_2, S_3, … is the SGPA of I, II, III, …. Semesters.

The CGPA is calculated, as per example given below, up to two decimal points:

Semester	Credit (C)	SGPA	C x SGPA (CS)	CGPA
Semester-I	20	7.30	20 x 7.30 = 146.0	ΣCS
Semester-II	20	7.69	20 x 7.69 = 153.8	= --------
Semester-III	20	7.23	20 x 7.23 = 144.6	ΣC
Semester-IV	20	7.86	20 x 7.86 = 157.2	925.80
Semester-V	20	8.12	20 x 8.12 = 162.4	= -------
Semester-VI	20	8.09	20 x 8.09 = 161.8	120
Total	**120**	**--**	**925.80**	= **7.71**

(e) The classification of successful candidates after last semester examination shall be as under:

Description of Marks Obtained	Division / Result	CGPA
• 75% and above marks in a paper with Distinction	First Class with Distinction	CGPA 7.50 and above
• A candidate who has secured aggregate 60% and above marks	First Class/Division	CGPA 6.00 to 7.49
• A candidate who has secured aggregate 50% and above but less than 60% marks	Second Class/Division	CGPA 5.00 to 5.99
• A candidate who has secured aggregate 40% and above but less than 50% marks	Pass	CGPA 4.00 to 4.99
• A candidate who has secured aggregate below to the 40% marks	Fail	CGPA below 4.00

..... x ..... x ..... x .....

Syllabus

B.Sc. (Pass Course) Biology and Mathematics Groups

Fifth Semester Examination

Paper-5.3(a): CHE.....T(a)
Chemistry-V(a): Inorganic Chemistry

Contact Hours / Week : 3 Hours / Week
Duration of Examination : 3 Hours
Maximum Marks : 100 Marks
Continuous Assessment : 30 Marks
Semester Assessment : 70 Marks

The syllabus is divided into five independent units and question paper will be divided into following two sections:

Section-A *will carry one compulsory question comprising 10 short answer type questions (answer about in 10-20 words) by taking two questions from each unit with no internal choice. Each short answer type question will have 2 marks and hence Section-A will carry total 20 marks.*

Section-B *will carry 50 marks equally divided into five long answer type questions (answer about in 400-500 words) with one question from each unit with internal choice (another question will be given in option or question may be divided in to sub-divisions). Paper setter shall be advised to set one question from each unit along with one option of each question and students are instructed to attempt total five questions by selecting one question from each unit. Each long answer type question will have 10 marks and hence Section-B will carry total 50 marks.*

Unit-I **Chemistry of *d*-Block Elements, Part-I**

Chemistry of Elements of First Transition Series:

Characteristics properties, properties of the elements of the first transition series, their binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry.

Chemistry of Elements of Second and Third Transition Series:

General characteristics, comparative treatment with their 3d analogues in respect to ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry.

Unit-II **Chemistry of *d*-Block Elements, Part-II**

Metal-Ligand Bonding in Transition Metal Complexes:

Elementary idea of crystal field theory, crystal field stabilization energy (CFSE), crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal field parameters, comparison of CFSE for O_h and T_d complexes, tetragonal distortions from octahedral geometry, Jahn-Teller distortions, applications and limitations of crystal field theory.

Thermodynamic and Kinetic Aspects of Metal Complexes:

A brief outline of thermodynamic and kinetic stability of metal complexes and factors affecting the stability, introduction to inorganic reaction mechanisms, substitution reactions of square planar and octahedral complexes, Trans-effect, theories of trans effect.

Unit-III **Chemistry of *d*-Block Elements, Part-III**

Magnetic Properties of Transition Metal Complexes:

Types of magnetic behaviour, methods of determining magnetic susceptibility, spin-only formula, spin-spin coupling, orbital coupling, L-S coupling, correlation of n_s

and n_{eff} and values, orbital contribution to magnetic moments, application of magnetic moment data for 3d-metal complexes.

Electronic Properties of Transition Metal Complexes:
Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel-energy level diagram for d^1 and d^9 states, discussion of the electronic spectrum of $[(T_i(H_2O)_6]^{3+}$ complexion.

Unit-IV Chemistry of *f*-Block Elements

Chemistry of Lanthanides:
Electronic structure, oxidation states, ionic radii and lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds.

Chemistry of Actinides:
General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between the later actinides and later lanthanides.

Unit-V Chemistry of Noble Gases:
Rationalization of inertness of noble gases, chemistry of helium, argon and xenon; preparation and properties of XeF_2, XeF_4 and XeF_6; nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2), molecular shapes of noble gas compounds (VSEPR theory).

Inorganic Polymers:
Types of inorganic polymers, comparison with organic polymers, preparation, properties, structure and uses of diboranes, borazines, silicates, siloxanes, poly-sulphates and phosphazenes.

Paper-5.3(b): CHE.....T(b)
Chemistry-V(b): Organic Chemistry

Contact Hours / Week	: 3 Hours / Week	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

The syllabus is divided into five independent units and question paper will be divided into following two sections:

Section-A *will carry one compulsory question comprising 10 short answer type questions (answer about in 10-20 words) by taking two questions from each unit with no internal choice. Each short answer type question will have 2 marks and hence Section-A will carry total 20 marks.*

Section-B *will carry 50 marks equally divided into five long answer type questions (answer about in 400-500 words) with one question from each unit with internal choice (another question will be given in option or question may be divided in to sub-divisions). Paper setter shall be advised to set one question from each unit along with one option of each question and students are instructed to attempt total five questions by selecting one question from each unit. Each long answer type question will have 10 marks and hence Section-B will carry total 50 marks.*

Unit-I Aldehydes and Ketones:
Structure, reactivity and preparation; Physical properties. Nucleophilic additions, nucleophilic addition-elimination reactions with ammonia derivatives with mechanism. Mechanisms of Aldol, Benzoin, Knoevenagel condensations, Claisen-Schmidt, Perkin, Cannizzaro, Wittig reactions, Mannich reaction, Beckmann and

Benzil-Benzilic acid rearrangements, haloform reaction, α-substitution reactions, Baeyer-Villiger oxidation, Clemmensen, Wolff-Kishner, $LiAlH_4$ and $NaBH_4$ reductions; Addition reactions of unsaturated carbonyl compounds: Michael addition. An introduction to α,β-unsaturated aldehydes and ketones.

Unit-II Carboxylic Acids and their Derivatives:

Structure and bonding, physical properties, acidity of carboxylic acids, effect of substituents on acid strength. Preparation and reactions of monocarboxylic acids. Hell-Volhard-Zelinsky reaction. Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic, phthalic, lactic, malic, tartaric, citric, maleic and fumaric acids.

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group-Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

Organic Synthesis via Enolates:

Acidity of α-hydrogens. alkylation of diethyl malonate and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation. Keto-enol tautomerism of ethyl acetoacetate.

Unit-III Synthetic Polymers:

Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step growth polymerization. Polyesters, polyamides, phenol-formaldehyde resins, urea-formaldehyde resins, epoxy resins and polyurethanes. Natural and synthetic rubbers.

Synthetic Dyes:

Colour and constitution (electronic concept), classification of dyes. Synthesis of methyl orange, Congo red, malachite green, crystal violet, phenolphthalein, fluorescein, Alizarin and Indigo.

Fats and Lipids:

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, saponification value, acid value, iodine number. Reversion and rancidity.

Unit-IV Amino Acids:

Classification, structure and stereochemistry of amino acids. Acid-base behaviour, isoelectric point and electrophoresis. Preparation and reactions of α-amino acids.

Peptides:

Structure and nomenclature of peptides. Peptide structure determination, end group analysis, selective hydrolysis of peptides. Classical peptide synthesis, solid-phase peptide synthesis. Structures of peptides and proteins, Levels of protein structure.

Proteins:

Overview of primary, secondary, tertiary, and quaternary structure of proteins. Protein denaturation/renaturation.

Unit-V Enzymes:

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition), enzyme kinetics.

Paper-5.3(c): CHE.....T(c)
Chemistry-V(c): Physical Chemistry

Contact Hours / Week : 3 Hours / Week
Duration of Examination : 3 Hours
Maximum Marks : 100 Marks
Continuous Assessment : 30 Marks
Semester Assessment : 70 Marks

The syllabus is divided into five independent units and question paper will be divided into following two sections:

Section-A *will carry one compulsory question comprising 10 short answer type questions (answer about in 10-20 words) by taking two questions from each unit with no internal choice. Each short answer type question will have 2 marks and hence Section-A will carry total 20 marks.*

Section-B *will carry 50 marks equally divided into five long answer type questions (answer about in 400-500 words) with one question from each unit with internal choice (another question will be given in option or question may be divided in to sub-divisions). Paper setter shall be advised to set one question from each unit along with one option of each question and students are instructed to attempt total five questions by selecting one question from each unit. Each long answer type question will have 10 marks and hence Section-B will carry total 50 marks.*

Unit-I Phase Equilibrium:

Concept of phases, components and degrees of freedom, derivation of Gibbs phase rule for non-reactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems (H_2O, CO_2 and S) with applications. Phase equilibria of two component systems (solid-liquid) involving eutectic (Pb-Ag), congruent (Mg-Zn) and incongruent (NaCl-H_2O) melting points, solid solutions. Three component systems, water-chloroform-acetic acid system, triangular plots. Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

Unit-II Electrochemistry-I:

Arrhenius theory of electrolytic dissociation. conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Hückel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules. Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

Unit-III Electrochemistry-II:

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass and SbO/Sb_2O_3 electrodes. Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

Unit-IV Surface Chemistry

Physical adsorption, chemisorption, Factors influencing adsorption, adsorption isotherms (Langmuir, Freundlich and Gibbs isotherms), Langmuir theory of unilayer adsorption isotherm, nature of adsorbed state, Applications.

Micelles:

Classification of surface-active agents. Surfactant action, micellization and micellar interactions, Structure of micelles – spherical and laminar. Critical micellar concentration (CMC). Factors affecting the CMC of surfactants. Counter ion binding to micelles

Unit-V Photochemistry

Lambert-Beer's law and its limitations, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes, photo stationary states, chemiluminescence.

Paper-5.4(a): CHE.....P(a)
Chemistry Practical-V(a): Inorganic Chemistry Practical

Contact Hours / Week : 4 Hours / Week
Duration of Examination : 6 Hours
Maximum Marks : 50 Marks
Semester Assessment : 50 Marks

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: ……..	10
2.	Exercise No. 2: ……..	10
3.	Exercise No. 3: ……..	10
4.	Practical Record	10
5.	Viva-voce	10
	Total Marks	**50**

Complexometric Titrations:

- Estimation of Mg^{2+} or Zn^{2+} by complexometric titrations using EDTA.
- Estimation of total hardness of a given sample of water by complexometric titration.

Iodo/Iodimetric Titrations:

- Estimation of Cu(II) and $K_2Cr_2O_7$ using sodium thiosulphate solution.
- Estimation of arsenite and antimony.
- Estimation of available chlorine in bleaching powder.

Acid-Base Titrations:

- Estimation of sodium carbonate using standardized HCl
- Estimation of carbonate and hydroxide present together in mixture.
- Estimation of carbonate and bicarbonate present together in a mixture.
- Estimation of free alkali present in different soaps/detergents

Redox Titrations:

- Estimation of oxalic acid using standardized $KMnO_4$ solution.
- Estimation of oxalic acid and sodium oxalate in a given mixture.
- Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$
- Estimation of Fe(II) using standardized $KMnO_4$ solution.
- Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Paper-5.4(b): CHE.....P(b)
Chemistry Practical-V(b): Organic Chemistry Practical

Contact Hours / Week : 4 Hours / Week
Duration of Examination : 6 Hours
Maximum Marks : 50 Marks
Semester Assessment : 50 Marks

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: ……..	10
2.	Exercise No. 2: ……..	10
3.	Exercise No. 3: ……..	10
4.	Practical Record	10
5.	Viva-voce	10
	Total Marks	**50**

Oils and Fats:
Determination of saponification value of an oil/fat.
Determination of iodine number of an oil/fat.

Amino acids and Proteins:
Determination of the concentration of glycine by Sorenson's formalin method.
Study of the titration curve of glycine.
Determination of protein by the Biuret reaction.
Estimation of proteins by Lowry's method.

Organic Synthesis:

- Oxidation: Preparation of benzoic acid from toluene.
- Reduction: Preparation of aniline from nitrobenzene and m-nitroaniline from m-dinitrobenzene.
- Diazotization/coupling: Preparation of methyl orange and methyl red.
- Aldol condensation:

- Benzil-Benzilic acid rearrangement:
- Oxime formation: Synthesis of benzophenone oxime from benzophenone
- Hydrazone Formation: Preparation of 2,4-dinitrophenylhydrazones of aldehyde / ketone
- Hydrolysis of amides and esters.
- Preparation of S-Benzylisothiouronium salts of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).

The solid samples of the compounds synthesized must be collected and may be used for recrystallization, melting point and TLC.

Paper-5.4(c): CHE.....P(c)
Chemistry Practical-V(c): Physical Chemistry Practical

Contact Hours / Week : 4 Hours / Week Maximum Marks : 50 Marks
Duration of Examination : 6 Hours Semester Assessment : 50 Marks
Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: ……..	10
2.	Exercise No. 2: ……..	10
3.	Exercise No. 3: ……..	10
4.	Practical Record	10
5.	Viva-voce	10
	Total Marks	**50**

Distribution Law:

- To study the distribution of iodine between water and CCl_4
- To study the distribution of benzoic acid between water and benzene.
- To study the distribution of acetic acid between water and cyclohexane

Phase Equilibrium:

- Construction of the phase diagram of a binary system (simple eutectic) using cooling curves.
- Determination of the critical solution temperature and composition of two partially miscible liquids and study of the effect of impurities on it.
- Study of the variation of mutual solubility temperature with concentration for the phenol water system and determination of the critical solubility temperature.

Conductometry:

- Determination of cell constant
- Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.
- Perform the following conductometric titrations:
  - Strong acid vs. strong base
  - Strong acid vs. weak base
  - iii Weak acid vs. strong base
  - iii Mixture of strong acid and weak acid vs. strong base

Electrochemistry:

- To determine the strength of the given acid conductometrically using standard alkali solution.
- To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.
- To study the saponification of ethyl acetate conductometrically.
- To determine the ionization constant of a weak acid conductometrically.

Suggested Books for Theory Papers:

Inorganic Chemistry:

- *Basic Inorganic Chemistry: F. A. Cotton and G. Wilkinson, Wiley Eastern*
- *Chemistry of the Elements, N.N. Greenwood and A. Earnshaw*
- *Shriver & Atkins' Inorganic Chemistry*
- *Concise Inorganic Chemistry: J. D. Lee, ELBS*
- *Theoretical Inorganic Chemistry, ACS Publications. M.C. Day and J. Selbin*
- *Advanced Inorganic Chemistry, Vol I & II. Satya Prakash, G.D. Tuli, S.K. Basu and R.D. Madan*
- *Principles of Inorganic Chemistry: B. R. Puri and L. R. Sharma*
- *Fundamentals of Inorganic Chemistry, Vol. I, Das, CBS Publications, 2nd Ed.*
- *Bioinorganic Chemistry-Bertini*
- *Biological Inorganic Chemistry-An Introduction-Robert R. Crichton*
- *The Organometallic Chemistry of Transition Metals, 4e-Robert H Crabtree*
- *Organometallic Chemistry, Mehrotra and Singh. New Age International Publishers, 2ndEdn.*
- *Basic Organometallic Chemistry, 2ndEdn., Gupta B. D. and Elias A. J., University Press.*

Organic Chemistry:

- *Organic Chemistry, Claydon, Nick Greeves and Stuart Warren, Oxford University Press*
- *Organic Chemistry, Graham Solomons, John Wiley & Sons, Inc.*
- *Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.*
- *Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.*
- *Organic Chemistry (Volume 1), I.L. Finar, Dorling Kindersley (India) Pvt. Ltd.*
- *Organic Chemistry (Volume 2): Stereochemistry and the Chemistry of Natural Products, I.L. Finar, Dorling Kindersley (India) Pvt. Ltd.*
- *Organic Chemistry, Vol. I, II & III. Jag Mohan, R. Chand & Company*
- *Organic Chemistry, (Vol. I, II & III. S. M. Mukherji, S. P. Singh and R. P. Kapoor*
- *Stereochemistry of Carbon Compounds, Ernest L. Eliel, Tata McGraw Hill.*
- *Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.*
- *Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.*
- *A Textbook of Organic Chemistry: P S Kalsi, New Age International*
- *A Text Book of Organic Chemistry: B. S. Bahl and Arun Bahl*
- *A Text Book of Organic Chemistry: P. L. Soni & H.M. Chawla*
- *A Text Book of Organic Chemistry: (Vol. I & II) O. P. Agarwal*
- *Organic Synthesis: Jagadamba Singh and L.D.S. Yadav*
- *Principles of Organic Synthesis-Norman & Coxon*
- *Heterocyclic Chemistry at a Glance 2e by Joule & Mills Blackwell*
- *Heterocyclic Chemistry by RK Bansal*
- *Heterocyclic Chemistry Volume I and II by RR Gupta*
- *Fundamentals of Biochemistry 5e Voet & Voet*
- *Lehninger Principles of Biochemistry 4e Nelson & Cox*
- *Harper's Illustrated Biochemistry. XXVIII edition. Murray, Granner, Mayes and Rodwell. Lange Medical Books/ McGraw-Hill.*
- *Elementary Organic Spectroscopy, 5th Edition, Y R Sharma, S. Chand & Company.*
- *Organic Spectroscopy and Applications, Jag Mohan, Narosa Publishers*
- *Organic Spectroscopy, Kemp, W. Palgrave*

Physical Chemistry:

- *Atkins' Physical Chemistry, Oxford University Press*

- *Principles of Physical Chemistry: Prutton and Marron*
- *Elements of Physical Chemistry: Lewis Glasstone*
- *Principles of Physical Chemistry: B. R. Puri and L. R. Sharma*
- *A Text Book of Physical Chemistry: A. S. Negi and S. C. Anand*
- *A Text Book of Physical Chemistry by K. L. Kapoor*
- *Modern Electrochemistry 2A-Fundamentals of Electrodics-Bockris, Reddy & Gamboa*
- *Introductory Quantum Chemistry, Chandra, A. K., Tata McGraw-Hill.*
- *Fundamentals of Quantum Chemistry, 2nd Ed. House, J. E., Elsevier*
- *Quantum Chemistry, Lowe, J. P. & Peterson, K. Academic Press.*
- *Fundamentals of Molecular Spectroscopy, 4th Ed. Banwell & McCash. Tata McGraw-Hill: New Delhi.*
- *Atomic & Molecular Spectroscopy, Kakkar, R. Cambridge University Press*
- *Fundamentals of Photochemistry, Rohatagi Mukherjee. Wiley Eastern Ltd.*

Analytical Chemistry:

- *Principles of Instrumental Analysis, Skoog, Holler and Nieman, Thomson Asia Pvt. Ltd. Singapore.*
- *Analytical Chemistry Vol-I Qualitative Analysis-Treadwell & Hall*
- *Analytical Chemistry Vol-II Quantitative Analysis-Treadwell & Hall*
- *Chemical Analysis-Modern Instrumentation Methods and Techniques, 2e-Francis Rouessac*
- *Handbook of Instrumental Techniques for Analytical Chemistry-Frank Settle*

Suggested Books for Practical Papers:

Inorganic Chemistry

- *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis*
- *Vogel's Textbook of Quantitative Analysis, Bassett, Denney, Jeffery and Mendham*
- *Qualitative Analysis by Welcher and Hahn.*
- *Practical Chemistry: Giri Bajpai and Pandey, S. Chand & Co. Ltd., New Delhi.*

Organic Chemistry:

- *Vogel's Textbook of Practical Organic Chemistry, Tatchell, John Wiley.*
- *Macro scale and Micro scale Organic Experiments, K.L. Williamson, D.C. Health*
- *Practical Organic Chemistry, 5th Ed., Furniss, Hannaford, Smith, Tatchell. Pearson.*
- *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Ahluwalia & Aggarwal, University Press.*
- *Comprehensive Practical Organic Chemistry: Qualitative Analysis, Ahluwalia, & Dhingra, S., University Press.*
- *Laboratory Hand Book of Chromatographic & Allied Methods, Mikes, & Chalmes, Elles Harwood Ltd. London*

Physical Chemistry

- *Practical Physical Chemistry, James and Prichard, Longman.*
- *Findley's Practical Physical Chemistry, Levitt, Longman.*
- *Experimental Physical Chemistry, Das and Behera, Tata McGraw Hill.*
- *Experimental Physical Chemistry, Athawale & Mathur, New Age International: New Delhi.*
- *Senior Practical Physical Chemistry, Khosla, Garg, and Gulati. R. Chand & Co.: New Delhi*
- *Experiments in Physical Chemistry 8th Ed.; Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. McGraw-Hill: New York*
- *Experimental Physical Chemistry 3rdEd.; Halpern, A.M. & McBane, G. C. W.H. Freeman & Co.: New York.*
- *Experimental Physical Chemistry, J. N. Gurtu, R. Kapoor*

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Syllabus

B.Sc. (Pass Course) Biology and Mathematics Groups

Sixth Semester Examination

Paper-6.3(a): CHE.....T(a)
Chemistry-VI(a): Inorganic Chemistry

Contact Hours / Week : 3 Hours / Week
Duration of Examination : 3 Hours
Maximum Marks : 100 Marks
Continuous Assessment : 30 Marks
Semester Assessment : 70 Marks

The syllabus is divided into five independent units and question paper will be divided into following two sections:

Section-A *will carry one compulsory question comprising 10 short answer type questions (answer about in 10-20 words) by taking two questions from each unit with no internal choice. Each short answer type question will have 2 marks and hence Section-A will carry total 20 marks.*

Section-B *will carry 50 marks equally divided into five long answer type questions (answer about in 400-500 words) with one question from each unit with internal choice (another question will be given in option or question may be divided in to sub-divisions). Paper setter shall be advised to set one question from each unit along with one option of each question and students are instructed to attempt total five questions by selecting one question from each unit. Each long answer type question will have 10 marks and hence Section-B will carry total 50 marks.*

Unit-I Acids and Bases:

Arrhenius, Bronsted-Lowry, the Lux-Flood and Lewis's concept of acids and bases, solvated proton, relative strength of acids, types of acid-base reactions, levelling solvents.

Hard and Soft Acids and Bases (HSAB):

Classification of acids and bases as hard and soft. Pearson's HSAB concept, acid-base strength and hardness and softness. Symbiosis, theoretical basis of hardness and softness, electronegativity and hardness and softness.

Non-aqueous Solvents:

Physical properties of solvents, type of solvents and their general characteristics, reactions in liquid NH_3, liquid SO_2 and liquid HF.

Oxidation and Reduction:

Redox equations, standard electrode potential and its application to inorganic reactions, use of redox potential data-analysis of redox cycle, redox stability in water, Frost, Latimer and Pourbaix diagrams, principle involved in the volumetric analysis.

Unit-II Organometallic Compounds-I:

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands, bonding and applications organometallic compounds.

Metal Carbonyls:

18 electron rules, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT. π-acceptor behaviour of CO (MO diagram of

CO to be discussed), synergic effect and use of IR data to explain extent of back bonding. Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

Unit-III Organometallic Compounds-II:

Metal Alkyls:

Important structural features of methyl lithium (tetramer) and trialkyl Aluminium (dimer), concept of multi-centre bonding in these compounds. Role of triethylaluminium in polymerization of ethene (Ziegler-Natta Catalyst). Species present in ether solution of Grignard reagent and their structures, Schlenk equilibrium.

Ferrocenes:

Preparation and reactions (acetylation, alkylation, metalation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene

Catalysis by Organometallic Compounds

Study of the following industrial processes and their mechanism: 1. Alkene hydrogenation (Wilkinsons Catalyst) 2. Hydroformylation (Co-salts) 3. Wacker Process 4. Synthetic gasoline (Fischer-Tropsch reaction) 5. Synthesis gas by metal carbonyl complexes

Unit-IV Nuclear Chemistry:

Nuclear models, alpha, beta and gamma decay, mass defect, binding energy, mean binding energy of stable nuclei, disintegration theory: Nuclear stability and group displacement law; contribution of the discovery of artificial radioactivity in the field of heavy element chemistry. Measurement of Radioactivity: Ionization chamber, Geiger-Muller, scintillation counters, Wilson cloud chamber.

Unit-V Bio-inorganic Chemistry:

Metal ions present in biological systems, classification of elements according to their action in biological system. Role of metal ions present in biological systems with special reference to Na^+, K^+ and Mg^{2+} ions, Geochemical effect on the distribution of metals. Sodium/K-pump, carbonic anhydrase and carboxypeptidase. Role of Mg^{2+} ions in energy production and chlorophyll. Role of Ca^{2+} in blood clotting, Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine. Iron and its application in bio-systems, Haemoglobin; Storage and transfer of iron.

Paper-6.3(b): CHE.....T(b)
Chemistry-VI(b): Organic Chemistry

Contact Hours / Week : 3 Hours / Week
Duration of Examination : 3 Hours

Maximum Marks : 100 Marks
Continuous Assessment : 30 Marks
Semester Assessment : 70 Marks

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***Section-B** will carry 50 marks equally divided into five long answer type questions (answer about in 400-500 words) with one question from each unit with internal choice (another question will be given in option or question may be divided in to sub-divisions). Paper setter shall be advised to set one question from each unit along with one option of each question and students are instructed to attempt total five questions by selecting one question from each unit. Each long answer type question will have 10 marks and hence Section-B will carry total 50 marks.*

Unit-I Heterocyclic Compounds:

Classification and nomenclature.

Five-membered heterocycles with one heteroatom: structure, stability, basicity, aromaticity, reactivity, synthesis and reactions of pyrrole, furan, thiophene.

Benzo-fused five-membered heterocycles with one nitrogen heteroatoms: synthesis, reactions and some medicinal importance of indole.

Six-membered heterocycles with one and two nitrogen heteroatoms: synthesis, reactions and some medicinal importance of pyridines and pyrimidine.

Benzo-fused six-membered heterocycles with one nitrogen heteroatoms: synthesis, reactions and some medicinal importance of quinoline and isoquinoline.

Unit-II Carbohydrates:

Classification and nomenclature, reducing and non-reducing sugars, epimers, mutarotation and anomers, mechanism of osazone formation, interconversion of glucose and fructose, chain lengthening and chain shortening of aldoses, configuration, erythro and threo diastereomers, conversion of glucose into mannose, formation of glycosides, ethers and esters, determination of ring size, cyclic structure of D(+) glucose, structure of ribose and deoxyribose sugars. An introduction to disaccharides (maltose, sucrose and lactose) and polysaccharides (starch and cellulose) without involving structure determination.

Nucleic Acids:

Constituents of Nucleic acids: Adenine, guanine, thymine, and Cytosine (Structure only), Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model) and RNA (types of RNA), Genetic Code, Biological roles of DNA and RNA: Replication, Transcription and Translation.

Unit-III Ultraviolet (UV) Spectroscopy:

Introduction to spectroscopy, absorption laws (Beer-Lambert's law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated dienes and enones.

Infrared (IR) Spectroscopy:

Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds.

Unit-IV Nuclear Magnetic Resonance (NMR) Spectroscopy:

Nuclear angular momentum and nuclear spin, nuclear spin states, basic theory, equivalent & non-equivalent protons, shielding and de-shielding of nuclei, chemical shift and its measurements, factors affecting chemical shift, spin-spin interactions: theory, types, factors affecting coupling constant, area of signals. interpretation of PMR spectra of simple organic molecules such as ethyl bromide, ethyl alcohol, acetaldehyde, 1,1,2-tribromoethane, ethyl acetate, toluene and acetophenone, etc.

Unit-V Mass Spectrometry:

Basic principle, production of ions by electron impact, chemical ionization and field desorption techniques, separation and detection of ions. mass spectrum: molecular ion peak, base peak, isotopic peak, metastable peak; fragmentation patterns of organic molecules with examples of various classes of compounds, McLafferty rearrangement, identification of molecular ion peaks, determination of molecular weight and molecular formula of compounds, hydrogen deficiency index, nitrogen rule, applications mass spectrometry.

Structure Elucidation:

An integrated problem-solving approach based on analytical data including CHNS/O percentage, spectral data (UV, IR, NMR, MS, *etc.*) of some simple organic compounds.

Paper-6.3(c): CHE.....T(c)
Chemistry-VI(c): Physical Chemistry

Contact Hours / Week	: 3 Hours / Week	Maximum Marks	: 100 Marks
Duration of Examination	: 3 Hours	Continuous Assessment	: 30 Marks
		Semester Assessment	: 70 Marks

The syllabus is divided into five independent units and question paper will be divided into following two sections:

Section-A *will carry one compulsory question comprising 10 short answer type questions (answer about in 10-20 words) by taking two questions from each unit with no internal choice. Each short answer type question will have 2 marks and hence Section-A will carry total 20 marks.*

Section-B *will carry 50 marks equally divided into five long answer type questions (answer about in 400-500 words) with one question from each unit with internal choice (another question will be given in option or question may be divided in to sub-divisions). Paper setter shall be advised to set one question from each unit along with one option of each question and students are instructed to attempt total five questions by selecting one question from each unit. Each long answer type question will have 10 marks and hence Section-B will carry total 50 marks.*

Unit-I Quantum Chemistry-I

Postulates of quantum mechanics, quantum mechanical operators, Schrödinger equation and its application to free particle and "particle-in-a-box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wavefunctions, probability distribution functions, nodal properties, Extension to two- and three-dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrödinger equation and discussion of solution and wavefunctions. Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.

Rigid rotator model of rotation of diatomic molecule. Schrödinger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Unit-II Quantum Chemistry-II

Qualitative treatment of hydrogen atom and hydrogen-like ions: setting up of Schrödinger equation in spherical polar coordinates, radial part, quantization of

energy (only final energy expression). Average and most probable distances of electron from nucleus.

Setting up of Schrödinger equation for many-electron atoms (He, Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

Valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localized and non-localized molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

Unit-III Principles of Spectroscopy:

Introduction, electromagnetic radiation with molecules and various types of spectra, natural line width and natural line broadening, transition probability, transition moment, selection rules, intensity of spectral lines, Born-Oppenheimer approximation; rotational, vibrational and electronic energy level and transitions.

Rotational Spectroscopy:

Diatomic molecules, energy levels of a rigid rotator (semi-classical principles), selection rules, spectral intensities, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution, qualitative description of non-rigid rotator.

Unit-IV Vibrational Spectroscopy:

Vibrational energies of diatomic molecules, zero-point energy, force constant and bond strengths; anharmonicity, potential energy diagram, vibration-rotation spectroscopy, PQR branches, breakdown of Oppenheimer approximation; vibrations of polyatomic molecules. Selection rules, normal modes of vibration, vibrations of polyatomic molecules, the Hook's law and calculation of frequencies for different types of bonds, group frequencies, Fermi resonance, combination bands, overtones, hot bands, factors affecting the band positions and intensities.

Raman Spectroscopy:

Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules. Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Unit-VElectronic Spectroscopy:

Concept of potential energy curves for bonding and anti-bonding molecular orbitals, qualitative description of selection rules and Frank-Condon principle. qualitative description of σ, π, n MOs and their energy levels, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation, calculation of electronic transitions of simple compounds using free electron model.

Atomic Spectroscopy:

Energies of atomic orbitals, vector representation of momenta and vector coupling, spectra of hydrogen atom and alkali metal atoms.

Paper-6.4(a): CHE.....P(a)
Chemistry Practical-VI(a): Inorganic Chemistry Practical

Contact Hours / Week : 4 Hours / Week Maximum Marks : 50 Marks
Duration of Examination : 6 Hours Semester Assessment : 50 Marks

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: ……..	10
2.	Exercise No. 2: ……..	10
3.	Exercise No. 3: ……..	10
4.	Practical Record	10
5.	Viva-voce	10
	Total Marks	**50**

Instrumentation

- Adulteration - Food stuff.
- Effluent analysis - Water analysis.
- Solvent Extraction - Separation and estimation of Mg(II) and Fe(II)
- Ion Exchange Method - Separation and estimation of Mg(II) and Zn(II)

Colorimetry:

- Verify Lambert-Beer's law and determine the concentration of $CuSO_4/KMnO_4/K_2Cr_2O_7$ in a solution of unknown concentration
- Determine the concentrations of $KMnO_4$ and $K_2Cr_2O_7$ in a mixture.
- Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.
- Determine the amount of iron present in a sample using 1,10-phenathroline.
- Determine the dissociation constant of an indicator (phenolphthalein).

Spectrophotometry:

- To separate a mixture of Ni^{2+} and Fe^{2+} by complexation with DMG and extracting the Ni^{2+}- DMG complex in chloroform and determine its concentration by spectrophotometry
- Determination of pKa values of indicator using spectrophotometry.
- Structural characterizations of compounds by infrared spectroscopy.

Flame Photometry:

- Determination of concentration of Na^+ and K^+ using flame photometry.
- Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometry.

Paper-6.4(b): CHE.....P(b)
Chemistry Practical-VI(b): Organic Chemistry Practical

Contact Hours / Week : 4 Hours / Week Maximum Marks : 50 Marks
Duration of Examination : 6 Hours Semester Assessment : 50 Marks

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: ……..	10
2.	Exercise No. 2: ……..	10

3.	Exercise No. 3: ……..	10
4.	Practical Record	10
5.	Viva-voce	10
	Total Marks	**50**

Estimation:
Estimation of amino group
Estimation of phenolic group
Estimation of carboxylic acid group
Estimation of glucose.

Carbohydrates:
Differentiation between aldoses and ketoses, reducing and non-reducing sugars.
Synthesis of Osazone.

Enzymes:
Study of the action of salivary amylase on starch at optimum conditions.
Effect of temperature on the action of salivary amylase.

Spectroscopy:
Structure elucidation of simple organic compounds by using UV, IR, NMR and MS spectra (spectra to be provided at the time of examination):

- Acetone
- Acetaldehyde
- Crotonaldehyde
- Cinnamaldehyde
- Ethyl alcohol
- Isopropyl alcohol
- t-Butyl alcohol
- *p*-aminophenol
- *p*-Bromophenol
- Acetic acid
- Benzoic acid
- Cinnamic acid
- Phthalic acid
- Ethyl bromide
- Propyl chloride
- Benzyl bromide
- n-Propylamine
- Triethylamine
- Aniline
- *p*-nitroaniline
- Nitrobenzene
- Toluene
- Xylenes
- Urea
- Acetamide
- Benzamide
- Acetonitrile
- Benzonitrile
- Anisole
- Cresols
- Toluidines
- Anisidines
- Methyl formate
- Methyl acetate
- Ethyl acetate
- Vinyl acetate
- Diethyl phthalate
- Acetic anhydride
- Phthalic anhydride

Paper-6.4(c): CHE.....P(c)
Chemistry Practical-VI(c): Physical Chemistry Practical

Contact Hours / Week : 4 Hours / Week
Duration of Examination : 6 Hours
Maximum Marks : 50 Marks
Semester Assessment : 50 Marks

Distribution of Marks:

S. No.	Name of Exercise	Marks
1.	Exercise No. 1: ……..	10
2.	Exercise No. 2: ……..	10
3.	Exercise No. 3: ……..	10
4.	Practical Record	10
5.	Viva-voce	10
	Total Marks	**50**

Potentiometry:

- To titrate potentiometrically the given ferrous ammonium sulphate solution using $KMnO_4$ / $K_2Cr_2O_7$ as titrant and calculate the redox potential of Fe^{2+}/Fe^{3+} system on the hydrogen scale.
- Perform the following potentiometric titrations:
  - Strong acid vs. strong base
  - Weak acid vs. strong base
  - Potassium dichromate vs. Mohr's salt

Refractometry and Polarimetry:

- To verify law of refraction of mixtures for ego of glycerol and water.
- To determine the specific rotation of a given optically active compound.

Adsorption:

- Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

UV-VIS Spectroscopy:

- Study the 200-500 nm absorbance spectra of $KMnO_4$ and $K_2Cr_2O_7$ (in 0.1 M H2SO4) and determine the λ_{max} values. Calculate the energies of the two transitions in different units (J molecule^{-1}, kJ mol^{-1}, cm^{-1}, eV).
- Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of $K_2Cr_2O_7$.
- Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water and observe the effect of structure on the UV spectra of organic compounds.

Suggested Books for Theory Papers:

Inorganic Chemistry:

- *Basic Inorganic Chemistry: F. A. Cotton and G. Wilkinson, Wiley Eastern*
- *Chemistry of the Elements, N.N. Greenwood and A. Earnshaw*
- *Shriver & Atkins' Inorganic Chemistry*
- *Concise Inorganic Chemistry: J. D. Lee, ELBS*
- *Theoretical Inorganic Chemistry, ACS Publications. M.C. Day and J. Selbin*
- *Advanced Inorganic Chemistry, Vol I & II. Satya Prakash, G.D. Tuli, S.K. Basu and R.D. Madan*
- *Principles of Inorganic Chemistry: B. R. Puri and L. R. Sharma*
- *Fundamentals of Inorganic Chemistry, Vol. I, Das, CBS Publications, 2nd Ed.*
- *Bioinorganic Chemistry-Bertini*
- *Biological Inorganic Chemistry-An Introduction-Robert R. Crichton*
- *The Organometallic Chemistry of Transition Metals, 4e-Robert H Crabtree*
- *Organometallic Chemistry, Mehrotra and Singh. New Age International Publishers, 2ndEdn.*
- *Basic Organometallic Chemistry, 2ndEdn., Gupta B. D. and Elias A. J., University Press.*

Organic Chemistry:

- *Organic Chemistry, Claydon, Nick Greeves and Stuart Warren, Oxford University Press*
- *Organic Chemistry, Graham Solomons, John Wiley & Sons, Inc.*
- *Organic Chemistry, R. T. Morrison and R. N. Boyd, Prentice-Hall.*
- *Structure and Mechanism in Organic Chemistry, C.K. Ingold, Cornell University Press.*
- *Organic Chemistry (Volume 1), I.L. Finar, Dorling Kindersley (India) Pvt. Ltd.*
- *Organic Chemistry (Volume 2): Stereochemistry and the Chemistry of Natural Products, I.L. Finar, Dorling Kindersley (India) Pvt. Ltd.*
- *Organic Chemistry, Vol. I, II & III. Jag Mohan, R. Chand & Company*
- *Organic Chemistry, (Vol. I, II & III. S. M. Mukherji, S. P. Singh and R. P. Kapoor*
- *Stereochemistry of Carbon Compounds, Ernest L. Eliel, Tata McGraw Hill.*
- *Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.*

- *Stereochemistry of Organic Compounds, P.S. Kalsi, New Age International.*
- *A Textbook of Organic Chemistry: P S Kalsi, New Age International*
- *A Text Book of Organic Chemistry: B. S. Bahl and Arun Bahl*
- *A Text Book of Organic Chemistry: P. L. Soni & H.M. Chawla*
- *A Text Book of Organic Chemistry: (Vol. I & II) O. P. Agarwal*
- *Organic Synthesis: Jagadamba Singh and L.D.S. Yadav*
- *Principles of Organic Synthesis-Norman & Coxon*
- *Heterocyclic Chemistry at a Glance 2e by Joule & Mills Blackwell*
- *Heterocyclic Chemistry by RK Bansal*
- *Heterocyclic Chemistry Volume I and II by RR Gupta*
- *Fundamentals of Biochemistry 5e Voet & Voet*
- *Lehninger Principles of Biochemistry 4e Nelson & Cox*
- *Harper's Illustrated Biochemistry. XXVIII edition. Murray, Granner, Mayes and Rodwell. Lange Medical Books/ McGraw-Hill.*
- *Elementary Organic Spectroscopy, 5th Edition, Y R Sharma, S. Chand & Company.*
- *Organic Spectroscopy and Applications, Jag Mohan, Narosa Publishers*
- *Organic Spectroscopy, Kemp, W. Palgrave*

Physical Chemistry:

- *Atkins' Physical Chemistry, Oxford University Press*
- *Principles of Physical Chemistry: Prutton and Marron*
- *Elements of Physical Chemistry: Lewis Glasstone*
- *Principles of Physical Chemistry: B. R. Puri and L. R. Sharma*
- *A Text Book of Physical Chemistry: A. S. Negi and S. C. Anand*
- *A Text Book of Physical Chemistry by K. L. Kapoor*
- *Modern Electrochemistry 2A-Fundamentals of Electrodics-Bockris, Reddy & Gamboa*
- *Introductory Quantum Chemistry, Chandra, A. K., Tata McGraw-Hill.*
- *Fundamentals of Quantum Chemistry, 2nd Ed. House, J. E., Elsevier*
- *Quantum Chemistry, Lowe, J. P. & Peterson, K. Academic Press.*
- *Fundamentals of Molecular Spectroscopy, 4th Ed. Banwell & McCash. Tata McGraw-Hill: New Delhi.*
- *Atomic & Molecular Spectroscopy, Kakkar, R. Cambridge University Press*
- *Fundamentals of Photochemistry, Rohatagi Mukherjee. Wiley Eastern Ltd.*

Analytical Chemistry:

- *Principles of Instrumental Analysis, Skoog, Holler and Nieman, Thomson Asia Pvt. Ltd. Singapore.*
- *Analytical Chemistry Vol-I Qualitative Analysis-Treadwell & Hall*
- *Analytical Chemistry Vol-II Quantitative Analysis-Treadwell & Hall*
- *Chemical Analysis-Modern Instrumentation Methods and Techniques, 2e-Francis Rouessac*
- *Handbook of Instrumental Techniques for Analytical Chemistry-Frank Settle*

Suggested Books for Practical Papers:

Inorganic Chemistry

- *Vogel's Textbook of Macro and Semimicro Qualitative Inorganic Analysis*
- *Vogel's Textbook of Quantitative Analysis, Bassett, Denney, Jeffery and Mendham*
- *Qualitative Analysis by Welcher and Hahn.*
- *Practical Chemistry: Giri Bajpai and Pandey, S. Chand & Co. Ltd., New Delhi.*

Organic Chemistry:

- *Vogel's Textbook of Practical Organic Chemistry, Tatchell, John Wiley.*
- *Macro scale and Micro scale Organic Experiments, K.L. Williamson, D.C. Health*
- *Practical Organic Chemistry, 5th Ed., Furniss, Hannaford, Smith, Tatchell. Pearson.*
- *Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, Ahluwalia & Aggarwal, University Press.*
- *Comprehensive Practical Organic Chemistry: Qualitative Analysis, Ahluwalia, & Dhingra, S., University Press.*
- *Laboratory Hand Book of Chromatographic & Allied Methods, Mikes, & Chalmes, Elles Harwood Ltd. London*

Physical Chemistry

- *Practical Physical Chemistry, James and Prichard, Longman.*
- *Findley's Practical Physical Chemistry, Levitt, Longman.*
- *Experimental Physical Chemistry, Das and Behera, Tata McGraw Hill.*
- *Experimental Physical Chemistry, Athawale & Mathur, New Age International: New Delhi.*
- *Senior Practical Physical Chemistry, Khosla, Garg, and Gulati. R. Chand & Co.: New Delhi*
- *Experiments in Physical Chemistry 8th Ed.; Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. McGraw-Hill: New York*
- *Experimental Physical Chemistry 3rdEd.; Halpern, A.M. & McBane, G. C. W.H. Freeman & Co.: New York.*
- *Experimental Physical Chemistry, J. N. Gurtu, R. Kapoor.*

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