AUXILIUM COLLEGE (AUTONOMOUS)

VELLORE

M.Sc. CHEMISTRY

Curriculum Development – Employability Needs

SEMESTER I

PCCHA20 - STEREOCHEMISTRY AND CONFORMATIONAL ANALYSIS

Year: I **SEM:** I	**Course Code** PCCHA20	**Title of the Course** Stereochemistry and Conformational Analysis	**Course Type** Theory	**Course Category** Core	**H/W** 5	**Credits** 5	**Marks** 100

Learning Objectives:

- To learn the concepts of stereochemistry, conformational analysis and their application in the determination of reaction mechanism.
- To understand the mechanism and stereo chemistry of substitution and elimination reactions.
- To gain knowledge about the optical rotatory dispersion and circular dichroism.

Course Outcomes:

The Learners will be able to

1. Assign the configuration of stereoisomers including those with no stereogenic carbon centre and classify the stereospecific and stereoselective reactions.
2. Compare the relative stability and reactivity of conformational isomers of cyclohexane and related compounds.
3. Ascertain the knowledge on the mechanism and stereo chemical outcome of aliphatic nucleophilic substitution reactions.
4. Compare the mechanistic spectra of elimination reactions.
5. Employ the principles of Optical Rotatory Dispersion and Circular Dichroism for various applications.

CO	**PSO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	M	H	M	H	H
CO2	H	M	H	M	H	H
CO3	H	M	M	H	H	H
CO4	H	M	M	H	H	H
CO5	H	H	H	H	H	H

CO	**PO**					
	1	**2**	**3**	**4**	**5**	**6**
CO1	H	H	H	H	M	M
CO2	H	H	H	H	M	M

CO3	H	H	H	H	M	M
CO4	H	H	H	H	M	M
CO5	H	H	H	H	M	M

H-High (3), M-Moderate (2), L-Low (1)

Unit I **(15 Hours)**

1.1 Chirality and optical activity - symmetry elements, classification of chiral molecules as asymmetric and dissymmetric. (K1, K2, K3, K4, K5 & K6)

1.2 Projection formulae - Sawhorse, Newmann and Fischer projections and their inter conversions. (K1, K2, K3, K4, K5 & K6)

1.3 Nomenclature - absolute configuration - R/S and D/L, relative configurations - threo/erythro and syn/anti. (K1, K2, K3, K4, K5 & K6)

1.4 A brief study of dissymmetry of allenes, biphenyls - atropisomerism, spiro compounds, transcyclooctene, cyclononene and molecules with helical structures. (K1, K2, K3, K4, K5 & K6)

1.5 Stereo specific and stereo selective reactions - definition and examples. Asymmetric synthesis - Cram's rule. (K1, K2, K3, K4, K5 & K6)

1.6 Geometrical isomerism - E/Z nomenclature of olefins, geometrical and optical isomerism of disubstituted cyclopropane, cyclobutane and cyclopentanes. (K1, K2, K3, K4, K5 & K6)

Unit II **(15 Hours)**

2.1 Conformational analysis of di-substituted cyclohexanes and their stereo chemical features - geometric and optical isomerism of these derivatives. (K1, K2, K3, K4 & K5)

2.2 Conformation and reactivity of cyclohexene - allylic 1, 2 and 1, 3 strains and related compound alkyldiene cyclohexane. (K1, K2, K3, K4 & K5)

2.3 Conformation of cyclohexanone - 2-alkyl and 3-alkyl ketone effect and reactivity of cyclohexanone in comparison with cyclopentanones. (K1, K2, K3, K4 & K5)

2.4 Conformations of six membered rings containing hetero atoms. (K1, K2, K3, K4 & K5)

2.5 Conformation and stereochemistry of cis and trans decalin and 9-methyl decalin. (K1, K2, K3, K4 & K5)

2.6 Quantitative correlation between conformation and reactivity - Curtin-Hammett principle. (K1, K2, K3, K4 & K5)

Unit III **(15 Hours)**

3.1 S_N2 reaction - kinetics, mechanism and factors influencing the reaction. (K1, K2, K3, K4, K5 & K6)

3.2 S_N1 reaction - kinetics, mechanism, factors influencing the reactions, rearrangement reaction. (K1, K2, K3, K4, K5 & K6)

3.3 Mixed S_N1 and S_N2 reactions - competition between S_N1 and S_N2 mechanism. (K1, K2, K3, K4, K5 & K6)

3.4 Substitution by ambident nucleophiles, substitution at allylic, vinylic, benzylic and aryl halides. (K1, K2, K3, K4, K5 & K6)

3.5 SET (single electron transfer) - types of electron transfer reactions - photo induced and chemically induced electron transfer. (K1, K2, K3, K4, K5 & K6)

3.6 Neighbouring group participation - introduction of an acyclic open chain system, Π systems of aromatic rings, cyclic system, double bond and σ bond. (K1, K2, K3, K4, K5 & K6)

Unit IV **(15 Hours)**

4.1 E_1, E_2, E_1CB reaction - kinetics, mechanism and evidences. (K1, K2, K3, K4 & K5)

4.2 E_1, E_2 and E_1CB variables - mechanistic spectrum, competition between elimination and substitution. (K1, K2, K3, K4 & K5)

4.3 Stereochemistry of E_2 - syn and anti-elimination reactions, orientation of the double bond. (K1, K2, K3, K4 & K5)

4.4 Regiochemistry of E_1, E_2 and E_1CB reactions with examples. (K1, K2, K3, K4 & K5)

4.5 Pyrolytic eliminations - acyclic and alicyclic systems, molecular rearrangements during elimination. (K1, K2, K3, K4 & K5)

4.6 Grob's fragmentations - incorporation of fragmentation - mechanism of fragmentation - mechanism allied to E_1 and E_2 eliminations. (K1, K2, K3, K4 & K5)

Unit V **(15 Hours)**

5.1 Optical Rotatory Dispersion and Circular Dichroism - terminology - optical rotation, circular birefringence, circular dichroism and Cotton effect. (K1, K2, K3, K4, K5 & K6)

5.2 Plain curves - application of plain curves - determination of structure, configuration, conformation and optical activity. (K1, K2, K3, K4K5 & K6)

5.3 Rotatory dispersion of ketones - structure, configuration, conformation of unsaturated ketones. (K1, K2, K3, K4, K5 & K6)

5.4 Empirical and semi empirical rules - the axial halo ketone rule, the octant rule (configuration and conformation) (K1, K2, K3, K4, K5 & K6)

5.5 Absolute configuration and ketal formation. (K1, K2, K3, K4, K5 & K6)

5.6 Stereochemical analysis - polarimetry, chiral GC & HPLC and NMR techniques. (K1, K2, K3, K4, K5 & K6)

Reference Books:

1. R. O. C. Norman & Coxon, Principles of Organic Chemistry, NY, 3rd Edition, 2017.
2. S. M. Mukherji and S. P. Singh, Reaction Mechanism in Organic Chemistry, MacMillan India Ltd., Chennai, Reprint 2010.
3. Stanley H Pines, Organic Chemistry, McGraw Hill Publication, 5th Edition, Reprint 2007.
4. Francis A. Carey and Richard J. Sundberg, Part A and B, Advanced Organic Chemistry, Plenum Press, 4th Edition, Reprint 2013.
5. Jerry March, Advanced Organic Reaction Mechanism and Structure, A Wiley Inter Science, 4th Edition, Reprint 2005.
6. D. Nasipuri, Stereochemistry of Organic Compounds, New Age Publishers, 2nd Edition, Reprint 2013.
7. P. S. Kalsi, Stereochemistry, Conformation and Mechanism, New Age International Ltd, Reprint 2017.
8. Ernest L. Eliel, Stereochemistry of Carbon Compounds, Tata McGraw Hill Publishing, Reprint 2007.

9. C. K. Ingold, Structure and Mechanism in Organic Chemistry, CBS Publishers and Distributors Pvt. Ltd., 2nd Edition, Reprint 2000.
10. P. S. Kalsi, Stereochemistry and Mechanism through Solved Problems, New Age International Publishers, Reprint 2003.
11. R. K. Bansal, Organic Reaction Mechanism, Tata McGraw Hill Publishing, 4th Edition, Reprint 2013.
12. Bernard Miller Advanced Organic Chemistry Reaction & Mechanism, Pearson Education, 2nd Edition, Reprint 2005.
13. P. S. Kalsi, Organic Reactions and their Mechanism, New Age International Publishers, 2nd Edition, Reprint 2017.
14. Nimai Tewari, Advanced Organic Stereochemistry (Problems & Solutions), Books and Allied (P), 1st Edition, 2010.

Open Educational Resources (OER):

1. https://babel.hathitrust.org/cgi/pt?id=umn.31951p01139217c&view=2up&seq=300
2. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 (P-01, P-05)
3. https://www.hippocampus.org/HippoCampus/Chemistry;jsessionid=D178EB9CB8034395C03D09EFC98A06CA
4. http://ocw.uci.edu/lectures/chem_51a_lecture_13_organic_chemistry_ch_4_conformations_of_cyclohexane.html

SEMESTER I

PCCHB20 - STRUCTURAL INORGANIC CHEMISTRY

Year: I SEM: I	Course Code PCCHB20	Title of the Course Structural Inorganic Chemistry	Course Type Theory	Course Category Core	H/W 5	Credits 4	Marks 100

Learning Objectives:

- To learn the concepts of Lewis acids and bases.
- To learn the structures of complex solids, metals, and alloys.
- To gain knowledge about the structure and bonding in poly acids, boron hydrides and metal clusters.

Course Outcomes:

The Learners will be able to

1. Summarize the theories of acids and bases.
2. Discuss conductors, semiconductors and insulators based on band theory.
3. Assess the structure and bonding in different types of ionic solids, metals and alloys.
4. Discuss the structure and bonding in polyacids, silicates and inorganic polymers.
5. Distinguish the structure and bonding in boranes, carboranes, metallo carboranes, boron nitrides and metal clusters.

CO	PSO					
	1	2	3	4	5	6
CO1	H	M	M	H	H	H
CO2	H	M	M	H	H	H
CO3	H	M	M	H	H	H
CO4	H	M	M	H	H	H
CO5	H	M	M	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

H-High (3), M-Moderate (2), L-Low (1)

Unit I **(15 Hours)**

1.1 Acids and bases, proton transfer equilibria in water - solvent leveling effects. (K1, K2, K3, K4, K5 & K6)

1.2 Aqua acids - periodic trends in aqua acids - simple oxo acids - anhydrous oxides - polyoxo compound formation. (K1, K2, K3, K4, K5 & K6)

1.3 Lewis acid - base concepts, hard and soft acids and bases, group characteristics of Lewis acids. (K1, K2, K3, K4, K5 & K6)

1.4 Lux - Flood theory of acids and bases, Usanovich acids and bases, super acids and super bases. (K1, K2, K3, K4, K5 & K6)

1.5 Non aqueous solvents, classification, protic and aprotic solvents, molten salts as solvents and ionic liquids. (K1, K2, K3, K4, K5 & K6)

1.6 Heterogeneous acids and bases - symbiosis and proton sponges. (K1, K2, K3, K4, K5 & K6)

Unit II **(15 Hours)**

2.1 Structure of complex solids - layered structures - conducting ionic solids – graphite - solids held together by covalent bonding - diamond - Madelung constants. (K1, K2, K3, K4 & K5)

2.2 Imperfections in crystals - stoichiometric defects - Schottky, controlled valency, F-center and Frenkel defect - non-stoichiometric defects - metal excess defect, metal deficient defect - impurity defect. (K1, K2, K3, K4 & K5)

2.3 Band theory of solids, intrinsic and extrinsic semiconductors, piezoelectric and pyroelectric crystals. (K1, K2, K3, K4 & K5)

2.4 Superconductivity – Meissner effect, critical temperature and critical magnetic field - BCS theory. (K1, K2, K3, K4 & K5)

2.5 Type I and Type II superconductors. (K1, K2, K3, K4 & K5)

2.6 Ternary oxides - structures of 123 oxides (YBa-Cu- O) - applications of high temperature superconducting materials. (K1, K2, K3, K4 & K5)

Unit III **(15 Hours)**

3.1 Structures of simple solids - unit cell and crystal structures. (K1, K2, K3, K4, K5 & K6)

3.2 Close packing of spheres - holes in closed packed structures. (K1, K2, K3, K4, K5 & K6)

3.3 Structure of metals and alloys - non-closed packed structures. (K1, K2, K3, K4, K5 & K6)

3.4 Atomic radii of metals - polytypism - polymorphism of metals. (K1, K2, K3, K4, K5 & K6)

3.5 Alloys - substitutional solid solutions, interstitial solid solutions of non-metals - intermetallic compounds. (K1, K2, K3, K4, K5 & K6)

3.6 Characteristic structures of ionic solids - binary phases (AX and AX_2) - ternary phases (ABO_3 and AB_2O_4). (K1, K2, K3, K4, K5 & K6)

Unit IV **(15 Hours)**

4.1 Structure and bonding - polyacids - isopolyacids and heteropolyacids of molybdenum and tungsten. (K1, K2, K3, K4 & K5)

4.2 Dawson and Keggins structure of poly acids, heteropolyanions and heteropoly blues. (K1, K2, K3, K4 & K5)

4.3 Inorganic polymers - silicates, structures, properties, correlation and applications. (K1, K2, K3, K4 & K5)

4.4 Molecular sieves, feldspar, zeolites and ultramarines and their applications. (K1, K2, K3, K4 & K5)

4.5 Polysulphur-nitrogen compounds - structure and bonding in tetrasulphur tetranitride, poythiazyl and S_xS_y compounds. (K1, K2, K3, K4 & K5)

4.6 Poly organo phosphazenes. (K1, K2, K3, K4 & K5)

Unit V **(15 Hours)**

5.1 Structure and bonding - boron hydrides - introduction, classification of boranes - diborane, tetra borane, pentaborane, hexaborane and decaborane. (K1, K2, K3, K4, K5 & K6)

5.2 Polyhedral boranes - Wade's rule - closo, nido and arachno structures, hydroboration. (K1, K2, K3, K4, K5 & K6)

5.3 Carboranes - closo, nido and arachno structures of carboranes. (K1, K2, K3, K4, K5 & K6)

5.4 Metallocarboranes - closo, nido and arachno structures of carboranes. (K1, K2, K3, K4, K5 & K6)

5.5 Structure and bonding of boronitrides. (K1, K2, K3, K4, K5 & K6)

5.6 Metal clusters - chemistry of low molecularity metal clusters (up to trinuclear metal clusters). (K1, K2, K3, K4, K5 & K6)

Reference Books:

1. J. E. Huheey, Inorganic Chemistry, Principles, Structure and Reactivity, Harper Collins, New York, 4th Edition, 2013.
2. F. A. Cotton and G. Wilkinson, Advanced Inorganic Chemistry: A Comprehensive Text, John Wiley and Sons, 6th Edition, 2007.
3. K. F. Purcell and J. C. Kotz, Inorganic Chemistry, WB Saunders Co., USA, 2010.
4. M. C. Day and J. Selbin, Theoretical Inorganic Chemistry, Van Nostrand Co., New York, 1974.
5. G. S. Manku, Inorganic Chemistry, Tata McGraw Hill Publications, 1989.
6. D. F. Shrivers, P. W. Atkins and C. H. Langford, Inorganic Chemistry, OUP, 2006.
7. N. H. Ray, Inorganic Polymers, Academic Press, 1978.
8. F. Basolo and R. G. Pearson, Mechanism of Inorganic Reaction, Wiley NY, 1967.

Open Educational Resources (OER):

1. https://nptel.ac.in/content/storage2/courses/104103071/pdf/mod2.pdf
2. https://nptel.ac.in/content/storage2/courses/104103069/module4/lec3/1.html
3. https://nptel.ac.in/courses/115/105/115105099/
4. http://epgp.inflibnet.ac.in/Home/ViewSubject?catid=5 (P-11, M-19)

SEMESTER I

PCCHC20 - KINETICS AND PHOTOCHEMISTRY

Year: I SEM: I	Course Code PCCHC20	Title of the Course Kinetics and Photochemistry	Course Type Theory	Course Category Core	H/W 5	Credits 4	Marks 100

Learning Objectives:

- To get exposed to the kinetics of reactions in solutions, acid- base catalysis and surface reactions.
- To gain knowledge on photochemical and photo physical processes.
- To have an in-depth knowledge on the kinetics of complex and fast reactions.

Course Outcomes:

The Learners will be able to

1. Describe Activated Complex Theory in terms of translational and vibrational partition functions and apply it to derive the kinetics of reactions in solutions, Hammett and Taft equations and kinetic isotope effects in studying the mechanism of chemical reactions.
2. Discuss the concepts and kinetics of homogeneous and heterogeneous catalysis and explain adsorption isotherms of Langmuir and BET.
3. Derive the kinetics of complex reactions and apply the techniques of fast reactions.
4. Analyse the principles involved in photo excitation of molecules.
5. Derive the kinetics of photochemical reactions, and explain the applications of radiation chemistry, kinetics of photochemical reactions, solar energy conversion and radiolysis of water.

CO	PSO					
	1	2	3	4	5	6
CO1	H	H	H	H	H	H
CO2	H	H	H	H	H	H
CO3	H	H	H	H	H	H
CO4	H	H	H	H	H	H
CO5	H	H	H	H	H	H

CO	PO					
	1	2	3	4	5	6
CO1	H	H	M	H	H	H
CO2	H	H	M	H	H	H
CO3	H	H	M	H	H	H
CO4	H	H	M	H	H	H
CO5	H	H	M	H	H	H

H-High (3), M-Moderate (2), L-Low (1)

Unit I **(15 Hours)**

1.1 Activated complex theory - derivation - partition functions and activated complex - Eyring equation in terms of translational and vibrational partition functions. **(**KI, K2, K3, K4, K5 & K6)

1.2 Determination of free energy, enthalpy and entropy of activation and their significance. **(**KI, K2, K3, K4, K5 & K6)

1.3 Potential energy surfaces. **(**KI, K2, K3, K4, K5 & K6)

1.4 Applications of activated complex theory to reactions in solution - effect of pressure, and dielectric constant. **(**KI, K2, K3, K4, K5 & K6)

1.5 Effect of ionic strength on reactions in solutions, cage effect. **(**KI, K2, K3, K4, K5 & K6)

1.6 Kinetic isotope effect, linear free energy relationships - Hammett and Taft equations. **(**KI, K2, K3, K4, K5 & K6)

Unit II **(15 Hours)**

2.1 Catalysis - homogeneous catalysis - acid-base catalysis - types of acid-base catalysis - specific and general acid-base catalysis. Mechanisms and kinetics of acid-base catalyzed reactions (protolytic and prototropic mechanism) – Bronsted catalysis law. **((**KI, K2, K3, K4 & K5)

2.2 Heterogeneous catalysis - surface reactions, types - physisorption and chemisorption, difference between physisorption and chemisorption, Lennard-Jones plots. **(**KI, K2, K3, K4 & K5)

2.3 Adsorption isotherms - Langmuir and BET isotherms - postulates and derivations. **(**KI, K2, K3, K4 & K5)

2.4 Kinetics of surface reactions - unimolecular and bimolecular reactions, catalysis by semiconductor oxides (n-type and p-type). **(**KI, K2, K3, K4 & K5)

2.5 Mechanism of heterogeneous catalytic reactions, Langmuir and Rideal-Eley mechanism - adsorption co-efficient and its significance. **(**KI, K2, K3, K4 & K5)

2.6 Enzyme catalysis - types of enzyme catalysis, rate of enzyme catalyzed reactions by Michaelis-Menton mechanism - study of effect of substrate concentration, pH and temperature on enzyme catalyzed reactions - inhibition in enzyme catalyzed reactions. **(**KI, K2, K3, K4 & K5)

Unit III **(15 Hours)**

3.1 Complex reactions - definition with examples, kinetics of reversible, consecutive and parallel reactions. **(**KI, K2, K3, K4, K5 & K6)

3.2 Chain reactions - types of chain reactions (stationary and non-stationary). **(**KI, K2, K3, K4, K5 & K6)

3.3 General treatment of chain reactions - chain length - explosion limits. **(**KI, K2, K3, K4, K5 & K6)

3.4 Rice Herzfeld mechanism - order of reactions of unity, one-half and three-halves for photolysis of acetaldehyde. **(**KI, K2, K3, K4, K5 & K6)

3.5 Fast reactions - relaxation methods - pressure and temperature jump methods **(**KI, K2, K3, K4, K5 & K6)

3.6 Stopped flow and flash photolysis methods. **(**KI, K2, K3, K4, K5 & K6)

Unit IV **(15 Hours)**

4.1 Photochemistry - introduction, absorption and emission of radiation - intensity distribution in the electronic, vibrational species - Franck Condon Principle. **(**K1, K2, K3, K4 & K5)

4.2 Jablonski diagram - radiative and non-radiative processes - fluorescence and phosphorescence - E-type and P-type delayed fluorescence - spin forbidden radiative transition - internal conversion and intersystem crossing. **(**K1, K2, K3, K4 & K5)

4.3 Electronically excited states - excited state dipole moment and acidity constant. **(**KI, K2, K3, K4 & K5)

4.4 Decay of electronically excited states, dissociation and predissociation of diatomic molecules - energy transfer process. **(**KI, K2, K3, K4 & K5)

4.5 Photophysical processes - kinetics of unimolecular and bimolecular photophysical processes - kinetic treatment of excimer and exciplex formation. **(**KI, K2, K3, K4 & K5)

4.6 Quenching - static and dynamic quenching - Stern-Volmer equation. **(**KI, K2, K3, K4 & K5)

Unit V **(15 Hours)**

5.1 Photochemical reactions - photo assisted mechanism, hydrogen and halogen reactions. **(**KI, K2, K3, K4, K5 & K6)

5.2 Kinetics of photochemical reaction, photoredox, photosubstitution, photoisomerization and photosensitized reactions. **(**KI, K2, K3, K4, K5 & K6)

5.3 Photovoltaic and photogalvanic cells, photo assisted electrolysis of water, application of solar energy conversion. **(**KI, K2, K3, K4, K5 & K6)

5.4 Radiation chemistry - interaction of high-energy radiation with matter - primary and secondary processes**. (**KI, K2, K3, K4, K5 & K6)

5.5 G value - radiolysis of water - hydrated electron, ion pair yield. **(**KI, K2, K3, K4, K5 & K6)

5.6 Photocatalysis - applications of TiO_2 photocatalyst for oxidation of organic pollutants - photochemical reaction of vision. **(**KI, K2, K3, K4, K5 & K6)

Reference Books:

1. R. G. Frost and Pearson, Kinetics and Mechanism, Wiley, New York, First Reprint 1970.
2. Keith J. Laidler, Chemical Kinetics, Pearson Edition Company Pvt. Ltd., 3rd Edition, 2005.
3. B. R. Puri, L. R. Sharma and M. S. Pathania, Principles of Physical Chemistry, Vishal Publishing Co., January 2019.
4. N. J. Turro, Modern Molecular Photo Chemistry, Benjamin, Cumming, Menlo Park, California, 1978.
5. K. K. Rohatgi Mukherjee, Fundamentals of Photo Chemistry, Wiley Eastern Ltd., 2nd Edition, 1992.
6. Gurdeep Raj, Photochemistry, Goel Publishing House, 4th Edition, 2002.
7. A. Singh, R. Singh, Photochemistry, Campus Books International, 1st Edition, 2005.
8. P. W. Atkins, Physical Chemistry, Oxford University Press, 11th Edition, 2018.
9. G. W. Castellan, Physical Chemistry, Narosa Publishing House, Seventh Reprint, 2004.

10. Donald A. Mc Quarrie and John D. Simon, Physical Chemistry: A Molecular Approach - 1997, Viva Books Pvt., Ltd., New Delhi, Reprint 2004.
11. J. Rajaram J.C. Kuriacose, Kinetics and Mechanisms of Chemical Transformations: Applications of Femto Chemistry, Mc Millan Publishers India Ltd., Reprint, 2009.

Open Educational Resources (OER):

1. http://photobiology.info/Ilichev.html (Photochemistry basics)
2. https://chem.libretexts.org/Courses/University_of_California_Davis/UCD_Chem_107B%3A_Physical_Chemistry_for_Life_Scientists/Chapters/2%3A_Chemical_Kinetics/2.10%3A_Fast_Reactions_in_Solution.
3. https://swayam.gov.in/nd1_noc20_cy22/preview (Introduction to Chemical Thermodynamics and Kinetics)
4. Brian Wardle, Principles and applications of photochemistry, Wiley publications, 2009, ISBN – 978-0-470-01494.

https://cds.cern.ch/record/1254287/files/9780470014936_TOC.pdf