To the Point Chemistry for undergraduate Students

(As Per Latest Syllabus of L. N. Mithila University, B.Sc. First Year Chemistry Honours Course.)



(Volume-I)

Dr. V. D. Tripathi
Om Prakash

Kripa Drishti Publications, Pune.

TO THE POINT CHEMISTRY

FOR UNDERGRADUATE STUDENTS

(Volume-I)

Dr. V. D. Tripathi

Assistant Professor,
Department of Chemistry,
C.M. Science College,
Darbhanga.

Om Prakash

C. M. Science College, Darbhanga, Bihar India.

Kripa-Drishti Publications, Pune.

Book Title: To the Point Chemistry for Undergraduate

Students

Authored By: **Dr. V. D. Tripathi, Om Prakash**

Price: ₹500

1st Edition

ISBN: 978-81-19149-13-1



Published: April 2023

Publisher:



Kripa-Drishti Publications

A/ 503, Poorva Height, SNO 148/1A/1/1A, Sus Road, Pashan- 411021, Pune, Maharashtra, India.

Mob: +91-8007068686

Email: editor@kdpublications.in Web: https://www.kdpublications.in

© Copyright Dr. V. D. Tripathi, Om Prakash

All Rights Reserved. No part of this publication can be stored in any retrieval system or reproduced in any form or by any means without the prior written permission of the publisher. Any person who does any unauthorized act in relation to this publication may be liable to criminal prosecution and civil claims for damages. [The responsibility for the facts stated, conclusions reached, etc., is entirely that of the author. The publisher is not responsible for them, whatsoever.]

PREFACE

Present book is written for undergraduate chemistry Honors students particularly as per syllabus of Lalit Narayan Mithila University Darbhanga Bihar. The content of book is tried to be concise and easy to understand for readers. I felt during the theory classes of B.Sc. Hons. Students that there is dire need of chemistry text book consisting the syllabus compilation at a single platform. This book is first of it's kind of book as per the syllabus contents of universities of Bihar.

Key Features

- 1) As per syllabus of B.Sc. Chemistry Hons. Students of Lalit Narayn Mithila University Darbhanga Bihar.
- 2) Book is written in a manner to make content very easy to understand for readers.
- 3) At the beginning of each chapter the topics of syllabus content is mentioned in the box to give reader an idea of the chapter contents.
- 4) Subject is presented in very precise, simple and systematic way to make the content more useful for slow learners as well.
- 5) All the figures and tables are arranged in easy manner to emphasize the geometry of molecules and demonstrate the reaction pathway.
- 6) Derivations are described in easy and step by step manner.

Organization

This book is organized in a way to make it most useful for students as per their need. The syllabus of B.Sc. first year chemistry Honors of L. N. Mithila university contains total 2 theory papers. The present book is the first book of series of 7 books as "To The Point Chemistry volume 1". The authors tried to cover all the syllabus in upcoming volumes. The volume 1 which covers topics from physical and inorganic chemistry. More emphasis is given to correlate the structures of compounds and molecular geometries which make the content easy for students. Fundamental principles of chemical bonding, periodic properties and p-block elements are provided to lay a strong foundation. An extensive index is provided for quick search of topics from syllabus. The latest style university questions are given at the end of each chapters.

I am sure that students will appreciate the concept and thought that gone into making of this book. This book is like a complete package for chemistry honors students where they can find complete syllabus at a single and common platform. I shall be glad to receive suggestions and comments for further improvements.

Vishwolapale

Foreword

It has been a pleasure to go over through the contents of the present book on "To the point Chemistry for undergraduate students" specifically for chemistry honors students in Lalit Narayan Mithila University in Bihar. This books presents much valued compendium of knowledge for B.Sc. students.

The content included in present book could be an excellent compilation to incorporate as recommended text book for undergraduate chemistry Hons. Students of L. N. Mithila University Darbhanga. I feel that the organization of contents in present book is designed in a manner to help students to find all the topics of their interest at a common platform. This allows students to get a more in-depth and broader exposure to the course content. Having these comprehensive material would greatly advance the student's knowledge and understanding regarding various topics given in syllabus of undergraduate chemistry students of L. N. Mithila University Darbhanga.

This book provides valuable window on the course content which covers all the topics one by one from the syllabus contents with more precisely and simple manner. As the present volume of the book to the Point Chemistry the contents given in Paper 1 of the syllabus which covers the topics from physical and inorganic chemistry.

In my opinion this book will not only provide the contents in a comprehensive and easy way but also reduce the hard work of students of searching topics from different places. This book was started with an excellent objective of serving the course content to students at one common platform and after going through the contents of I feel that this book has fulfilled the objective very nicely. I strongly recommend this book for B.Sc. Chemistry Honors students of L. N. Mithila University.

Prof. Prem Mohan Mishra

INDEX

Chapter 1: Gaseous State	1
1.1 Kinetic Theory of Gases:	1
1.1.1 Postulates or Assumptions of Kinetic Theory of Gases:	
1.2 Derivation of Kinetic Gas Equation:	
1.3 Different Type of Molecular Velocities / Speeds	
1.3.1 Expressions for Most Probable Velocity(A), Average Velocity (
And Root Mean Square Velocity (U):	
1.3.2 Relationship Between Most Probable Velocity(A), Average Velocity (V) And Root Moon Square Velocity (U):	
(V) And Root Mean Square Velocity (U): 1.4 Ideal and Real Gases:	
1.5 Deviations from the Gas Laws and Explanation of the Terms-Compressibility and Paylo Temperature.	-
Factor and Boyle Temperature:	
1.5.1 Deviations from Boyle's Law:	
1.6 Van Der Waals Equation: 1.6.1 Correction for the Volume:	
1.6.2 Correction for the Forces of Attraction i.e., Pressure Correction:	
1.6.3 SI Units of van Der Waal's Equation:	
1.7 Explanation of Behaviour of Real Gases By van Der Waal's Equation:	
1.7.1 At Low Pressures:	
1.7.1 At Low Fressures. 1.7.2 At Moderate Pressure:	
1.7.2 At Moderate Pressure. 1.7.3 At High Pressures:	
1.7.4 At High Temperatures:	
1.7.4 At High Temperatures	
1.8 Critical State (Critical Phenomena and Critical Constants):	
1.8.1 Van Der Waals Equation and The Critical Phenomena:	
1.9 Reduced Equation of State and the Law of Corresponding States:	
1.10 Liquefaction of Gases:	
1.10.1 By the Use of Freezing Mixtures:	
1.10.1 By the Use of Preezing Wixtures	.21 28
1.10.3 By the Adiabatic Expansion of Compressed Gas- Linde's Process:	
1.10.3 By the Adiabatic Expansion of a Compressed Gas Involv	
Mechanical Work-Claude's Process:	
1.10.5 By Adiabatic Demagnetization:	
1.10.5 By Adiabatic Demagnetization	.50
Chapter 2: Solid State	.31
	1
2.1 Solids and their Classification:	.31
2.1.1 Points of Difference Between Crystalline and Amorphous Solids:	
2.1.2 Classification of Crystalline Solids:	

2.2 Law of Symmetry:	. 36
2.2.1 Hauy's Law of Rational Indices:	. 37
2.2.2 Identification/Designation of Crystal Planes and Faces:	. 38
2.3 Crystal Systems:	. 43
2.4 Isomorphism and Polymorphism:	. 44
2.5 Space Lattice and Unit Cell:	. 44
2.6 Bravais Lattices:	. 46
2.7 X—Ray Diffraction by Crystals: Study of The Internal Structure:	. 48
2.8 Laue's Method:	. 48
2.9 Bragg's Method:	. 49
Chapter 3: Colloidal State of Matter	. 55
3.1 Introduction:	55
3.1.1 Size (Diameters) of Particles:	
3.2 Types of Colloidal Systems:	
3.2.1 Classification of Colloids or Colloidal Sols:	
3.2.2 Purification of Colloidal Solutions:	
3.2.3 Properties of Colloidal Solutions:	
3.3 Hardy Schulze Law:	
3.4 Protective Action of Lyophillic Colloids and Gold Number:	
3.5 Emulsions:	
3.6.1 Definition:	
3.5.2 Method of Preparation:	
3.5.3 Role of Emulsifier:	
3.5.4 Types of Emulsions.	
3.5.5 Properties of Emulsions:	
3.6 Applications of Colloids:	
3.7 Gels:	. 71
3.7.1 Methods of Preparation of Gels:	. 71
Chapter 4: Atomic Structure	. 72
4.1 Idea of De-Broglie Matter Waves:	. 72
4.1.1 Derivation of de-Broglie Relationship:	
4.1.2 Significance of de-Broglie Relationship	
4.1.3 Distinction Between Matter Waves and Electromagnetic Waves:	
4.2 Heisenberg's Uncertainty Principle:	
4.2.1 Explanation of Uncertainty Principle:	
4.3 Schrödinger Wave Equation:	
4.3.1 Derivation of Schrodinger Wave Equation:	
4.3.2 Significance of Wave Function (ψ):	. 79
4.4 Concept of Atomic Orbitals:	
4.4.1 Shapes of Orbitals:	
4.5 Aufbau Principle:	. 83
4.5.1 Limitations of Aufbau's Principle:	. 84

4.6 Pauli's Exclusion Principle:	85
4.7 Representation of Electronic Configuration:	88
4.7.1 Electronic Configuration of Elements:	89
4.8 Cause of Stability of Half-filled and completely filled Orbitals:	94
4.9 The Shielding Effect and the Effective Nuclear Charge:	96
4.10 Radial and Angular Wave Function:	
4.10.1 Features of Radial Wave Functions:	100
4.10.2 Angular Wave Function:	102
4.11 Probability Distribution Curves:	
4.11.1 Probability Distribution Curve:	103
4.11.2 Electron Cloud Representation:	104
Chapter 5: Periodic Properties	105
5.1 Electronic Layout of Elements in Periodic Table:	105
5.1.1 S, P, D And F-Blocks of Elements:	107
5.2 Periodic Properties:	107
5.2.1 Atomic and Ionic Radii:	
5.2.2 Ionization Energy:	115
5.2.3 Electron Affinity:	118
5.2.4 Electronegativity:	123
5.3 Chemical Properties and the Periodic Table:	
5.3.1 Change in the Properties Down a Group:	128
5.3.2 Change in the Properties Across a Period	129
Chapter 6: Covalent Bond	131
6.1 Introduction:	131
6.2 Covalent Bond:	
6.3 Limitations of Valence Bond Theory:	
6.4 Hybridization:	
6.4.1 Types of Hybridization:	
6.4.2 Shapes of Inorganic Molecules and Ions:	
6.5 Sigma (σ) And Pi (π) Bonds:	
6.5.1 Sigma (σ) Covalent Bond:	
$6.5.2 \text{Pi} (\pi) \text{Covalent Bond:}$	
6.5.3 Strength of σ and π -Bond:	
6.6 Valence Shell Electron Pair Repulsion Theory:	
6.6.1 Applications of VSEPR Theory:	
6.7 Molecular Orbital Theory:	
6.8 Linear Combination of Atomic Orbitals (LCAO):	
6.8.1 Combination Of 2s and 2p Atomic Orbitals to Form Molecular:	
6.8.2 Conditions for the Combination of Atomic Orbitals:	
6.9 Electronic Configuration and Molecular Behaviour:	
6.9.1 Bonding in Homonuclear Diatomic Molecules:	
6.10 Boron Oxide (Bo):	
\ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	

6.10.1 CN Molecule:	164
6.10.2 Comparison of CN And CN ⁻ :	165
6.10.3 Carbon Monoxide Molecule (CO):	
6.11 Electron Deficient Compounds:	
6.11.1 Bornes:	167
6.11.2 Diborane:	167
Chapter 7: Ionic Bonds	169
7.1 Ionic Bonds:	169
7.2 General Characteristics of Ionic Solids:	169
7.3 Radius Ratio Rule and Coordination Number:	171
7.3.1 Calculation of Radius Ratios:	172
7.3.2 Radius Ratio for Cubic Site:	176
7.4 Limitations of Radius Ratio Rule:	177
7.5 Lattice Energy:	178
7.5.1 Calculations of Lattice Energies of Ionic Solids:	178
7.5.2 Importance of Lattice Energy:	183
7.6 Born Haber Cycle for Lattice Energies:	
7.7 Applications of Born-Haber Cycle:	186
7.8 Solvation Energy and Solubilities of Ionic Compounds:	
7.9 Polarizing Power and Polarizability:	188
7.10 Lattice Defects:	190
7.11 Metal Excess:	
7.12 Metal Deficiency:	194
Chapter 8: s-Block Elements	195
8.1 The Hydrides of s-Block Elements:	195
8.1.1 The Ionic Hydrides:	195
8.2 Solvation and Complexation Tendencies:	197
8.3 Diagonal Relationship:	201
8.3.1 Diagonal Relationship of Lithium with Magnesium:	
8.3.2 Diagonal Relationship of Beryllium and Aluminium:	203
Chapter 9: p-Block Elements	205
9.1 General Characteristics of Group 13 Elements:	205
9.2 Compounds of Group 13 Elements:	
9.3 Trihalides of Other Group 13 Elements:	
9.4 Dimeric Structure of Aluminium Chloride:	
9.4.1 Trihalides of Gallium, Indium and Thallium:	
9.5 Elements of Group 14:	
9.5.1 Electronic Configurations:	
9.5.2 General Characteristics of Group 14 Elements:	
9.6 Compounds of Group 14 Elements:	
9.6.1 Structure of CO ₂ and SiO ₂	

9.7 Dioxides of Germanium, Tin and Lead:	220
9.8 Fluorocarbons:	222
9.9 Carbides:	223
9.10 Silicates:	226
9.11 Types of Silicates:	
9.12 Silicones:	
9.13 Hydrides of Boron:	232
9.13.1 Properties of Diborane:	
9.13.2 Borazine, B ₃ N ₃ H ₆ :	
9.13.3 Borohydrides:	
9.14 Chemistry of Tin:	
9.15 Chemistry of Lead:	
9.16 Ozone:	

ABOUT THE AUTHOR



Dr. V. D. Tripathi was born in Lucknow, Uttar Pradesh and completed his Graduation and Post-Graduation from University of Lucknow in 2003 and 2006 respectively. He qualified for CSIR NET-JRF and joined for research work at CSIR (Central Drug Research Institute) Lucknow. He was awarded Ph.D. degree by Jawaharlal Nehru University, New Delhi in 2012. He is professional medicinal chemist and has worked in different laboratories of esteemed organisations including Central Drug

Research Institute Lucknow, Jubilant Chemsys Noida, Zydus Cadila Healthcare Limited, LCC Toulouse France and University Paul Sabatier in field of Organic Synthesis and Medicinal Chemistry. He has the experience of working as one of the leading team members for the development of process for the first indigenous antidiabetic molecule Lipaglyn by Zydus Cadila Healthcare Limited. He was awarded prestigious CEFIPRA Indo French Research Fellowship in 2015 by DST, Government of India. He has a rich experience of research work in laboratory at CNRS-LCC Toulouse France in area of Dendrimer Synthesis. Presently he is working as Assistant Professor in the Department of Chemistry, C.M. Science College, Darbhanga. He has the experience of teaching Organic Chemistry to the students at undergraduate and Post Graduate level. He has over 35 research publications to his credit in reputed national and international journals. He has authored two books in Organic Chemistry. He has the experience as an Editor of book titled 'Future Science for Sustainable Development'. He has three Patents to his credit. He has delivered more than a dozen invited talks.



Om Prakash was born in Darbhanga Bihar India. He completed his graduation from C. M. Science College Darbhanga in 2013. He did his postgraduation from College of Commerce Patna, Bihar in 2016. He qualified for Ph.D. admission test at L.N. Mithila University, Darbhanga and joined for his Doctoral Research in 2020. Currently he is pursuing his Ph.D. from L.N. Mithila University under the supervision of Dr. V. D. Tripathi. He has published two research articles in international journals. He has

presented two research papers in International journals. He has experience as an author contributing to a book entitled "Future science for Sustainable Development".



Kripa-Drishti Publications A-503 Poorva Heights, Pashan-Sus Road, Near Sai Chowk, Pune – 411021, Maharashtra, India.

Mob: +91 8007068686

Email: editor@kdpublications.in Web: https://www.kdpublications.in ISBN: 978-81-19149-13-1



Price: ₹500