

# Chemistry

## Part II

*Textbook for Class XI*



11083



राष्ट्रीय शैक्षिक अनुसंधान और प्रशिक्षण परिषद्  
NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

## 11083 – CHEMISTRY PART II

Textbook for Class XI

ISBN 81-7450-494-X (Part I)

ISBN 81-7450-535-0 (Part II)

### First Edition

March 2006

Phalguna 1927

### Reprinted

October 2006

Kartika 1928

November 2007

Kartika 1929

January 2009

Magha 1930

December 2009

Pausa 1931

November 2010

Kartika 1932

January 2012

Pausa 1933

November 2012

Kartika 1934

November 2013

Kartika 1935

December 2014

Pausa 1936

December 2015

Agrahayna 1937

February 2017

Phalguna 1938

February 2018

Phalguna 1939

December 2018

Agrahayna 1940

September 2019

Bhadrapada 1941

August 2021

Shravana 1943

November 2021

Agrahayna 1943

PD 330T RSP

© National Council of Educational  
Research and Training, 2006

₹ 120.00

Printed on 80 GSM paper with NCERT  
watermark

Published at the Publication Division  
by the Secretary, National Council of  
Educational Research and Training,  
Sri Aurobindo Marg, New Delhi 110 016  
and printed at Swan Press, 308 & 309,  
Sector-7 Manesar, Gurugram - 122 050  
Haryana

### ALL RIGHTS RESERVED

- No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording or otherwise without the prior permission of the publisher.
- This book is sold subject to the condition that it shall not, by way of trade, be lent, re-sold, hired out or otherwise disposed of without the publisher's consent, in any form of binding or cover other than that in which it is published.
- The correct price of this publication is the price printed on this page. Any revised price indicated by a rubber stamp or by a sticker or by any other means is incorrect and should be unacceptable.

### OFFICES OF THE PUBLICATION DIVISION, NCERT

NCERT Campus  
Sri Aurobindo Marg  
New Delhi 110 016

Phone : 011-26562708

108, 100 Feet Road  
Hosdakere Halli Extension  
Banashankari III Stage  
Bengaluru 560 085

Phone : 080-26725740

Navjivan Trust Building  
P.O. Navjivan  
Ahmedabad 380 014

Phone : 079-27541446

CWC Campus  
Opp. Dhankal Bus Stop  
Panihati  
Kolkata 700 114

Phone : 033-25530454

CWC Complex  
Maligaon  
Guwahati 781 021

Phone : 0361-2674869

### Publication Team

Head, Publication Division : Anup Kumar Rajput

Chief Editor : Shweta Uppal

Chief Production Officer : Arun Chitkara

Chief Business Manager : Vipin Dewan

Editor : Binoy Banerjee

Production Assistant : Om Prakash

### Cover

Shweta Rao

### Illustrations

Nidhi Wadhwa

Anil Nayal

## FOREWORD

The National Curriculum Framework (NCF), 2005 recommends that children's life at school must be linked to their life outside the school. This principle marks a departure from the legacy of bookish learning which continues to shape our system and causes a gap between the school, home and community. The syllabi and textbooks developed on the basis of NCF signify an attempt to implement this basic idea. They also attempt to discourage rote learning and the maintenance of sharp boundaries between different subject areas. We hope these measures will take us significantly further in the direction of a child-centred system of education outlined in the National Policy on Education (1986).

The success of this effort depends on the steps that school principals and teachers will take to encourage children to reflect on their own learning and to pursue imaginative activities and questions. We must recognise that, given space, time and freedom, children generate new knowledge by engaging with the information passed on to them by adults. Treating the prescribed textbook as the sole basis of examination is one of the key reasons why other resources and sites of learning are ignored. Inculcating creativity and initiative is possible if we perceive and treat children as participants in learning, not as receivers of a fixed body of knowledge.

These aims imply considerable change in school routines and mode of functioning. Flexibility in the daily time-table is as necessary as rigour in implementing the annual calendar so that the required number of teaching days are actually devoted to teaching. The methods used for teaching and evaluation will also determine how effective this textbook proves for making children's life at school a happy experience, rather than a source of stress or boredom. Syllabus designers have tried to address the problem of curricular burden by restructuring and reorienting knowledge at different stages with greater consideration for child psychology and the time available for teaching. The textbook attempts to enhance this endeavour by giving higher priority and space to opportunities for contemplation and wondering, discussion in small groups, and activities requiring hands-on experience.

The National Council of Educational Research and Training (NCERT) appreciates the hard work done by the textbook development committee responsible for this book. We wish to thank the Chairperson of the advisory group in science and mathematics, *Professor J.V. Narlikar* and the Chief Advisor for this book, *Professor B. L. Khandelwal* for guiding the work of this committee. Several teachers contributed to the development of this textbook; we are grateful to their principals for making this possible. We are indebted to the institutions and organisations which have generously permitted us to draw upon their resources, material and personnel. We are especially grateful to the members of the National Monitoring Committee, appointed by the Department of Secondary and Higher Education, Ministry of Human Resource Development under the Chairpersonship of Professor Mrinal Miri and Professor G.P. Deshpande, for their valuable time and contribution. As an organisation committed to systemic reform and continuous improvement in the quality of its products, NCERT welcomes comments and suggestions which will enable us to undertake further revision and refinement.

New Delhi  
20 December 2005

*Director*  
National Council of Educational  
Research and Training

© NCERT  
not to be republished

## TEXTBOOK DEVELOPMENT COMMITTEE

### CHAIRPERSON, ADVISORY GROUP FOR TEXTBOOKS IN SCIENCE AND MATHEMATICS

J.V. Narlikar, *Emeritus Professor*, Chairman, Advisory Committee, Inter University Centre for Astronomy and Astrophysics (IUCCA), Ganeshbhind, Pune University, Pune

### CHIEF ADVISOR

B.L. Khandelwal, *Professor (Retd.)*, *Emeritus Scientist*, CSIR; *Emeritus Fellow*, AICTE and formerly *Chairman*, Department of Chemistry, Indian Institute of Technology, New Delhi

### MEMBERS

A. S. Brar, *Professor*, Indian Institute of Technology, Delhi

Anjni Koul, *Lecturer*, DESM, NCERT, New Delhi

H.O. Gupta, *Professor*, DESM, NCERT, New Delhi

I.P. Aggarwal, *Professor*, Regional Institute of Education, NCERT, Bhopal

Jaishree Sharma, *Professor*, DESM, NCERT, New Delhi

M. Chandra, *Professor*, DESM, NCERT, New Delhi

Poonam Sawhney, *PGT (Chemistry)*, Kendriya Vidyalaya, Vikas Puri, New Delhi

R.K. Parashar, *Lecturer*, DESM NCERT, New Delhi

S.K. Dogra, *Professor*, Dr. B.R. Ambedkar Centre for Biomedical Research Delhi University, Delhi

S.K. Gupta, *Reader*, School of Studies in Chemistry, Jiwaji University, Gwalior

Sadhna Bhargava, *PGT (Chemistry)*, Sardar Patel Vidyalaya, Lodhi Estate, New Delhi

Shubha Keshwan, *Headmistress*, Demonstration School, Regional Institute of Education, NCERT, Mysore

Sukhvir Singh, *Reader*, DESM, NCERT, New Delhi

Sunita Malhotra, *Professor*, School of Sciences, IGNOU, Maidan Garhi, New Delhi

V.K. Verma, *Professor (Retd.)* Institute of Technology, Banaras Hindu University, Varanasi

V.P. Gupta, *Reader*, Regional Institute of Education, NCERT, Bhopal

### MEMBER-COORDINATOR

Alka Mehrotra, *Reader*, DESM, NCERT, New Delhi

## ACKNOWLEDGEMENTS

The National Council of Educational Research and Training acknowledges the valuable contributions of the individuals and organisations involved in the development of Chemistry textbook for Class XI. It also acknowledges that some useful material from the reprint editions (2005) of Chemistry textbooks has been utilised in the development of the present textbook. The following academics contributed effectively for editing, reviewing, refining and finalisation of the manuscript of this book: G.T. Bhandage, *Professor*, RIE, Mysuru; N. Ram, *Professor*, IIT, New Delhi; R. Sindhu, *Reader*, RIE (NCERT), Bhopal; Sanjeev Kumar, *Reader*, Desh Bandhu College, Kalkaji, New Delhi; Shampa Bhattacharya, *Reader*, Hans Raj College, Delhi; Vijay Sarada, *Reader*, Zakir Husain College, New Delhi. K.K. Arora, *Reader*, Zakir Husain College, New Delhi; Shashi Saxena, *Reader*, Hans Raj College, Delhi; Anuradha Sen, Apeejay School, Sheikh Sarai, New Delhi; C. Shrinivas, *PGT*, Kendriya Vidyalaya, Pushp Vihar, New Delhi; D.L. Bharti, *PGT*, Ramjas School, Sector IV, R.K. Puram, New Delhi; Ila Sharma, *PGT*, Delhi Public School, Dwarka, Sector-B, New Delhi; Raj Lakshmi Karthikeyan, *Head (Science)*, Mother's International School, Sri Aurobindo Marg, New Delhi; Sushma Kiran Setia, *Principal*, Sarvodaya Kanya Vidyalaya, Hari Nagar (CT), New Delhi; Nidhi Chaudray, *PGT*, CRPF Public School, Rohini, Delhi; and Veena Suri, *PGT*, Bluebells School, Kailash, New Delhi. We are thankful to them.

We express gratitude to R.S. Sindhu, *Professor (Retd.)*, DESM, NCERT, New Delhi, for editing, reviewing and refining the textbook right from the initial stage.

We are also grateful to Ruchi Verma, *Associate Professor*, DESM, NCERT, New Delhi; Pramila Tanwar, *Assistant Professor*, DESM, NCERT, New Delhi; R.B. Pareek, *Associate Professor*, RIE, Ajmer and A.K. Arya, *Associate professor*, RIE, Ajmer, for reviewing and refining the content of the textbook.

Special thanks are due to M. Chandra, *Professor and Head*, DESM, NCERT for her support.

The Council also gratefully acknowledges the contribution of Surendra Kumar and Hari Darshan Lodhi *DTP Operator*; Subhash Saluja, Ramendra Kumar Sharma and Abhimanyu Mohanty, *Proof Readers*; Bhavna Saxena, *Copy Editor* and Deepak Kapoor, *Incharge*, Computer Station, in shaping this book. The contributions of the Publication Department in bringing out this book are also duly acknowledged.

## CONTENTS

	<b>FOREWORD</b>	<b>iii</b>
<b>Unit 8</b>	<b>Redox Reactions</b>	<b>263</b>
8.1	Classical Idea of Redox Reactions-Oxidation and Reduction Reactions	263
8.2	Redox Reactions in Terms of Electron Transfer Reactions	265
8.3	Oxidation Number	267
8.4	Redox Reactions and Electrode Processes	277
<b>Unit 9</b>	<b>Hydrogen</b>	<b>284</b>
9.1	Position of Hydrogen in the Periodic Table	284
9.2	Dihydrogen, $H_2$	285
9.3	Preparation of Dihydrogen, $H_2$	286
9.4	Properties of Dihydrogen	286
9.5	Hydrides	288
9.6	Water	289
9.7	Hydrogen Peroxide ( $H_2O_2$ )	293
9.8	Heavy Water, $D_2O$	294
9.9	Dihydrogen as a Fuel	294
<b>Unit 10</b>	<b>The s-Block Elements</b>	<b>299</b>
10.1	Group 1 Elements: Alkali Metals	300
10.2	General Characteristics of the Compounds of the Alkali Metals	303
10.3	Anomalous Properties of Lithium	304
10.4	Some Important Compounds of Sodium	304
10.5	Biological Importance of Sodium and Potassium	306
10.6	Group 2 Elements : Alkaline Earth Metals	306
10.7	General Characteristics of Compounds of the Alkaline Earth Metals	309
10.8	Anomalous Behaviour of Beryllium	310
10.9	Some Important Compounds of Calcium	310
10.10	Biological Importance of Magnesium and Calcium	312
<b>Unit 11</b>	<b>The p-Block Elements</b>	<b>315</b>
11.1	Group 13 Elements: The Boron Family	317
11.2	Important Trends and Anomalous Properties of Boron	320
11.3	Some Important Compounds of Boron	320
11.4	Uses of Boron and Aluminium and their Compounds	322
11.5	Group 14 Elements: The Carbon Family	322
11.6	Important Trends and Anomalous Behaviour of Carbon	325
11.7	Allotropes of Carbon	325
11.8	Some Important Compounds of Carbon and Silicon	327

<b>Unit 12</b>	<b>Organic Chemistry – Some Basic Principles and Techniques</b>	<b>334</b>
12.1	General Introduction	334
12.2	Tetravalence of Carbon: Shapes of Organic Compounds	335
12.3	Structural Representations of Organic Compounds	336
12.4	Classification of Organic Compounds	339
12.5	Nomenclature of Organic Compounds	340
12.6	Isomerism	348
12.7	Fundamental Concepts in Organic Reaction Mechanism	349
12.8	Methods of Purification of Organic Compounds	356
12.9	Qualitative Analysis of Organic Compounds	362
12.10	Quantitative Analysis	363
<b>Unit 13</b>	<b>Hydrocarbons</b>	<b>373</b>
13.1	Classification	373
13.2	Alkanes	374
13.3	Alkenes	384
13.4	Alkynes	392
13.5	Aromatic Hydrocarbon	396
13.6	Carcinogenicity and Toxicity	403
<b>Unit 14</b>	<b>Environmental Chemistry</b>	<b>406</b>
14.1	Environmental Pollution	406
14.2	Atmospheric Pollution	407
14.3	Water Pollution	414
14.4	Soil Pollution	416
14.5	Industrial Waste	417
14.6	Strategies to control Environmental Pollution	418
14.7	Green Chemistry	419
	<b>Answers</b>	<b>423</b>
	<b>Index</b>	<b>427</b>

## CONTENTS OF CHEMISTRY PART I

<b>UNIT 1</b>	SOME BASIC CONCEPTS OF CHEMISTRY	1
<b>UNIT 2</b>	STRUCTURE OF ATOM	29
<b>UNIT 3</b>	CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES	74
<b>UNIT 4</b>	CHEMICAL BONDING AND MOLECULAR STRUCTURE	100
<b>UNIT 5</b>	STATES OF MATTER	136
<b>UNIT 6</b>	THERMODYNAMICS	160
<b>UNIT 7</b>	EQUILIBRIUM	192
	APPENDICES	239
	ANSWER TO SOME SELECTED QUESTIONS	253
	INDEX	259