

Based on New Syllabus



UPKAR'S

**CSIR-UGC
NET/JRF/SET
CHEMICAL SCIENCES**

(Through Solved Problems)

Dr. HEMANT KULSHRESTHA
&
Dr. AJAY TANEJA

 **UPKAR'S**
CSIR-UGC
NET/JRF/SET
CHEMICAL SCIENCES
Through Solved Problems
(With Multiple Objective Questions and their Explanations)

By
Dr. Hemant Kulshrestha
&
Dr. Ajay Taneja
Department of Chemistry
St. John's College
Agra

UPKAR PRAKASHAN, AGRA-2

Introducing Direct Shopping

Now you can purchase from our vast range of books and magazines at your convenience :

- Pay by Credit Card/Debit Card or Net Banking facility on our website www.upkar.in OR
- Send Money Order/Demand Draft of the print price of the book favouring 'Upkar Prakashan' payable at Agra. In case you do not know the price of the book, please send Money Order/Demand Draft of ₹ 100/- and we will send the books by VPP (Cash on delivery).

(Postage charges FREE for purchases above ₹ 100/-. For orders below ₹ 100/-, ₹ 20/- will be charged extra as postage)

© Authors & Publishers

Publishers

UPKAR PRAKASHAN

(An ISO 9001 : 2000 Company)

2/11A, Swadeshi Bima Nagar, AGRA-282 002

Phone : 4053333, 2530966, 2531101

Fax : (0562) 4053330, 4031570

E-mail : care@upkar.in, **Website :** www.upkar.in

Branch Offices :

4845, Ansari Road, Daryaganj,

New Delhi—110 002

Phone : 011-23251844/66

Pirmohani Chowk,

Kadamkuan,

Patna—800 003

Phone : 0612-2673340

1-8-1/B, R.R. Complex (Near Sundaraiah Park, Adjacent to Manasa Enclave Gate),
Bagh Lingampally,

Hyderabad—500 044 (A.P.)

Phone : 040-66753330

28, Chowdhury Lane, Shyam Bazar, Near Metro Station, Gate No. 4

Kolkata—700004 (W.B.)

Phone : 033-25551510

B-33, Blunt Square, Kanpur

Taxi Stand Lane, Mawaiya,

Lucknow—226 004 (U.P.)

Phone : 0522-4109080

- *The publishers have taken all possible precautions in publishing this book, yet if any mistake has crept in, the publishers shall not be responsible for the same.*
- *This book or any part thereof may not be reproduced in any form by Photographic, Mechanical, or any other method, for any use, without written permission from the Publishers.*
- *Only the courts at Agra shall have the jurisdiction for any legal dispute.*

ISBN : 978-81-7482-381-6

Price : ₹ 835/-

(Rs. Eight Hundred Thirty Five Only)

Code No. 1588

Printed at : UPKAR PRAKASHAN (Printing Unit) Bye-pass, AGRA

PREFACE

We are extremely delighted to present this version of Chemical Sciences which will cover the total need of the student preparing for CSIR-UGC (NET) examination for selection of scholars for Junior Research Fellowship of CSIR and UGC and for determining the eligibility for Lectureship in the Colleges and Universities of India.

Our major objective is also to develop confidence among the candidates who are taking competitive examination in the field related to Chemical Sciences after Postgraduation by providing them solved objective as well as short descriptive type questions which covers both fundamental and practical aspects of the topic. This book is designed to satisfy the challenging requirements of NET (CSIR-UGC), GATE, SET, ONGC, IARI, BARC and Ph.D. Entrance of Various Indian University.

The final form of this book is the outcome of an extensive survey of related literature than our knowledge. We have tried to consult the best available sources of information in respect to various topics discussed. We sincerely hope that the book will go a long way to satisfy the long felt need of students for a friendly book on Chemistry.

We gratefully acknowledge the assistance and constructive comments of our colleagues and Research students during the preparation of this book. Any suggestions for improvement of the book are welcome and will be gratefully acknowledged.

—Authors

CONTENTS

● Previous Years' Solved Papers

PART 'A'

General Aptitude	1-96
-------------------------	-------------

PART 'B'

Unit-1	: Atomic Structure	3-58
Unit-2	: Acids and Bases	59-74
Unit-3	: Redox Reactions	75-93
Unit-4	: Introductory Energetics and Dynamic of Chemical Reactions	94-115
Unit-5	: Aspects of <i>s</i> -, <i>p</i> -, <i>d</i> - and <i>f</i> - Block Elements	116-177
Unit-6	: IUPAC Nomenclature of Simple Organic and Inorganic Compounds ...	178-189
Unit-7	: Stereochemistry : Concept of Chirality	190-208
Unit-8	: Common Organic Reactions and Mechanisms	209-235
Unit-9	: Elementary Principles and Applications of Spectral Techniques	236-256
Unit-10	: Data Analysis	257-264

PART 'C'

Unit-1	: Quantum Chemistry.....	3-22
Unit-2	: The Variation Method and Perturbation Theory.....	23-34
Unit-3	: Born Oppenheimer Approximation, MO, VB.....	35-48
Unit-4	: Group Theoretical Representations and Quantum Mechanics	49-62
Unit-5	: Spectroscopy : Theoretical Treatment of Rotational, Vibrational and Electronic Spectroscopy, Principles of Magnetic Resonance, Mossbauer and Photoelectron Spectroscopy.....	63-76
Unit-6, 7	: Thermodynamics and Chemical Equilibrium.....	77-103
Unit-8	: Ideal and Non-ideal Solutions.....	104-116
Unit-9	: Electrochemistry.....	117-130
Unit-10	: Surface Phenomenon.....	131-140
Unit-11	: Statistical Thermodynamics.....	141-153
Unit-12	: Non-equilibrium Thermodynamics.....	154-159
Unit-13	: Reaction Kinetics.....	160-182
Unit-14	: Fast Reactions.....	183-189

Unit-15	: Macromolecules.....	190-200
Unit-16	: Solids.....	201-212
Unit-17	: Nuclear Chemistry.....	213-232
Unit-18	: Chemistry of Non-transition Elements	233-292
Unit-19	: Chemistry of Transition Elements.....	293-353
Unit-20	: Chemistry of Lanthanides and Actinides.....	354-362
Unit-21	: Organometallic Chemistry of Transition Elements.....	363-397
Unit-22	: Analytical Chemistry.....	398-415
Unit-23	: Bio-inorganic Chemistry.....	416-442
Unit-24	: Aromaticity.....	443-449
Unit-25	: Stereochemistry and Conformational Analysis.....	450-468
Unit-26	: Selective Organic Name Reactions.....	469-505
Unit-27	: Mechanism of Organic Reactions.....	506-521
Unit-28	: Pericyclic Reactions.....	522-541
Unit-29	: Heterocyclic Chemistry	542-556
Unit-30	: Reagents in Organic Synthesis.....	557-584
Unit-31	: Chemistry of Natural Products	585-608
Unit-32	: Bio-organic Chemistry.....	609-622
Unit-33	: Photochemistry.....	623-639
Unit-34	: Spectroscopy.....	640-667

Interdisciplinary Topics

1.	Chemistry in Nanoscience and Technology.....	3-9
2.	Catalysis and Green Chemistry.....	10-17
3.	Medicinal Chemistry.....	18-30
4.	Supramolecular Chemistry.....	31-37
5.	Environmental Chemistry.....	38-48
●	Part-B—Multiple Choice Questions.....	1-54
●	Part-C—Multiple Choice Questions.....	55-119

GENERAL INFORMATION

SCHEME OF EXAMINATION

Time : 3 Hrs.

Max. Marks : 200

Single Paper Test having Multiple Choice Questions (MCQs) is divided in three parts.

PART 'A'

This part shall carry 20 questions pertaining to General aptitude with emphasis on logical reasoning graphical analysis, analytical and numerical ability, quantitative comparisons, series formation, puzzles etc. The candidates shall be required to answer any 15 questions. Each question shall be of two marks. The total marks allocated to this section shall be 30 out of 200.

PART 'B'

This part shall contain 50 Multiple Choice Questions (MCQs) generally covering the topics given in the syllabus. A candidate shall be required to answer any 35 questions. Each question shall be of two marks. The total marks allocated to this section shall be 70 out of 200.

PART 'C'

This part shall contain 75 questions that are designed to test a candidate's knowledge of scientific concepts and/or application of the scientific concepts. The questions shall be of analytical nature where a candidate is expected to apply the scientific knowledge to arrive at the solution to the given scientific problem. A candidate shall be required to answer any 25 questions. Each question shall be of four marks. The total marks allocated to this section shall be 100 out of 200.

- There will be negative marking @25% for each wrong answer.
- To enable the candidates to go through the questions, the question paper booklet shall be distributed 15 minutes before the scheduled

time of the exam. The Answer sheet shall be distributed at the scheduled time of the exam.

SYLLABUS

PART 'A'

This part shall carry 20 questions pertaining to General aptitude with emphasis on logical reasoning graphical analysis, analytical and numerical ability, quantitative comparisons, series formation, puzzles etc. The candidates shall be required to answer any 15 questions. Each question shall be of two marks. The total marks allocated to this section shall be 30 out of 200.

COMMON SYLLABUS FOR PART 'B' & 'C'

Inorganic Chemistry

1. Chemical periodicity.
2. Structure and bonding in homo- and heteronuclear molecules, including shapes of molecules (VSEPR Theory).
3. Concepts of acids and bases, Hard-Soft acid base concept, Non-aqueous solvents.
4. **Main group elements and their compounds** : Allotropy, synthesis, structure and bonding, industrial importance of the compounds.
5. **Transition elements and coordination compounds** : Structure, bonding theories, spectral and magnetic properties, reaction mechanisms.
6. **Inner transition elements** : Spectral and magnetic properties, redox chemistry, analytical applications.
7. **Organometallic compounds** : Synthesis, bonding and structure, and reactivity. Organometallics in homogeneous catalysis.
8. Cages and metal clusters.
9. **Analytical chemistry** : Separation, spectroscopic, electro- and thermoanalytical methods.

10. **Bioinorganic chemistry** : Photosystems, porphyrins, metalloenzymes, oxygen transport, electron-transfer reactions; nitrogen fixation, metal complexes in medicine.
11. Characterisation of inorganic compounds by IR, Raman, NMR, EPR, Mössbauer, UV-vis, NQR, MS, electron spectroscopy and microscopic techniques.
12. **Nuclear chemistry** : Nuclear reactions, fission and fusion, radio-analytical techniques and activation analysis.
9. **Electrochemistry** : Nernst equation, redox systems, electrochemical cells; Debye-Huckel theory; electrolytic conductance – Kohlrausch's law and its applications; ionic equilibria; conductometric and potentiometric titrations.
10. **Chemical kinetics** : Empirical rate laws and temperature dependence; complex reactions; steady state approximation; determination of reaction mechanisms; collision and transition state theories of rate constants; unimolecular reactions; enzyme kinetics; salt effects; homogeneous catalysis; photochemical reactions.

Physical Chemistry

1. **Basic principles of quantum mechanics** : Postulates; operator algebra; exactly-solvable systems – particle-in-a-box, harmonic oscillator and the hydrogen atom, including shapes of atomic orbitals; orbital and spin angular momenta; tunneling. .
2. **Approximate methods of quantum mechanics** : Variational principle; perturbation theory up to second order in energy; applications.
3. Atomic structure and spectroscopy; term symbols; many-electron systems and antisymmetry principle.
4. Chemical bonding in diatomics; elementary concepts of MO and VB theories; Huckel theory for conjugated π -electron systems.
5. Chemical applications of group theory; symmetry elements; point groups; character tables; selection rules.
6. **Molecular spectroscopy** : Rotational and vibrational spectra of diatomic molecules; electronic spectra; IR and Raman activities – selection rules; basic principles of magnetic resonance.
7. **Chemical thermodynamics** : Laws, state and path functions and their applications; thermodynamic description of various types of processes; Maxwell's relations; spontaneity and equilibria; temperature and pressure dependence of thermodynamic quantities; Le Chatelier principle; elementary description of phase transitions; phase equilibria and phase rule; thermodynamics of ideal and non-ideal gases, and solutions.
8. **Statistical thermodynamics** : Boltzmann distribution; kinetic theory of gases; partition functions and their relation to thermodynamic quantities – calculations for model systems.
11. **Colloids and surfaces** : Stability and properties of colloids; isotherms and surface area; heterogeneous catalysis.
12. **Solid state** : Crystal structures; Bragg's law and applications; band structure of solids.
13. **Polymer chemistry** : Molar masses; kinetics of polymerization.
14. **Data analysis** : Mean and standard deviation; absolute and relative errors; linear regression; covariance and correlation coefficient.

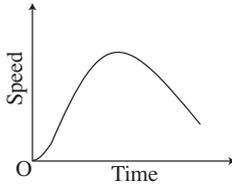
Organic Chemistry

1. IUPAC nomenclature of organic molecules including regio- and stereoisomers.
2. Principles of stereochemistry: Configurational and conformational isomerism in acyclic and cyclic compounds; stereogenicity, stereoselectivity, enantioselectivity, diastereoselectivity and asymmetric induction.
3. Aromaticity: Benzenoid and non-benzenoid compounds – generation and reactions.
4. Organic reactive intermediates: Generation, stability and reactivity of carbocations, carbanions, free radicals, carbenes, benzynes and nitrenes.
5. Organic reaction mechanisms involving addition, elimination and substitution reactions with electrophilic, nucleophilic or radical species. Determination of reaction pathways.
6. Common named reactions and rearrangements – applications in organic synthesis.

7. **Organic transformations and reagents :** Functional group interconversion including oxidations and reductions; common catalysts and reagents (organic, inorganic, organometallic and enzymatic). Chemo, regio and stereoselective transformations.
 8. **Concepts in organic synthesis :** Retro-synthesis, disconnection, synthons, linear and convergent synthesis, umpolung of reactivity and protecting groups.
 9. **Asymmetric synthesis :** Chiral auxiliaries, methods of asymmetric induction –substrate, reagent and catalyst controlled reactions; determination of enantiomeric and diastereomeric excess; enantio-discrimination. Resolution – optical and kinetic.
 10. **Pericyclic reactions :** Electrocyclisation, cycloaddition, sigmatropic rearrangements and other related concerted reactions.
 - Principles and applications of photochemical reactions in organic chemistry.
 11. Synthesis and reactivity of common heterocyclic compounds containing one or two heteroatoms (O, N, S).
 12. **Chemistry of natural products :** Carbohydrates, proteins and peptides, fatty acids, nucleic acids, terpenes, steroids and alkaloids. Biogenesis of terpenoids and alkaloids.
 13. Structure determination of organic compounds by IR, UV-Vis, ^1H & ^{13}C NMR and Mass spectroscopic techniques.
- Interdisciplinary Topics**
1. Chemistry in nanoscience and technology.
 2. Catalysis and green chemistry.
 3. Medicinal chemistry.
 4. Supramolecular chemistry.
 5. Environmental chemistry.
-

CSIR UGC-NET/JRF Exam., December 2013 Solved Paper Chemical Sciences

PART-A

1. A cylinder of radius 1 cm and height 1 cm is broken into three pieces. Which of the following must be true ?
 (A) At least one piece has volume equal to 1 cm^3
 (B) At least two pieces have equal volumes
 (C) At least one piece has volume less than 1 cm^3
 (D) At least one piece has volume greater than 1 cm^3
2. For real number x and y , $x^2 + (y - 4)^2 = 0$. Then the value of $x + y$ is—
 (A) 0 (B) 2
 (C) $\sqrt{2}$ (D) 4
3. Every time a ball falls to ground, it bounces back to half the height it fell from. A ball is dropped from a height of 1024 cm. The maximum height from the ground to which it can rise after the tenth bounce is—
 (A) 102.4 cm (B) 1.24 cm
 (C) 1 cm (D) 2 cm
4. A farmer gives 7 full, 7 half-full and 7 empty bottles of honey to his three sons and asks them to share these among themselves such that each of them gets the same amount of honey and the same number of bottles. In how many ways can this be done ? (bottles cannot be distinguished otherwise, they are sealed and cannot be broken)—
 (A) 0 (B) 1
 (C) 2 (D) 3
5. A car is moving along a straight track. Its speed is changing with time as shown.

6. Which of the following statements is correct ?
 (A) The speed is never zero
 (B) The acceleration is zero once on the path
 (C) The distance covered initially increases and then decreases
 (D) The car comes back to its initial position once
7. If $a + b + c + d + e = 10$ (all positive numbers), then the maximum value of $a \times b \times c \times d \times e$ is—
 (A) 12 (B) 32
 (C) 48 (D) 72
8. How many nine-digit positive integers are there, the sum of squares of whose digits is 2 ?
 (A) 8 (B) 9
 (C) 10 (D) 11
9. A circle of radius 7 units lying in the fourth quadrant touches the x -axis at $(10, 0)$. The centre of the circle has coordinates—
 (A) $(7, 7)$ (B) $(-10, 7)$
 (C) $(10, -7)$ (D) $(7, -7)$
10. One of the four—A, B, C and D committed a crime. A said, "I did it." B said, "I didn't." C said, "B did it." D said, "A did it." Who is lying ?
 (A) A (B) B
 (C) C (D) D
11. What is the arithmetic mean of $\frac{1}{1 \times 2}, \frac{1}{2 \times 3}, \frac{1}{3 \times 4}, \frac{1}{4 \times 5}, \dots, \frac{1}{100 \times 101}$?
 (A) 0.01 (B) $\frac{1}{101}$
 (C) 0.001111... (D) $\frac{\frac{1}{49 \times 50} + \frac{1}{50 \times 51}}{2}$

CSIR-UGC NET/JRF/SET Chemical Sciences



Publisher : **Upkar Prakashan**

ISBN : 9788174823816

Author : Dr. Hemant
Kulshrestha & Dr. Ajay
Taneja

Type the URL : <http://www.kopykitab.com/product/3940>



Get this eBook