

FOR CLASS 8 AND 9 · THE FOUNDATION FOR CBSE · NEET · JEE

ROOTS

of

CHEMISTRY

VOLUME 1

A book every student must read

Symbols · Formulae · Valency · Chemical Equations · Ionic Equations · Oxidation and
Reduction



S K SHUKLA

Mentoring IIT-JEE Aspirants Since 1994

Roots of Chemistry Vol 1

The Language of Chemistry for Class 8 and 9: Symbols, Formulae, Equations and Redox Reactions

S K Shukla

Mentoring IIT-JEE Aspirants Since 1994

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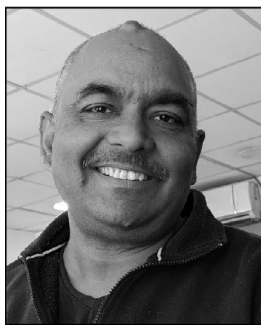
Every chemical equation in this book — in the lessons, the examples and the answers — has been checked by computer: the atoms of every element and the electric charges are the same on both sides. The book is not printed if any equation fails this check. If you still find a mistake, please write to the author.

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S K Shukla has taught chemistry to IIT-JEE students since 1994. In more than thirty years of teaching he has seen one thing again and again: a student who can write formulae and equations correctly finds chemistry easy, and a student who cannot finds every chapter hard.

He is the founder of Master Testing Agency, Roorkee, which writes practice tests for CBSE, NEET, JEE Main and JEE Advanced, sold at www.mastertestingagency.com. He is also the author of *Octacurv of Inorganic Chemistry*, *Octacurv of Organic Chemistry* and *Octacurv of Organic Reactions*.

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Preface

Chemistry has its own language. Its letters are the **symbols** of the elements. Its words are the **formulae** of substances. Its sentences are **chemical equations**. Before you can read or write chemistry, you must learn this language — just as you learnt the alphabet before you read a story.

This book is written for students of Class 8 and 9, in the simplest words I could find. It is also for anyone who never felt sure about formulae and equations. It starts from the very beginning: what chemistry is, and the meaning of element, compound, atom and molecule. It then teaches symbols, valency and the writing of formulae. After that it teaches how to write and balance chemical equations — first by the simple hit and trial method, then by the method of partial equations, the ion-electron method and the oxidation number method.

Every chapter has the same plan:

- **The lesson**, in short and simple sentences;
- **Solved examples**, worked out step by step;
- **Remember** boxes with the common mistakes;
- **Test your understanding** — fill in the blanks, with the key;
- **Exercises** — many equations to write and balance, with all the answers at the end of the chapter.

The last two chapters, **Test Yourself I and II**, are mixed questions of the kind asked in school and entrance examinations.

Do not try to learn equations by heart. Learn what the substances are and what they become; then write the equation and balance it yourself. Check your answer only after you have tried. With practice, writing equations will become easy.

I wish every reader success.

S K Shukla

How to use this book

- Read each lesson slowly. Write every formula and equation in your notebook as you read.
- Learn the tables of symbols and radicals (Chapter 2) by heart before you go further. Everything after depends on them.
- Do the exercises yourself first. Then check with the answers at the end of the chapter.
- If an answer does not match, find your mistake: count the atoms of each element on both sides again.

Signs used in equations

→	gives, forms	⇌	reversible reaction
↑	a gas is given off	↓	a precipitate (solid) is formed
(s), (l), (g)	solid, liquid, gas	(aq)	dissolved in water
Δ or heat	the substance is heated	[O], [H]	nascent (newly formed, single-atom) oxygen, hydrogen
e ⁻	an electron	dil., conc.	dilute, concentrated

Atomic masses used in this book

H 1, C 12, N 14, O 16, Na 23, Mg 24, Al 27, P 31, S 32, Cl 35.5, K 39, Ca 40, Fe 56, Cu 63.5, Zn 65, Ag 108, I 127, Ba 137.

Chapter 1 · Introduction to Chemistry

1.1 What is chemistry?

Everything around you is made of **matter**: the air you breathe, the water you drink, the food you eat and the book you are reading. Matter is anything that has mass (weight) and takes up space.

Chemistry is the study of matter: what it is made of, how it behaves, and how it changes into new things.

You see chemistry every day:

- Milk turns into curd.
- Iron gets rusty in the rain.
- Food is cooked on a gas stove.
- Soap removes dirt from clothes.

In each of these, one kind of matter changes into a new kind. Such a change is called a **chemical change**.

1.2 Chemistry has its own language

English has letters, words and sentences. Chemistry has them too.

English	Chemistry	Example
letters	symbols	H, O, Na
words	formulae	H ₂ O, NaCl
sentences	equations	2H ₂ + O ₂ → 2H ₂ O

This book teaches you this language, step by step. First, we learn a few basic words.

1.3 Element

Some substances are very simple. They cannot be broken into anything simpler. Hydrogen, oxygen, iron and silver are examples.

An element is a simple substance that cannot be broken into simpler substances.

1.4 Compound

When two or more elements join together, a new substance is made. It looks and behaves quite differently from the elements that made it. Water and carbon dioxide are examples.

Look at common salt. It is made from sodium, a metal that catches fire in water, and chlorine, a poisonous gas. Yet salt is safe to eat!

A compound is a substance made when two or more elements join together in a fixed ratio. A compound can be broken back into its elements by chemical methods.

A **mixture** is different. Its parts are only mixed, not joined. They can be mixed in any amount, and they can be separated again easily. Air and salt water are mixtures.

1.5 Atom

An atom is the smallest particle of an element that can take part in a chemical change.

Atoms are far too small to see, even with a good microscope. Some atoms can live alone (helium). Others cannot; they always join with other atoms (hydrogen).

1.6 Atomic mass

Atoms are very, very light. One carbon atom weighs about 0.000 000 000 000 000 000 0199 g. That is too small to use. So scientists use a tiny unit:

1 atomic mass unit (1 u) = one-twelfth of the mass of one carbon-12 atom.

Some atoms of the same element have different masses. They are called **isotopes**. Chlorine has two kinds of atoms, of mass 35 u and 37 u. On average a chlorine atom has a mass of 35.5 u. This average is the **atomic mass** of chlorine.

Atomic mass is the average mass of the atoms of an element, in atomic mass units (u).

Atomic mass only compares atoms. "The atomic mass of magnesium is 24" means a magnesium atom is twice as heavy as a carbon-12 atom (mass 12).

1.7 Molecule

A molecule is the smallest particle of a substance that can live on its own and still has all the properties of that substance.

- A molecule of an element has atoms of one kind: O_2 (two oxygen atoms).
- A molecule of a compound has atoms of different kinds: H_2O (two hydrogen atoms and one oxygen atom).

1.8 Molecular mass

Molecular mass is the sum of the atomic masses of all the atoms in a molecule.

For magnesium carbonate, $MgCO_3$: $Mg\ 24 + C\ 12 + O\ 3 \times 16 = 84$. So one unit of $MgCO_3$ is 7 times as heavy as a carbon-12 atom ($84 \div 12 = 7$).

1.9 Radical

Most compounds have two parts. Each part is called a **radical**.

- In sodium chloride the radicals are sodium and chloride.
- In potassium nitrate they are potassium and nitrate.

A radical is an atom, or a group of atoms, that moves as one unit in a reaction.

- A **simple radical** has only one atom: sodium (Na), chloride (Cl).
- A **compound radical** has a group of atoms: nitrate (NO_3) has one nitrogen and three oxygen atoms; sulphate (SO_4) has one sulphur and four oxygen atoms.

Acid radical and basic radical. An acid and a base react to give a salt and water. This is called **neutralisation**:

Sodium hydroxide (base) + Hydrochloric acid (acid) $\rightarrow$ Sodium chloride (salt) + Water

In sodium chloride, the sodium came from the base. So it is the **basic radical**. The chloride came from the acid. So it is the **acid radical**.

Ions. When salt dissolves in water, its radicals separate and carry an electric charge. Charged radicals are called **ions**.

- Basic radicals carry a positive (+) charge: Na^+ . They are also called **positive radicals** or **cations**.
- Acid radicals carry a negative (–) charge: Cl^- . They are also called **negative radicals** or **anions**.

Test your understanding

Fill in the blanks.

1. The study of matter and its changes is called
2. Simple substances that cannot be broken into simpler substances are called
3. A is made when two or more join in a fixed ratio.
4. The smallest particle of an element that can take part in a chemical change is called an
5. The smallest particle of a substance that can live on its own is called a
6. Atomic mass is measured in (u).
7. A is an atom or a group of atoms that moves as one unit in a reaction.
8. In sodium chloride, sodium is the radical and chloride is the radical.
9. Charged radicals are called

Key. 1. chemistry. 2. elements. 3. compound, elements. 4. atom. 5. molecule. 6. atomic mass units. 7. radical. 8. basic, acid. 9. ions.

Exercises

1. What is chemistry? Give two examples of chemical changes from daily life.
2. Define with one example each: (i) element, (ii) compound, (iii) atom, (iv) molecule, (v) radical, (vi) atomic mass, (vii) molecular mass.
3. What is the difference between (i) an acid radical and a basic radical, (ii) a simple radical and a compound radical, (iii) a positive radical and a negative radical?
4. Why do we say that atomic mass is only a comparison?
5. How is a compound different from a mixture? Give one example of each.
6. Find the molecular mass of (i) H_2SO_4 , (ii) CaCO_3 , (iii) NaOH , (iv) CO_2 .

Answers

1–5. See the lesson.

6. (i) 98, (ii) 100, (iii) 40, (iv) 44.