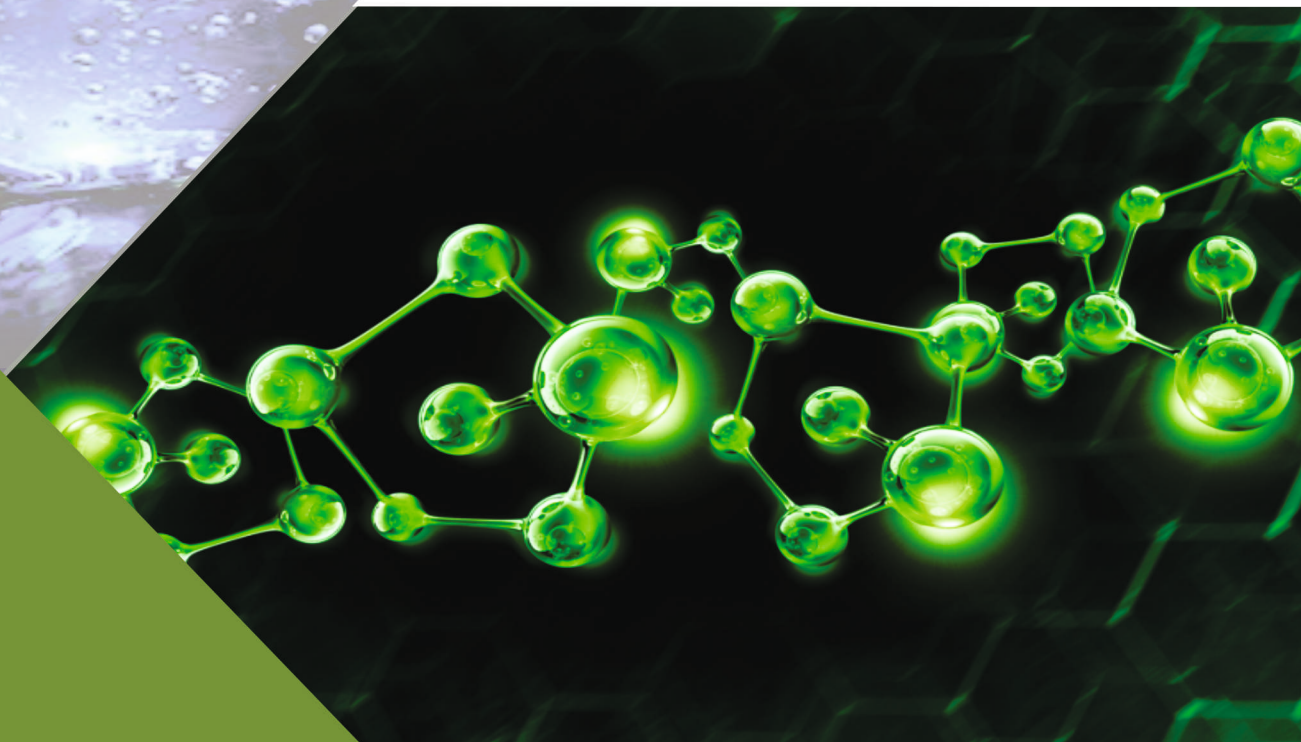




# A Textbook of **ENGINEERING CHEMISTRY-I**

As per the Latest Syllabus of Diploma in Engineering Courses Under  
Jharkhand University of Technology, Ranchi

**Dr. Altaf Ahmad**



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# ENGINEERING CHEMISTRY-I

As per SBTE, Jharkhand Syllabus  
*of*  
First Semester Polytechnic

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Dr. Altaf Ahmad



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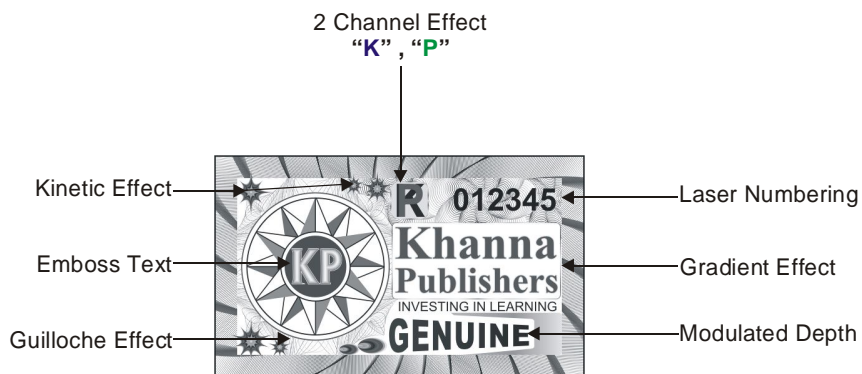
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## ***PREFACE***

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This book is exclusively written for the students of various branches of diploma in engineering throughout the country in general and for the students of Jharkhand in particular, keeping in view of their professional requirements, after entering into their practical life.

The objective of the present book is to serve the students with an elementary knowledge of chemistry. The syllabi of chemistry taught in the name of engineering chemistry in different diploma colleges is fairly diverse in nature. It is therefore quite impossible to provide a complete coverage at all the topics in a limited space for all students. However, author have dealt with modern views of the topics of the syllabi and attempted to give a major coverage at the recent syllabi taught in various diploma level institutions.

This book embodies seven chapters which are strictly as per the syllabus prescribed by the Jharkhand University of Technology, Jharkhand for the students of first semester of three years Diploma in Engineering. Each chapter consists of a methodical introduction, historical background, discussion of basic physico-chemical principles involved and practical applications and significance. Chapter on Electrochemistry also contain systematic methods of solving problems followed by several worked out examples. Further, at the end of each chapter various review questions are given which also include multiple choice questions and answers.

This book is written solely with a conviction to cater the academic and professional requirements of the students of all branches of Diploma in Engineering.

Although, every attempt has been taken to make this edition error-free. However, some mistakes may crept in, so, if the reader bring to such mistakes; I would be highly thankful to them. I shall do my level best to reactify them in the next edition.

Any suggestions and constructive criticism towards this objective are welcome.

September, 2019

Dr. Altaf Ahmad

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# Atomic Structure

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**Syllabus:** Definition of Atom, Fundamental Particles of Atom – their Mass, Charge, Location, Definition of Atomic no., Atomic Mass no., Isotopes & Isobars, & their distinction with suitable examples, Bohr's Theory, Definition, Shape of the orbitals and distinction between Orbits & Orbitals, Hund's Rule, Aufbau's Principle, Electronic Configuration (till Atomic no. 30).

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## 1.1 INTRODUCTION

Atoms are present at the most basic level in everything we see around us. In fact, every living organism is composed of atoms. Every non-living thing around us is made up of matter. The building blocks of matter are atoms. Therefore, living or non-living, everything is composed of atoms. Atoms are the fundamental basis of all matter present in the universe and form the foundation of chemistry.

The Greek philosopher Democritus (460 B.C. – 370 B.C.) was among the first to suggest the existence of atoms. The name 'atom' comes from the Greek word 'atomos', which means indivisible. He believed that atoms were indivisible and indestructible. He also proposed that all substances are made up of matter. His ideas were just philosophical but shown agreement with later scientific theory.

Later in the year 1808, John Dalton (1766 – 1844) the British school teacher proposed the first modern atomic theory and explained the laws of chemical combinations. He visualised the atom as a hard solid individual particle incapable of subdivision. At the end of the nineteenth century there accumulated enough experimental evidence to show that the atom is composed of still smaller particles called subatomic particles. The number of subatomic particles now known is very large. By the end of mid-20th century, many scientists such as William Crookes, J.J. Thomson, Goldstein, E. Rutherford, Niels Bohr among others developed and proposed several concepts on 'atom'.

## 1.2 ATOM AND MOLECULES

The term 'atoms' and 'molecules' are most important term of and are most frequently used in chemistry. Let us now familiarise ourselves with these terms in its real meanings.

### 1.2.1 Atom

An atom is the smallest indivisible particle of an element that participates in chemical combinations i.e., in chemical bond formations.

The general characteristics of atom are following.

1. All elements are composed of atoms.
2. An atom has all the characteristics of the parent element.
3. An atom can neither be created nor can be destroyed by any chemical means.
4. Atoms are always in motion.
5. Atom cannot exist freely. However, atoms of noble gases are stable and can exist freely.

6. It is the ultimate particle of an element, which may or may not have independent existence. The atoms of certain elements such as hydrogen, oxygen, nitrogen, etc. do not have independent existence whereas atoms of helium, neon, argon, etc. do have independent existence.
7. Atoms attain stability by combining with one or more atoms of same or other elements.
8. An atom retains its identity during all chemical and physical changes.

### 1.2.2 Molecules

A molecule is the smallest particle of an element or a compound that has all the chemical properties of that element or compound and can exist independently under ordinary conditions.

The general characteristics of molecules are following.

1. Molecules are made of atoms.
2. Molecules are electrically neutral.
3. A molecule is a single chemical entity.
4. These are always in motion.
5. In a molecule the atoms are held together by chemical bonds.
6. These bonds formed as a result of the sharing or exchange of electron between them.
7. The atoms of certain elements readily combine with other atoms to form molecules by forming bonds between them. For example oxygen, chlorine etc.
8. The atoms of some elements do not easily bond with other atoms and behave as molecules. For example neon, argon etc.
9. Molecules can vary greatly in their size and complexity.
10. The number of atoms present in a molecule is called its atomicity.
11. A molecule containing only one atom is known as monatomic molecule. For example, atom of noble gases are stable particles. They are their monatomic molecules. Molecules consist of two or three atoms either of same or different elements are called diatomic and triatomic molecules respectively.
12. The molecules consist of more than three atoms either of same or different elements are referred to as polyatomic molecules.
13. Molecules consist of the atoms of one element are called 'homonuclear' such as  $H_2$ ,  $O_2$ ,  $O_3$ ,  $N_2$ ,  $P_4$ , and  $S_8$  and the molecules consist of atoms of different elements are called 'heteronuclear' such as  $H_2O$ ,  $H_2S$ ,  $CH_4$ ,  $NO_2$ ,  $CO$ ,  $PCl_5$ , and  $C_6H_{12}O_6$ .
14. The molecular formula of a compound indicates the number of atoms of each element present in one molecule of the compound. A molecule of water as shown in Fig. 1.1 consists of two atoms of hydrogen and one atom of oxygen, which is quite clear in its molecular formula,  $H_2O$ .

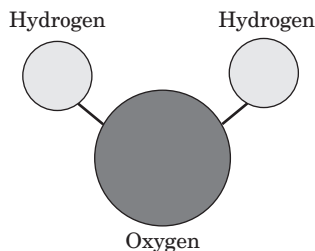


Fig. 1.1: Water ( $H_2O$ ) molecule

### 1.2.3 Atomicity

The atomicity of a molecule refers to the number atoms either same or different present in one molecule of the compound. Table 1.1 shows the atomicity of some homonuclear and heteronuclear molecules.

**Table 1.1: Atomicity of molecules**

Atomicity	Molecules	
	Homonuclear	Heteronuclear
1	Noble gases (He, Ne, Ar, Kr, Xe etc.)	—
2	Hydrogen – H <sub>2</sub> Oxygen – O <sub>2</sub> Nitrogen – N <sub>2</sub> Chlorine – Cl <sub>2</sub>	Hydrogen halide – HX Carbon monoxide – CO Nitric oxide – NO
3	Ozone – O <sub>3</sub>	Water – H <sub>2</sub> O Hydrogen Sulphide – H <sub>2</sub> S Carbon dioxide – CO <sub>2</sub>
4	Phosphorus – P <sub>4</sub>	Ammonia – NH <sub>3</sub> Phosphorus trichloride – PCl <sub>3</sub> Sulphur trioxide – SO <sub>3</sub>
5	Sulphur – S <sub>8</sub>	—

### 1.2.4 Difference between Atom and Molecule

The distinction between atoms and molecules are summarized in Table 1.2.

**Table 1.2: Distinction between Atom and Molecule**

	Atom	Molecule
1	An atom is the smallest particle of an element which may or may not have independent existence and possess all the properties of the element.	A molecule is an atom or group of atoms held together by chemical bonds, indicating the smallest unit of a compound having an independent existence.
2	An atom may or may not be a stable particle	A molecule is a stable particle.
3	Atoms may or may not exist in free state.	Molecules exist in free state.
4	An atom consists of a nucleus and electrons	A molecule consists of two or more atoms either same or different, bonded chemically.
5	Atoms are the indivisible unit of matter.	Molecules can be divided into individual atoms.
6	Atoms are spherical.	Molecules may be of different shapes such as linear, angular, trigonal etc.
7	Atoms are highly reactive with exceptions of the atoms of noble gases.	Molecules are comparatively less reactive.
8	It is the smallest particle that takes part in a chemical reaction without losing its identity.	It is the smallest particle that takes part in physical changes without losing its identity. During a chemical reaction, molecules of reactants break and molecules of products are formed.

### 1.3 SUB-ATOMIC AND FUNDAMENTAL PARTICLES OF ATOM

#### 1.3.1 Sub-atomic Particles of Atom

This has been experimentally established that atoms of any element consist of several elementary particles such as electron, proton, neutron, positron, meson, neutrino, antineutrino etc. These elementary particles are called sub-atomic particles.

#### 1.3.2 Fundamental Particles of atom

The total mass and total charge of the atom depends upon three elementary particles electron, proton and neutron. These three particles are the major component of any atom and are called as fundamental particles of atom.

#### 1.3.3 Characteristics of Fundamental Particles of Atom

The characteristics of fundamental particles of atom i.e., electron, proton and neutron can be summarized below in Table 1.3.

**Table. 1.3: Characteristics of Fundamental Particles of Atom**

	<i>Electron</i>	<i>Proton</i>	<i>Neutron</i>
Discoverer	J. J. Thomson	Eugen Goldstein	James Chadwick
Year of Discovery	1897	1886	1932
Symbol	$e, {}_{-1}e^0$	$p, {}_1p^1, H^+$	$n, {}_0n^1$
Location	In orbits outside the nucleus	In the nucleus	In the nucleus
Relative Charge	- 1 unit	+1 unit	Charge less or Neutral
Absolute Charge	$- 4.8 \times 10^{-10}$ esu (CGS) $- 1.6 \times 10^{-19}$ C (SI)	$+4.8 \times 10^{-10}$ esu (CGS) $+1.6 \times 10^{-19}$ C (SI)	0
Relative Mass	1/1837 amu or 0.00055 amu	1 amu, or 1.00728 amu	1 amu, or 1.00866 amu
Absolute Mass	$9.109 \times 10^{-28}$ g or $9.109 \times 10^{-31}$ kg	$1.673 \times 10^{-24}$ g or $1.673 \times 10^{-27}$ kg	$1.673 \times 10^{-24}$ g or $1.673 \times 10^{-27}$ kg
e/m [Charge/mass]	$1.76 \times 10^5$ C/g	$0.957 \times 10^5$ C/g	0
Effect in Electric Field	Attracted to the positive pole	Attracted to the negative pole	Un-attracted in the electrical field

### 1.4 ATOMIC NUMBER AND MASS NUMBER

Atomic number and mass number also called as Atomic mass number are two important parameters for describing an atom. Atomic number is the most fundamental property of an atom whereas mass number is particularly useful in describing different isotopes of an element.

#### 1.4.1 Atomic Number (Z)

The total number of protons present in the nucleus of an atom is called atomic number and is designated by  $Z$ .

i.e., Atomic number = Number of protons in the nucleus.

or,  $Z = p$

For a neutral atom,  
Number of protons = Number of electrons

or  $p = e$

Therefore,

Atomic number = Number of protons in the nucleus.

= Number of electrons

or  $Z = p = e$

#### 1.4.2 Mass Number or Atomic Mass Number (A)

The total number of protons and neutrons present in the nucleus of an atom is called *mass number*. In other words the total number of nucleons is called mass number. Mass number is always a whole number and is different from atomic mass. It is designated by 'A'.

i.e. Mass number = Total number of nucleons

or Mass number = Total number of protons + Total number of neutrons

or  $A = p + n$

also, Total number of protons = Atomic number (Z)

Therefore,  $A = Z + n$

#### 1.4.3 Representation of an Atom

An atom is generally represented as  ${}^A_Z X$  or  ${}_Z X^A$ .

where,  $Z$  = Atomic number = Total number of protons

$A$  = Mass number = Total number of protons and neutrons

$X$  = Symbol of the element

Thus, carbon atom having atomic number 6 and mass number 12 can be represented as  ${}^{12}_6 C$  or  $C^{12}_6$ .

#### 1.4.4 Difference between Atomic Number (Z) and Mass Number (A)

The difference between Atomic number (Z) and Mass number (A) is given in Table 1.4.

**Table 1.4: Difference between Atomic number and Mass number**

	<i>Atomic number</i>	<i>Mass number</i>
1	The total number of protons present in the nucleus of an atom is called atomic number.	The sum of the total number of protons and neutrons present in the nucleus of an atom i.e., the sum of the nucleons is called mass number.
2	Atomic number is represented by $Z$ .	Mass number is represented by $A$ .
3	$Z = p = e$	$A = p + n$
4	Atomic number determines the position of an element in periodic table.	Mass number has nothing to do with the position of the element in periodic table.
5	Atomic number is the fundamental characteristic of an atom because atoms of an element have a fixed atomic number.	Mass number is not fundamental because atoms of same element may have different mass number.
6	Atoms of different elements have different atomic number.	Atoms of different elements may or may not have same mass number.
7	Atomic number does not provide any idea about the mass of the nucleus of an atom of an element.	Mass number provides an approximate idea about the mass of the nucleus of an atom of an element.

### 1.5 ISOTOPE

The term isotope is formed from the Greek roots 'isos' (means equal or same) and topos (means place), meaning the 'same place'. The logic behind the name is that the different isotopes of a single element occupy the same position in periodic table.

The existence of isotopes was first suggested by the radio-chemist Frederick Soddy in 1913 on the basis of the studies of radioactive decay chains. The first evidence for multiple isotopes of a stable i.e., non-radioactive element was found by J. J. Thomson in 1913 in exploring the composition of canal rays. Thomson channelled (directed) streams of neon ions through a magnetic and an electric field and measured their deflection by placing a photographic plate in their path. He eventually concluded that some of the atoms in the neon gas were of higher mass than the rest.

It was F. W. Aston, who discovered multiple stable isotopes for numerous elements using mass spectrograph. In 1919, Aston studied neon with sufficient resolution and found the two isotopes of neon with mass number 20 and 22. Similarly, Aston showed that the molar mass of chlorine is the weight average of two isotopes of chlorine i.e.,  $\text{Cl}^{35}$  and  $\text{Cl}^{37}$ .

Isotopes are the atoms of same elements having same atomic number but different mass number. In other words, two or more atoms of same element having same number of protons but different number of neutrons are called isotopes. For example:

1. Hydrogen has three isotopes called as ordinary hydrogen or protium, heavy hydrogen or deuterium and radioactive hydrogen or tritium. The three isotopes of hydrogen are shown in Table 1.5.

**Table 1.5: Isotopes of Hydrogen**

Name of isotopes	Ordinary hydrogen or Protium	Heavy hydrogen or Deuterium	Radioactive hydrogen or Tritium
Symbol	${}_1\text{H}^1$	${}_1\text{H}^2$ or ${}_1\text{D}^2$	${}_1\text{H}^3$ or ${}_1\text{T}^3$
Atomic number (Z)	1	1	1
Mass number (A)	1	2	3
No. of protons (p)	1	1	1
No. of neutrons (n)	0	1	2
No. of electrons (e)	1	1	1

2. Oxygen has thirteen isotopes from  $\text{O}^{13}$  to  $\text{O}^{28}$  except  $\text{O}^{21}$ ,  $\text{O}^{24}$  and  $\text{O}^{25}$ . Out of these thirteen isotopes, the naturally occurring oxygen is composed of three stable isotopes  ${}_8\text{O}^{16}$ ,  ${}_8\text{O}^{17}$  and  ${}_8\text{O}^{18}$  as shown in Table 1.6. Out of these three stable isotopes the  ${}_8\text{O}^{16}$  is most abundant in nature about 99.76%.

**Table 1.6: Isotopes of Oxygen**

Symbol	${}_8\text{O}^{16}$	${}_8\text{O}^{17}$	${}_8\text{O}^{18}$
Atomic number (Z)	8	8	8
Mass number (A)	16	17	18
No. of protons (p)	8	8	8
No. of neutrons (n)	8	9	10
No. of electrons (e)	8	8	8

3. Carbon has 15 isotopes from  $\text{C}^8$  to  $\text{C}^{22}$  of which  $\text{C}^{12}$  and  $\text{C}^{13}$  are stable and  $\text{C}^{14}$  is the longest lived radioisotope. These three isotopes are naturally occurring isotopes of carbon as shown in Table 1.7.

Table 1.7: Isotopes of Carbon

Symbol	${}_6\text{C}^{12}$	${}_6\text{C}^{13}$	${}_6\text{C}^{14}$
Atomic number (Z)	6	6	6
Mass number (A)	12	13	14
No. of protons (p)	6	6	6
No. of neutrons (n)	6	7	8
No. of electrons (e)	6	6	6

### 1.5.1 Characteristics of Isotopes.

Some of the important characteristics of isotopes are following.

1. Isotopes are the atoms of same element.
2. They have same number of valence electrons.
3. Isotopes have same electronic configuration.
4. They are placed at the same place in the periodic table.
5. Because of same number of electrons they have identical chemical properties.
6. They have different physical properties such as melting point, boiling point, density etc.

### 1.5.2 Application of Carbon Isotopes

Carbon is most abundant element in living organisms. It forms the fundamental basis of organic chemistry. The atomic number of carbon is 6 and it is placed in group IVA or group 14 of the modern periodic table. It is a p-block element with electronic configuration  $1s^2, 2s^2, 2p^2$ . Carbon has 15 known isotopes from  ${}_6\text{C}^8$  to  ${}_6\text{C}^{22}$  of which three isotopes  ${}_6\text{C}^{12}$ ,  ${}_6\text{C}^{13}$  and  ${}_6\text{C}^{14}$  are natural. Out of these three isotopes  ${}_6\text{C}^{12}$  and  ${}_6\text{C}^{13}$  are stable isotopes and  ${}_6\text{C}^{14}$  is the longest lived radioisotope.

#### (a) Application of ${}_6\text{C}^{12}$ isotope

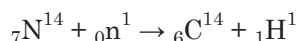
${}_6\text{C}^{12}$  is most abundant stable isotope of carbon and occurs naturally. It is mainly found in all living organisms. The percentage of  ${}_6\text{C}^{12}$  in nature is about 98.89%.  $\text{C}^{12}$  has endless uses and is considered to be the backbone of life on earth. All metabolic processes, including the life-sustaining processes such as respiration and photosynthesis, are possible by carbon-based compounds. Most of our energy needs are gratified by fossil fuels like coal, petroleum etc. These fossil fuels are originated from living organisms containing carbon based compound.

#### (b) Application of ${}_6\text{C}^{13}$ isotope

${}_6\text{C}^{13}$  is another stable isotope of carbon. It is less abundant in nature. Its percentage in nature is about 1.11%.  $\text{C}^{13}$  is widely used in NMR (Nuclear Magnetic Resonance) spectroscopy. This is due to the fact that  $\text{C}^{13}$  has a nuclear spin, which respond to the radio frequency signal.  $\text{C}^{13}$  is also used in the structure determination of proteins using NMR.  $\text{C}^{13}$  also finds its application in identifying the water sources.

#### (c) Application of ${}_6\text{C}^{14}$ isotope

${}_6\text{C}^{14}$  is the longest lived radioisotope with half life 5700 years and mainly formed by the nuclear reaction of  ${}_7\text{N}^{14}$  with neutron in the upper atmosphere about 9 to 15 km above the Earth's surface. The abundance of  $\text{C}^{14}$  is extremely rare about 1ppt (parts per trillion).  $\text{C}^{14}$  was discovered by Grosse in 1934, in the mineral endialyte. Later Curie discovered  $\text{C}^{14}$  by the bombardment of fast moving neutrons on nitrogen.  $\text{C}^{14}$  is also created in the upper atmosphere about 9 to 15 km above the Earth's surface through the bombardment of cosmic neutrons on  $\text{N}^{14}$ .



$\text{C}^{14}$  is primarily used in determining the age of a carbon containing material and fossil through radiocarbon dating technique.

### 1.5.3 Application of Cobalt Isotopes

Cobalt is a transition element and belongs to the group VIII. Cobalt has 30 known isotopes from  ${}_{27}\text{Co}^{47}$  to  ${}_{27}\text{Co}^{77}$  except  ${}_{27}\text{Co}^{73}$ . The naturally occurring cobalt ( $Z = 27$ ) has only one stable isotope  ${}_{27}\text{Co}^{59}$ . 29 radioisotopes are now known with the most stable being  $\text{Co}^{60}$  followed by  $\text{Co}^{57}$ ,  $\text{Co}^{56}$  (half-life 77.27 days) and  $\text{Co}^{58}$  (half-life 70.86 days). All other radioisotopes have half-lives less than 18 hours and majority of them have half-lives less than 1 second.

#### (a) Application of ${}_{27}\text{Co}^{57}$

$\text{Co}^{57}$  is a radioisotope of cobalt with half-life 271.8 days. It is used in medical tests. It is also used as radiolabel for vitamin B-12.  $\text{Co}^{57}$  also finds its application in Schilling test. The Schilling test is a medical investigation used for patients with cobalamin (vitamin B-12). The purpose of this test is to determine how well the patient is able to absorb vitamin B-12 from their intestinal tract.

#### (b) Application of ${}_{27}\text{Co}^{60}$

$\text{Co}^{60}$  is the most stable radioisotope of cobalt with half-life 5.2714 years. It is useful as a gamma ray source.  $\text{Co}^{60}$  finds its application in the following.

1. In the measurement of density of porous materials such as concrete.
2. In the industrial radiography for detecting weld integrity.
3. In the sterilization of medical supplies and medical wastes.
4. In the sterilization of foods by radiation treatments.
5. In radiotherapy for the treatment of cancer.

### 1.6 ISOBAR

The term 'isobar' was originally suggested by Alfred Walter Stewart in 1918. It is derived from the Greek roots 'isos' (means equal or same) and 'baros' (means weight), meaning the 'same weight'.

Isobars are the atoms of different elements having same mass number but different atomic number. In other words, two or more atoms of different element having same number of nucleons but different number of protons are called isobars. For example:

#### 1. ${}_{18}\text{Ar}^{40}$ , ${}_{19}\text{K}^{40}$ , ${}_{20}\text{Ca}^{40}$

Symbol	${}_{18}\text{Ar}^{40}$	${}_{19}\text{K}^{40}$	${}_{20}\text{Ca}^{40}$
Atomic number (Z)	18	19	20
Mass number (A)	40	40	40
No. of protons (p)	18	19	20
No. of neutrons (n)	22	21	20
No. of electrons (e)	18	19	20

2.  ${}_{17}\text{Cl}^{37}$ ,  ${}_{18}\text{Ar}^{37}$ 

Symbol	${}_{17}\text{Cl}^{37}$	${}_{18}\text{Ar}^{37}$
Atomic number (Z)	17	18
Mass number (A)	37	37
No. of protons (p)	17	18
No. of neutrons (n)	20	19
No. of electrons (e)	17	18

3.  ${}_{6}\text{C}^{14}$ ,  ${}_{7}\text{N}^{14}$ 

Symbol	${}_{6}\text{C}^{14}$	${}_{7}\text{N}^{14}$
Atomic number (Z)	6	7
Mass number (A)	14	14
No. of protons (p)	6	7
No. of neutrons (n)	8	7
No. of electrons (e)	6	7

4.  ${}_{82}\text{Pb}^{210}$ ,  ${}_{83}\text{Bi}^{210}$ 

Symbol	${}_{82}\text{Pb}^{210}$	${}_{83}\text{Bi}^{210}$
Atomic number (Z)	82	83
Mass number (A)	210	210
No. of protons (p)	82	83
No. of neutrons (n)	128	127
No. of electrons (e)	82	83

### 1.6.1 Characteristics of Isobars

Some of the important characteristics of isobars are following.

1. Isobars are the atoms of different elements.
2. They have different number of valence electrons.
3. Isobars have different electronic configuration.
4. They are placed at the different places in the periodic table.
5. Isobars have entirely different physical and chemical properties.

### 1.6.2 Difference between Isotopes and Isobars

The difference between Isotopes and Isobars are summarized in Table 1.8.

**Table 1.8: Difference between Isotopes and Isobars**

	Isotopes	Isobars
1	Two or more atoms having same atomic number but different mass number are called isotopes.	Two or more atoms having same mass number but different atomic number are called isobars.
2	Isotopes are the atoms of same element.	Isobars are the atoms of different elements.
3	Isotopes occupy same place in periodic table.	Isobars occupy different places in periodic table.
4	They have same valence electrons.	They have different valence electrons.
5	They have same electronic configuration.	They have different electronic configuration.
6	They have identical chemical properties	They have different chemical properties

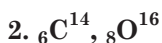
### 1.7 ISOTONES

The term isotone was introduced by K. Guggenheimer by changing the “p” (for proton) in ‘isotope’ with “n” (for neutron).

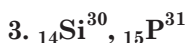
Isotones are the atoms of different element having same number of neutrons but different atomic number and mass number. In other words, Isotopes are the atoms of different elements having same number of neutrons but different number of protons. For example;



<i>Symbol</i>	${}_{16}\text{S}^{36}$	${}_{17}\text{Cl}^{37}$	${}_{18}\text{Ar}^{38}$
Atomic number (Z)	16	17	18
Mass number (A)	36	37	38
No. of protons (p)	16	17	18
No. of neutrons (n)	20	20	20
No. of electrons (e)	16	17	18



<i>Symbol</i>	${}_{6}\text{C}^{14}$	${}_{8}\text{O}^{16}$
Atomic number (Z)	6	8
Mass number (A)	14	16
No. of protons (p)	6	8
No. of neutrons (n)	8	8
No. of electrons (e)	6	8



<i>Symbol</i>	${}_{14}\text{Si}^{30}$	${}_{15}\text{P}^{31}$
Atomic number (Z)	14	15
Mass number (A)	30	31
No. of protons (p)	14	15
No. of neutrons (n)	16	16
No. of electrons (e)	14	16

### 1.8 STRUCTURE OF ATOM

From the beginning of 19th century to the first half of 20th century several attempts have been made to understand the structure of atom. In this effort a variety of models were proposed by different scientist based upon their own experiments and observations. The idea of these atomic models was to establish the arrangement of sub-atomic particles in the atom. The basic atomic models which have contributed to the structure of atom are following.

1. John Dalton’s atomic model: Dalton’s Billiard Ball (Solid Sphere) model
2. J.J. Thomson’s model: Plum Pudding model
3. Ernest Rutherford’s model: Nuclear model
4. Niels Bohr’s model: Planetary model
5. Erwin Schrödinger’s model: Electron Cloud model

# A Textbook of **ENGINEERING CHEMISTRY-I**

As per the Latest Syllabus of Diploma in Engineering Courses Under  
Jharkhand University of Technology, Ranchi

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The objective of the present book is to serve the students with an elementary knowledge of chemistry. The syllabi of chemistry taught in the name of engineering chemistry in different diploma colleges are fairly diverse in nature. It is therefore quite impossible to provide a complete coverage at all the topics in a limited space for all students. However, author have dealt with modern views of the topics of the syllabi and attempted to give a major coverage at the recent syllabi taught in various diploma level institutions.

## About the Author:



Dr. Altaf Ahmad obtained M.Sc. degree in Chemistry (Special-Organic Chemistry) from Ranchi University, Ranchi and M.Tech. degree in Surface Engineering from NIT, Jamshedpur. He completed his Ph.D. (Corrosion Science and Engineering) from Ranchi University, Ranchi, Jharkhand. Dr. Altaf is a Senior Lecturer and Incharge of Department of Chemistry, Al-Kabir Polytechnic, Jamshedpur, Jharkhand. He has been teaching Chemistry for last 25 years. He is also associated with research work and published many research papers in the Journals of National and International repute and also presented his research papers at conferences. His research paper “Rebar Corrosion – Inhibition and Testing” presented at the National Level Seminar held at Central Electrochemical Research Institute (CECRI), CSIR, Karaikudi, Tamilnadu in 2013 was awarded with first prize.

Dr. Altaf has worked as the member of Syllabus review committee, Moderation Committee etc. for Engineering Chemistry in Diploma Engineering of Jharkhand University of Technology. He is the Life member of Indian Society for Technical Education, New Delhi.



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