

SEMESTER-I

FIRST YEAR DIPLOMA
Engineering and Technology

MSBTE's
I
SCHEME

BASIC SCIENCE

CHEMISTRY



S. N. NARKHEDE

Mrs. R. M. GANGRADE

 **NIRALI**
PRAKASHAN
GOVERNMENT OF KNOWLEDGE

A Text Book of

BASIC SCIENCE

CHEMISTRY

FOR

FIRST YEAR DIPLOMA COURSES IN ENGINEERING AND TECHNOLOGY

COMMON FOR ALL BRANCHES

ACCORDING TO NEW REVISED SYLLABUS OF 'I' SCHEME

EFFECTIVE FROM JUNE 2017

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Price ₹ 110.00



N4292

Second Edition : July 2018© : **Authors**

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Published By :**NIRALI PRAKASHAN**

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Off J.M. Road, PUNE – 411005
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CTP**Printed By :****SHREE OM PRINTERS PVT. LTD.**

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Tel - (020) 24690371

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Dedicated
To The Loving Memory of
MY MOTHER
and
Students of Today and Engineers of Tomorrow

– Prof. S. N. Narkhede

Dedicated
To The Loving Memory of
MY FATHER
Late Mr. K. M. Gangrade

– Mrs. R. M. Gangrade

Preface ...

It gives us a great pleasure to bring this book of '**Basic Science Chemistry**' for the students of First Semester Diploma in Engineering and Technology. The book is written according to the revised syllabus of Board of Technical Examinations, Mumbai (M.S.), implemented since June 2017.

This book also covers the curriculum of Autonomous institutions.

In the present edition, a number of solved problems and marathi equivalent terms are incorporated.

We honestly feel that this edition will be well appreciated by the students as well as the teachers of polytechnics all over the Maharashtra state.

We would like to express our gratitude to the publishers Shri. D. K. Furia, Mr. Jignesh Furia, and the staff of Nirali Prakashan, especially Mr. Santosh Bare, Mr. Kiran Velankar and Mrs. Anjali Muley for bringing out this book within a very short time. We would still welcome the constructive suggestions from our colleagues and students for further improvements in the book.

Prof. S. N. NARKHEDE
Mrs. R. M. GANGRADE

Syllabus ...

BASIC SCIENCE CHEMISTRY

Unit-IV

4. CHEMICAL BONDING AND CATALYSIS

Hrs. 08, Marks 09

Specific Objectives:

- 4a. Explain the properties of given material based on the bond formation.
- 4b. Describe the molecular structure of given solids, liquids and gases.
- 4c. Describe the crystal structure of given solids.
- 4d. Select the relevant catalyst for given application.

Theory :

- 4.1 Electronic Theory of Valency, Chemical Bonds :** Types and characteristics, Electrovalent bond, Covalent bond, Co-ordinate bond, Hydrogen bond, Metallic bond, Metallic properties, Intermolecular force of attraction.
- 4.2 Molecular Arrangement in Solids, Liquids and Gases.**
- 4.3 Structure of Solids :** Crystalline and Amorphous solids, Properties of metallic solids – Unit cell of – Simple cubic, Body centered cubic, Face centered cubic, Hexagonal close pack crystals.
- 4.4 Catalysis :** Types of catalysis, Catalyst, Types of catalysts, Positive catalyst, Negative catalyst, Auto-catalyst, Catalytic promoter and Catalytic inhibitor, Industrial applications of catalyst.

Unit-V

5. METAL CORROSION, ITS PREVENTION AND ELECTROCHEMISTRY

Hrs. 12, Marks 12

Specific Objectives:

- 5a. Describe the phenomenon of the given type of corrosion and its prevention.
- 5b. Identify the different factors affecting rate of corrosion for the given type of material.
- 5c. Select the protective measures to prevent the corrosion in the given corrosive medium.
- 5d. Differentiate the salient features of the given electrolytic cell and electrochemical cell.
- 5e. Distinguish the given primary and secondary electrolytic cells.
- 5f. Describe the process of electrolysis for the given electrolyte.
- 5g. Describe the process of electroplating of the given material.

Theory :

- 5.1 Corrosion :** Types of corrosion : Dry corrosion, Wet corrosion, Oxidation corrosion (Atmospheric corrosion due to oxygen gas), Mechanism, Types of oxide film, Wet corrosion mechanism (Hydrogen evolution in acidic medium).
- 5.2 Concentration Cell Corrosion :** Oxygen absorption mechanism in neutral or alkaline medium, Pitting corrosion, Waterline corrosion, Crevice corrosion.
- 5.3 Factors Affecting the Rate of Corrosion Control :** Modification of environment, Use of protective coatings – Coating of less active metal like Tin (Tinning), Coating of more active metal like Zinc

(Galvanizing), Anodic and cathodic protection, Choice of material – Using pure metal and using metal alloys.

5.4 Electrolyte : Strong and weak, Non-electrolyte, Electrolytic cell, Electrochemical cell. Cathode, Anode, Electrode potential – Oxidation and Reduction, Construction and Working of Daniel cell, Ionisation and Dissociation.

5.5 Faraday's First and Second Law.

5.6 Primary cell and Secondary cell : Electrolysis – Mechanism, Electroplating and Electro-refining of copper.

Unit-VI

6. PAINTS, VARNISHES, INSULATORS, POLYMERS, ADHESIVES AND LUBRICANTS

Hrs. 12, Marks 14

Specific Objectives:

- 6a. Identify the ingredients of given paints.
- 6b. Differentiate salient properties of the given paint and varnish.
- 6c. Describe the properties of insulating materials for the given application.
- 6d. Differentiate the given types of structural polymers.
- 6e. Describe the polymerization process of the given polymer.
- 6f. Explain the properties and uses of the given polymer, elastomer and adhesive.
- 6g. Describe the application of relevant adhesives required for the given material.
- 6h. Explain the properties of given type of lubricants.

Theory :

6.1 Paints : Purpose of applying paint, Characteristics of paints, Ingredients of paints, Function and examples of each ingredient.

6.2 Varnish : Types, Difference between paints and varnishes.

6.3 Insulators : Characteristics, Classification, Properties and Applications of Glass Wool, Thermocole.

6.4 Polymer and Monomer : Classification on the basis of molecular structure, on the basis of monomers (Homopolymer and Copolymer), on the basis of thermal behavior (Thermoplastic and Thermosetting).

6.5 Types of Polymerization Reaction : Addition polymerization, Condensation polymerization, Synthesis, Properties and Applications of Polyethylene, Polyvinyl chloride, Teflon, Polystyrene, Phenol-Formaldehyde, Epoxy Resin.

6.6 Adhesives : Characteristics, Classification and their Uses.

6.7 Lubricants : Classification, Properties and Applications.



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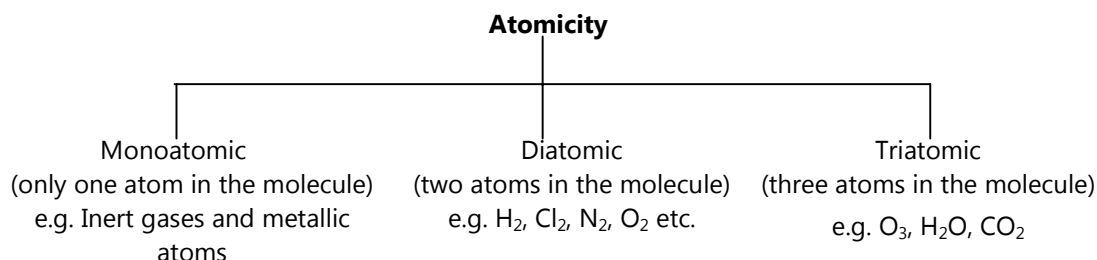
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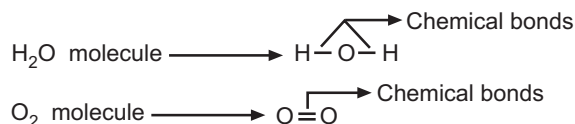
CHEMICAL BONDING AND CATALYSIS

1.1 INTRODUCTION

- Except noble gases, atoms of active elements do not have free existence. They readily combine to form molecules.
- Molecules are formed by certain kind of chemical bonds between similar or dissimilar atoms.
- Number of atoms in a molecule is the atomicity of that molecule or compound.



- Atoms of active elements are not stable in free state but the chemical bonds make them stable.
 - A chemical bond is the force of attraction between the atoms to hold them together as a stable molecule.
- Examples :



- There are different types of chemical bonds (primary bonds), as ionic bond/covalent bond/co-ordinate bond/metallic bond existing between atoms of molecules.
- Some secondary bonds (generally weak) also exist either within the same molecule or between the neighbouring molecules known as Van der Waal's force of attraction and hydrogen bond.
- It should be noted that chemical properties of compounds mainly depend upon the strength of primary bonds (ionic/covalent/co-ordinate/metallic) in the molecule and physical properties including mechanical strength depend upon secondary bonds (Van der Waal's force of attraction/hydrogen bond).

1.1.1 Electronic Theory of Valency

The salient features of the electronic theory of valency are :

- (i) The electrons present in the outermost orbit of an atom determine the valency of an atom and hence called 'valency electrons'.
- (ii) Atoms of elements with 8 electrons in the outermost orbit or shell (or 2 electrons, if there is one orbit or shell only) are **stable**. Therefore, electronic arrangement in which 8 electrons (octet) or 2 electrons (duplet) are present in the outermost shell of an atom is known as **stable** configuration.
- (iii) Only those elements having less than 8 electrons in their outermost shell of their atoms are capable of chemical combination (such elements are active or unstable elements), so that they may also acquire a stable inert gas configuration with 8 electrons (duplet, if one shell only) in the outermost shell.

- (iv) Octet (or duplet) can be achieved either (a) by the transfer (gain or loss) of one or more electrons from atom of one element to atom of another element of (b) by the sharing of electrons between the atoms.
- (v) According to their mode of formation, different types of bonds may be classified as :
- (1) Ionic bond (or electrovalent bond).
 - (2) Covalent bond.
 - (3) Coordinate bond.
 - (4) Metallic bond.

In addition, there can be attractive interactions, known by the name hydrogen bond and Van der Waals interactions.

1.1.2 Chemical Bond Formation

- In chemical bond formation, atoms interact by losing, gaining or sharing of electrons so as to acquire inert gas configuration.
- Therefore, there are following modes of chemical combinations by which a chemical bond is formed between two combining atoms.
 - (1) By transfer of electrons (lose or gain) → forms ionic or electrovalent bond.
 - (2) By mutual sharing of electrons → forms covalent bond.
 - (3) By one sided sharing of electrons → forms co-ordinate bond.
 - (4) By delocalization of electrons through metal lattice → forms metallic bond.
 - (5) When hydrogen atom acts as a bridge between two electronegative atoms → forms hydrogen bond.

1. Ionic or Electrovalent bond :

- An ionic bond is formed by the complete transference of one or more electrons from the outermost energy shell (called valence electrons) of one atom to outermost energy shell of another dissimilar atom, so that both acquire stable inert gas configuration.
- The atom which loses the electrons, acquires positive charge and becomes a positive ion (cation).
- On the other hand, the other atom which gains electrons, acquires negative charge and becomes a negative ion (anion).
- These two oppositely charged ions (cation and anion) combine, due to electrostatic forces of attraction, to form an electrovalent or ionic compound.
- Thus, electrovalent bond is the force of attraction between the positive ion (cation) and negative ion (anion).
- Chemical reactions between two combining atoms are represented by means of an electron dot diagram or atomic diagram in which the atoms of combining elements are represented as symbols of that element and the valence electrons as dot placed around the symbol.
- Examples of electrovalent compounds are NaF, KCl, MgS, CaO, AlCl₃, MgCl₂ etc.
- Table showing electropositive and electronegative character of elements

Table 1.1

Elements	Electronic configuration	Valency electron	Valency	Nature
¹¹ Na	2, 8, 1	1	1	Metallic : Loses electrons with ease to form electropositive radicals (except He, H ₂).
¹² Mg	2, 8, 2	2	2	
¹³ Al	2, 8, 3	3	3	
¹⁴ Si	2, 8, 4	4	4	Non-metallic : Gains electrons with ease to form electronegative radicals.
¹⁵ P	2, 8, 5	5	3	
¹⁶ S	2, 8, 6	6	2	
¹⁷ Cl	2, 8, 7	7	1	Inert : Does not lose or gain electrons.
¹⁸ Ar	2, 8, 8	8	0	

Properties of electrovalent bonds/ionic bonds :

- (1) Ionic bonds are formed by lose or gain of electrons between dissimilar atoms.
- (2) This type of bonding generally takes place between a metal and the non-metal.
- (3) Ionic bonds are non-directional and extend in all directions (three dimensional structure called an ionic lattice).
- (4) Due to strong intermolecular forces of attraction, ionic compounds have high melting and boiling points.
- (5) Ionic compounds are more soluble in water because they have ion-dipole interaction in water.
- (6) Since ionic bonded compounds are ionised in the fused as well as in solution state, they conduct electricity.

Examples of ionic bond formation :**(i) Formation of MgO :**

Mg-atom $\rightarrow A = 24, Z = 12$.

Electronic configuration $\rightarrow 2, 8, 2$.

Number of valence electrons $\rightarrow 2$.

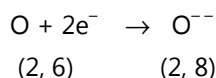
To attain stable configuration of nearest inert gas Ne (Ne = 2, 8), Mg-atom loses its two valence electrons and becomes an ion with two positive charges (Mg^{++}).

- Oxygen atom $\rightarrow A = 16, Z = 8$.

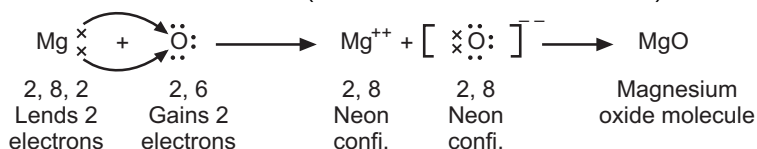
Electron configuration $\rightarrow 2, 6$.

Number of valence electrons $\rightarrow 6$.

To attain stable electronic configuration of nearest inert gas Neon (Ne = 2, 8), O-atom gains two electrons given up by the Mg-atom, resulting in the formation of a negative oxide ion [O^{-}].



- Hence only one O-atom is required to take up both the electrons given up by the Mg-atom. Therefore a molecule of magnesium oxide is made up of one magnesium ion (Mg^{++}) and one oxygen ion (O^{-}) held together by an electrostatic force of attraction (an electrovalent or ionic bond).

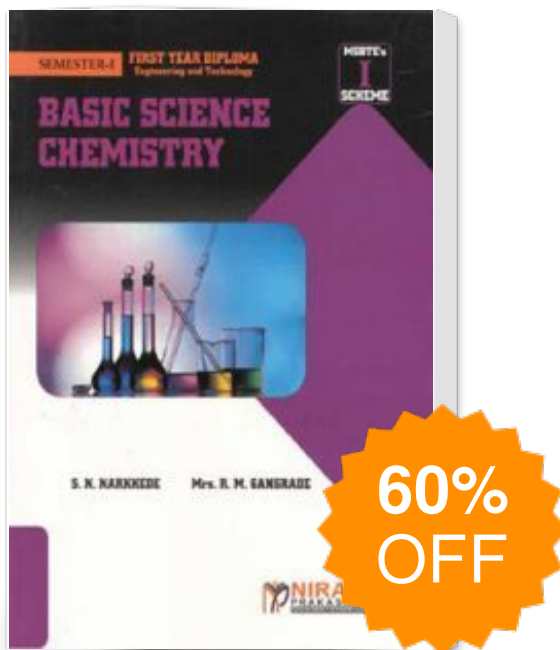
**2. Covalent bond :**

- Covalent bond is formed by **sharing of electrons** in pairs between two similar or dissimilar atoms, both of which make equal contribution of electrons.
- In covalent bond, there is no loss and gain of electrons (hence, no electrical charges are developed) and only sharing of electrons takes place.
- These shared electrons become common property of both atoms and account for the stability of both atoms i.e., both atoms acquire stable configuration.

Sharing of electrons takes place by following three ways :

- (i) When a covalent compound is formed by mutual sharing of 'one pair' of electrons between two atoms, it is called a 'single covalent bond' represented as (–).
e.g. $H_2, Cl_2, H_2O, NH_3, CH_4$ etc.
- (ii) When a covalent compound is formed by mutual sharing of two pairs of electrons between the two atoms, it is called 'double covalent bond' represented as (=).
e.g. O_2, CO_2, C_2H_4 etc.
- (iii) When a covalent compound is formed by mutual sharing of 'three pairs' of electrons between the two atoms, it is called a 'triple covalent bond' represented as (\equiv).
e.g. N_2, C_2H_2 etc.

Basic Science Chemistry



Publisher : **Nirali Prakashan**

ISBN : 9789386700124

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Mrs. R. M. Gangrade**

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