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UNIT 9

MATTER AROUND US

Learning Objectives

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After the completion of this lesson, students will be able to:

- know about the types of matter.
- know the symbols of various elements.
- classify elements into metals, non-metals and metalloids
- compare the properties of metals and non metals.
- acquire knowledge about compounds of solids, liquids and gases.
- know about the uses of compounds in daily life.

Introduction

In the universe all manifestations, phenomena and evolution of life are caused by matter and energy. All the objects which exist around us are made of some kind of matter. We perceive these objects through our senses like sight, touch, hearing, taste and smelling. A glass tumbler can be seen, agarbatti burning can be recognized by its smell whereas wind blowing can be felt. All kinds of matter possess mass and occupy space. Of course some are heavy and others are light. Thus, matter can be defined as anything which has definite mass and occupies space.

As we know already, matter exists as solids (wood, stone, sand, iron etc.), liquids (water, milk, fruit juice, etc.) and gases (oxygen, nitrogen, carbon dioxide, steam, etc.). Matter in any physical state is composed of smaller particles such as atom, molecules or ions. An atom is the smallest particle of an element which exhibits all the properties of that element. Atoms of the same element or different elements combine to form a molecule. Atoms or group of atoms having a charge (positive or negative) are called ions.

Hence, atoms are the building blocks of matter. In this lesson, we will study about symbols of elements, metals and non metals, compounds of solids, liquids and gases, and the uses of compounds in daily life.

9.1 Elements

Elements are everywhere. They are the building blocks of everything on Earth: pencil, desk, mountains, car, book, etc. Do you know that when you are breathing you are actually inhaling air? The air you breathe is made up of many elements like oxygen, nitrogen and argon.

An element is a pure substance that cannot be broken down by chemical methods into simpler components. For example, the element gold cannot be broken down into anything other than gold. If you keep hitting gold with a hammer, the pieces would get smaller, but each piece will always be gold.

Elements consist of only one type of atoms. An atom is the smallest particle of an element that still has the same properties of that element.

All atoms of a specific element have exactly the same chemical makeup, size, and mass. Each atom has an atomic number, which represents the number of protons that are in the nucleus of a single atom of that element. There are a total of 118 elements. Many elements occur naturally on Earth; however, some are created in laboratory by scientists.

9.1.1 Symbols of Elements

A symbol is an image, object, etc., that stands for some meaning. For instance, a dove is a symbol of peace. Similarly, we denote mathematical operations by symbols. For example '+' denotes addition; '–' denotes subtraction etc. In the same way in chemistry each element is denoted by a symbol. Writing out the name of an element every time would become too troublesome. So, the name of an element is represented by shortened form called as symbol. Let us learn the brief history of symbols of elements.

a. Greek Symbols

The symbols in the form of geometrical shapes were used by the ancient Greeks to represent the four basic elements around us such as earth, air, fire and water.

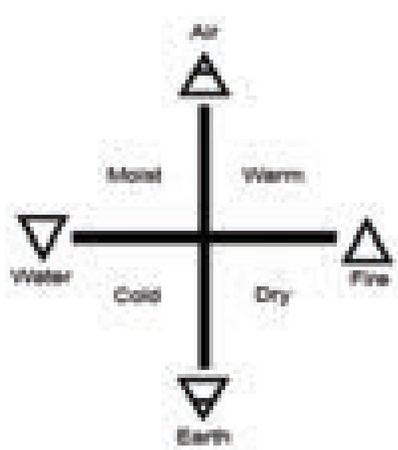

Figure 9.1 Greek symbols

b. Alchemist Symbols

In the days of alchemists, different materials that people used were represented by different symbols while they tried to change less valuable metal into gold. That process was called **alchemy** and the men who did this work were known as **alchemists**.

Nickel *Arsenic* *Antimony* *Water*

Figure 9.2 Symbols used by Alchemist

c. Dalton Symbols

In 1808, John Dalton, English scientist tried to name various elements based on pictorial symbols. Those symbols are difficult to draw and hence they are not used. It is only of historical importance.

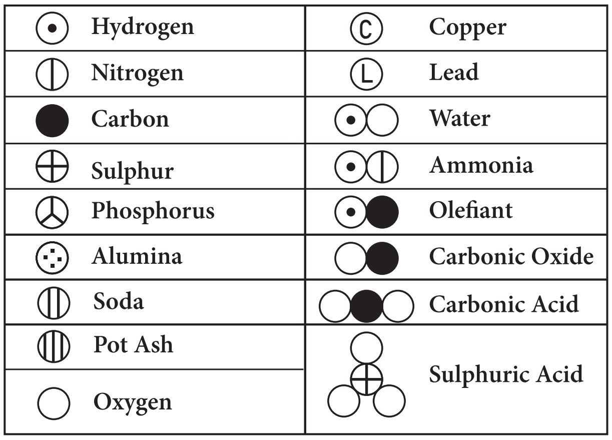

Figure 9.3 Dalton Symbols

d. Berzelius Symbols

In 1813, Jon Jakob Berzelius devised a system using letters of alphabet rather than signs. The modified version of Berzelius system follows under the heading 'System for Determining Symbols of the Elements'.

e. Present system for determining symbols of the elements

1. The symbols of the most common elements, mainly non-metals, use the first letter of their English name.

Table 9.1 Elements having first letter as symbol

Element	Symbol	Element	Symbol
Boron	B	Oxygen	O
Carbon	C	Phosphorus	P
Fluorine	F	Sulphur	S
Hydrogen	H	Vanadium	V
Iodine	I	Uranium	U
Nitrogen	N	Yttrium	Y

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2. If two elements have same first letter, then the first and second letters of the name are used as symbols. The first letter is in uppercase and the second letter is in lowercase.

Table 9.2 Elements with same first letter

Element	Symbol	Element	Symbol
Aluminium	Al	Hydrogen	H
Barium	Ba	Helium	He
Beryllium	Be	Nickel	Ni
Bismuth	Bi	Neon	Ne
Bromine	Br	Silicon	Si
Cobalt	Co	Sulphur	S

3. If the first two letters of the names of the elements are same, then the symbol consists of first letter and second or third letter of English name that they do not have in common.

Table 9.3 Elements with same two letters

Element	Symbol	Element	Symbol
Argon	Ar	Calcium	Ca
Arsenic	As	Cadmium	Cd
Chlorine	Cl	Magnesium	Mg
Chromium	Cr	Manganese	Mn

4. Some symbols are used on the basis of their Greek name or Latin name of the elements. There are eleven such elements.

Table 9.4 Greek or Latin name of elements

Element	Latin Name	Symbol
Sodium	Natrium	Na
Potassium	Kalium	K
Iron	Ferrum	Fe
Copper	Cuprum	Cu
Silver	Argentum	Ag
Gold	Aurum	Au
Mercury	Hydrargyrum	Hg
Lead	Plumbum	Pb
Tin	Stannum	Sn
Antimony	Stibium	Sb
Tungsten	Wolfram	W

5. Some elements are named using the name of the country / scientist / colour / mythological character / planet.

Table 9.5 Elements named using name of the country, scientist etc.

Name	Symbol	Name derived from
Americium	Am	**Am**erica (Country)
Europium	Eu	**Eu**rope (Country)
Nobelium	No	Alfred **No**bel (Scientist)
Iodine	I	Violet (Colour, Greek)
Mercury	Hg	God Mercury (Mythologic character)
Plutonium	Pu	Pluto (Planet)
Neptunium	Np	Neptune (Planet)
Uranium	U	Uranus (planet)

9.1.2 Writing the Symbols

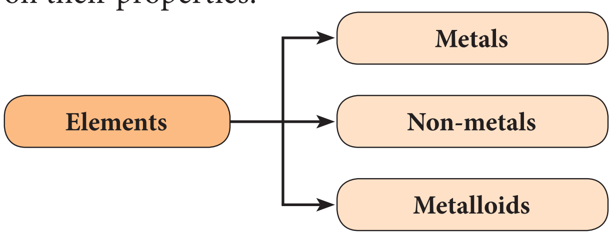
While writing the symbol for an element, we should adhere to the following rules.

1. If the element has a single English letter as a symbol, it should be written in capital letter.
2. For elements having two letter symbols, the first letter should be in capital followed by small letter

9.2 Metals and Non-metals

The progress of man towards civilization is linked with the discovery of several metals and non-metals. Even today, the index of prosperity of a country depends upon the amount of metals and non-metals it produces. The wealth of a country is measured by the amount of gold in its reserve.

An element can be identified as metal or non-metal by comparing its properties with the general properties of metals and non-metals. In doing so, we find that some elements neither fit with the metals nor with non-metals. Such elements are called semi-metals or metalloids. Elements are classified into metals, non-metals, and metalloids based on their properties.



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9.2.1 Metals

Iron, copper, gold, silver, etc. that we use in our daily life are metals. The properties and uses of metals are given below.

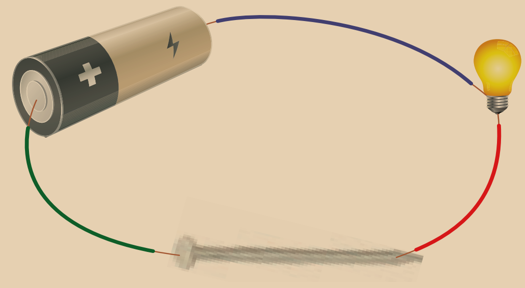
a. Physical properties of Metals

- Metals are solid under normal conditions of temperature and pressure.
- Most metals are hard.
- All metals are shiny. The typical shine of metals is called metallic lustre.
- Metals generally have high density.
- Metals in general have high melting point and boiling point.
- Metals can be hammered into very thin sheets. This tendency of metals is called malleability. Using this property aluminum is transformed into silvery foils.
- Metals can be drawn into thin wires. This property of metals is called ductility. Example: Copper wires.
- Generally metals are good conductors of heat and electricity.
- On being hit, metals produce a typical sound. Hence, they are said to be sonorous. This property is being made used in making temple bells.

Figure 9.4 Shining metal

Activity 1

Take a battery, few wire pieces, a bulb, a nail and a pencil lead. First connect the nail in the circuit as shown in the figure. Is the bulb glowing? Now, connect the pencil lead in the circuit. What do you observe?



b. Uses of Metals

- Iron is used for making bridges, engine parts, iron-sheets and bars.
- Copper is used for making electrical wires, coins and statue.
- Silver and gold are used for making jewels, and for decorative purposes and photography.
- Mercury is used in thermometers and barometers because of its high density and uniform expansion at different temperature.
- Aluminium is used in electrical wires, cables and in aerospace industries.
- Lead is used in automobile batteries, X-ray machines.

9.2.2 Non-metals

Elements like sulphur, carbon, oxygen etc. are non-metals. Some of the properties and uses of non-metals are given below.

a. Properties of Non-metals

- Non-metals occur as solids, liquids or gases at normal temperature. For example, sulphur and phosphorus occur in solid state while bromine occurs in liquid state. Elements like oxygen, nitrogen etc., occur in gaseous state.

- Non-metals are generally not hard except diamond (a form of carbon).
- Non-metals have a dull appearance.
- Non-metals are generally soft and have low densities. The exception here is diamond (a form of carbon) which is the hardest naturally occurring substance.
- Non-metals have low melting point and boiling point.
- Non-metals are non-malleable.
- Non-metals are not ductile. Carbon fibre is highly ductile.
- Non-metals are generally bad conductors of electricity. Graphite (a form of carbon) is an exception.
- Non-metals do not produce sound (non-sonorous) when hit.

Activity 2

Strike a metal utensil with a metal spoon. Note the kind of sound emitted. Now, strike a piece of wood charcoal with the same spoon. Do you find difference in the kind of sound produced?

Most metals produce ringing sound when struck i.e. they are sonorous. Non-metals are non sonorous.

b. Uses of Non-metals

- Diamond (a form of carbon) is used for making jewels, cutting and grinding equipments. Graphite is used in making pencil lead.
- Sulphur is used in the manufacturing of gun powder and vulcanization of rubber.
- Phosphorus is used to make match boxes, rat poison etc.
- Nitrogen is used for manufacturing ammonia.
- Chlorine is used as a bleaching agent and in sterilizing water.
- Hydrogen is used as a rocket fuel and hydrogen flame is used for cutting and welding purposes. Hydrogen is also used as a reducing agent.

Figure 9.5 Diamond

Table 9.6 Difference between Metals and Non-metals

Property	Metal	Non Metal
Physical state at room temperature	Usually solid (Occasionaly liquid)	Solid, liquid or gas
Malleablity	Good	Poor (Usually soft or brittle)
Ductility	Good	Poor (Usually soft or brittle)
Melting point	Usually high	Usually low
Boiling point	Usually high	Usually low
Density	Usually high	Usually low
Conductivity (Thermal and Electrical)	Good	Very poor

9.2.3 Metalloids

The elements which exhibit the properties of metals as well as non-metals are called metalloids. Examples: Boron, Silicon, Arsenic, Germanium, Antimony, Tellurium and Polonium.

a. Physical properties of Metalloids

- Metalloids are solids at room temperature.
- They can form alloys with other metals.

- Some metalloids, such as silicon and germanium, can act as electrical conductors under specific conditions. Thus, they are called semiconductors.
- Silicon which is a metalloid appears lustrous, but it is neither malleable nor ductile. It is brittle - a characteristic of some non metals. It is a much poorer conductor of heat and electricity than the metals.
- The physical properties of metalloids tend to be metallic, but their chemical properties tend to be non-metallic.

b. Uses of Metalloids

- Silicon is used in electronic devices.
- Boron is used in fireworks and as a fuel for ignition in rocket.

9.3 Compounds

XSX83W

A compound is a pure substance which is formed due to the chemical combination of two or more elements in a fixed ratio by mass. The properties of a compound are different from those of its constituents. Water, carbon dioxide, sodium chloride etc. are few examples of compounds. A molecule of water is composed of one oxygen atom and two hydrogen atoms in the ratio 1:2 by volume or 8:1 by mass.

9.3.1 Classsification of Compounds

Based on the origin of chemical constituents, compounds are classified as inorganic compounds and organic compounds.

a. Inorganic compounds

Compounds obtained from non living sources such as rock, minerals etc., are called inorganic compounds. Example: Chalk, baking powder etc.,

b. Organic compounds

Compounds obtained from living sources such as plants, animals etc., are called organic compounds. Example: Protein, carbohydrates, etc.,

Both inorganic and organic compounds exist in all three states ie., solids, liquids and gases. Let us learn about some important compounds in solid, liquid and gaseous states.

Some compounds that exist in solid state are given in Table 9.7.

Table 9.7 Compounds in solid state

Compounds	Consitituent Elements
Silica (Sand)	Silicon, Oxygen
Potassium hydroxide (Caustic potash)	Potassium, Hydrogen, Oxygen
Sodium hydroxide (Caustic soda)	Sodium, Oxygen, Hydrogen
Copper sulphate	Copper, Sulphur, Oxygen
Zinc carbonate (Calamine)	Zinc, Carbon, Oxygen

Compounds which exist in liquid state are given in Table 9.8.

Table 9.8 Compounds in liquid state

Compounds	Consitituent Elements
Water	Hydrogen, Oxygen
Hydrochloric acid	Hydrogen, Chlorine
Nitric acid	Hydrogen, Nitrogen, Oxygen
Sulphuric acid	Hydrogen, Sulphur, Oxygen
Acetic acid (Vinegar)	Carbon, Hydrogen, Oxygen

Some compounds exist in gaseous state also. They are given in Table 9.9.

Table 9.9 Compounds in gaseous state

Compounds	Consititutent Elements
Carbon dioxide, carbon monoxide	Carbon, Oxygen
Sulphur dioxide	Sulphur, Oxygen
Methane	Carbon, Hydrogen
Nitrogen dioxide	Nitrogen, Oxygen
Ammonia	Nitrogen, Hydrogen

9.3.2 Uses of Compounds

We use a number of compounds in our daily life. Some of them are listed in table 9.10.

More to Know

Compounds	Common name
Copper sulphate	Blue Vitriol
Ferrous sulphate	Green Vitriol
Potassium nitrate	Saltpetre
Sulphuric acid	Oil of Vitriol
Calcium sulphate	Gypsum
Calcium sulphate hemi hydrate	Plaster of paris
Potassium chloride	Muriate of potash

Table 9.10 Uses of Compounds

Common Name	Chemical Name	Constituents	Uses
Water	Dihydrogen monoxide	Hydrogen and Oxygen	For drinking and as solvent.
Table salt	Sodium chloride	Sodium and Chlorine	Essential component of our daily diet, preservative for meat and fish.
Sugar	Sucrose	Carbon, Hydrogen and Oxygen	Preparation of sweets, toffees and fruit juices.
Baking soda	Sodium bicarbonate	Sodium, Hydrogen, Carbon and Oxygen	Fire extinguisher, preparation of baking powder and preparation of cakes and bread.
Washing soda	Sodium carbonate	Sodium, Carbon and Oxygen	As cleaning agent in soap and softening of hardwater.
Bleaching powder	Calcium oxy chloride	Calcium, Oxygen and Chlorine	As bleaching agent, disinfectant and sterilisation of drinking water.
Quick lime	Calcium oxide	Calcium and Oxygen	Manufacture of cement and glass.
Slaked lime	Calcium hydroxide	Calcium, Oxygen and Hydrogen	White washing of walls.
Lime stone	Calcium carbonate	Calcium, Carbon and Oxygen	Preparation of chalk pieces.

Points to Remember

- Anything which occupies space and has mass is called matter.
- Material which has a definite shape and definite volume at room temperature with any number of free surfaces is called solid.
- The molecule of a substance that contains two or more atoms of different elements combined together in a definite ratio, is said to be a molecule of a compound.
- Material which has a definite volume, but no definite shape and has one free surface, is called liquid.

- Material which has neither definite shape nor definite volume, is easily compressible and has no free surface is called gas.
- Metals are elements that are hard and shiny in appearance. Some metals used in our daily life are iron, copper, gold, silver, etc. Metals conduct heat and electricity.
- Elements that generally do not shine, that are neither too hard nor too soft are non-metals. All gases are non-metals. Some non-metals are sulphur, carbon, oxygen etc.
- Elements which have the properties of metal and non-metals are called metalloids. Some examples are arsenic, germanium etc.
- On being hit, metals produce a typical sound. They are said to be sonorous.This property is being made used in making temple bells.
- The easiest way to represent the element and to write the chemical formula is using symbols.

A-Z GLOSSARY

Disinfectant	Chemical substance which kills or prevents the disease causing microorganism.
Semiconductor	Substance which acts as bad conductor at low temperature and as good conductor at high temperature.
Reducing agent	Substance which undergoes oxidation reaction.
Carbohydrate	Compound which contains carbon, hydrogen and oxygen.
Bleaching agent	Substance which is used to remove the colour.
Preservative	Substance which prevents food being spoiled by microorganism.

TEXTBOOK EXERCISE

APJ2SS

I. Choose the best answer.

1. The liquid metal used in thermometers is

   a) copper b) mercury c) silver d) gold

2. The pictorial symbol for water given by the alchemists was

   a) 🜂 b) 🜃 c) 🜄 d) 🜁

3. Which one of the following element name is not derived from planet?

   a) Plutonium b) Neptunium
   c) Uranium d) Mercury

4. Symbol of mercury is

   a) Ag b) Hg c) Au d) Pb

5. A form of non-metal which has high ductility is

   a) nitrogen b) oxygen
   c) chlorine d) carbon

6. The property which allows the metals to be hammered into their sheets is ___________

   a) ductility b) malleability
   c) conductivity d) shining strength

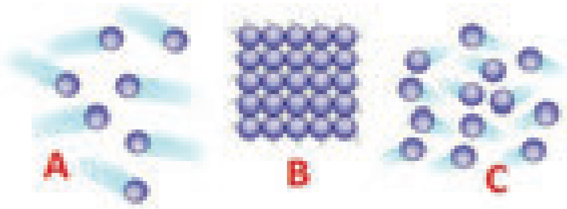
7. The non-metal which conducts electric current is

   a) carbon b) oxygen
   c) aluminium d) sulphur

8. Pencil lead contains

   a) graphite   b) diamond
   c) aluminium   d) sulphur

9. Identify the state of matter based on the arrangement of the molecules.



   a) A - Gas,   B - Solid,   C - Liquid
   b) A - Liquid,   B - Solid,   C - Gas
   c) A - Gas,   B - Solid,   C - Liquid
   d) A - Liquid,   B - Gas,   C - Solid

II. Fill in the blanks.

1. The element which possesses the character of both metals and non metals are called ___________
2. The symbol of tungsten is ___________
3. Melting point of most metal is ___________ than non-metal.
4. Water contains __________ and __________ element.
5 _____________ is used as semiconductor.

III. Match the following.

a.

Iron	For making wires
Copper	Sewing needle
Tungsten	As a fuel for ignition in rocket
Boron	Making the filament of a bulb

b.

Atom	Building block of matter
Element	Atoms of different kinds
Compound	Atoms of the same kind
Molecule	Smallest unit of a substance

IV. Answer very briefly.

1. What is ductility?
2. Write the constituent elements and their symbols for the following compounds.
   a) Carbon monoxide   b) Washing soda
3. Write the symbols for the following elements.
   a) Oxygen   b) Gold   c) Calcium
   d) Cadmium   e) Iron
4. Which non-metal is essential for our life and all living beings?
5. Why are bells made of metals?
6. What does a chemical symbol represent?
7. Give two examples for metalloids.
8. Mention any three compounds that exist in liquid state.
9. Write three properties of metalloids.

V. Answer briefly.

1. Can you store pickle in an aluminium utensil? Give reason.
2. Tabulate the differences between metals and non-metals.
3. Why are utensils made up of aluminium and brass?
4. Define Alchemy.
5. Name the elements with the following symbols.
   a) Na   b) W   c) Ba   d) Al   e) U
6. Name six common non-metals and write their symbols.
7. Mention any four compounds and their uses.
8. Name the metals that are used in jewellery.
9. Mention the uses of the following compounds.
   a) Baking soda   b) Bleaching powder
   c) Quick lime

VI. Given reason.

1. Give reasons for the following.
   (a) Aluminum foils are used to wrap food items.
   (b) Immersion rods for heating liquids are made up of metallic substances.

(c) Sodium and potassium are stored in kerosene.

(d) Mercury is used in thermometers.

2. Why wires cannot be drawn from materials such as stone or wood?

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INTERNET RESOURCES

1. https://schools.aglasem.com/1747
2. https://www. chem1.com/acad/webtext/pre/pre-1.html

Concept Map

Matter around us

- **Symbols of Elements**
  - Greek
  - Alchemist
  - Dalton
  - Berzelius
  - Present system
- **Properties of Metal**
  - Solid
  - Hard
  - Shiny
  - Malleable
  - Sonorous
- **Properties of Non-metal**
  - Solid, liquid or gases
  - Soft
  - Dull
  - Non-malleable
  - Non-sonorous
- **Properties of Compounds**
  - Solid
  - Form alloys
  - Semi-conductors
  - Non-malleable
  - Non-ductile

ICT CORNER

Matter around us

This activity enables the students helps to know about the States of Matter

Steps

- Open the Browser and type the URL link given below (or) Scan the QR Code.
- Select the title "States of Matter: Basics"
- States of Matter: Basics display on the screen. Follow this Experiment
- Click the next and to know about this states of matter

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Cells alive

URL: https://phet.colorado.edu/sims/html/states-of-matter-basics/latest/states-of-matter-basics_en.htm
(or) scan the QR Code

UNIT 10

CHANGES AROUND US

4BPSEI

Learning Objectives

After the completion of this lesson, students will be able to:

- define chemical reaction.
- differentiate chemical changes from physical changes.
- know about the factors which determine a chemical reaction.
- know about the importance and effects of chemical reactions.
- identify the chemical reactions in day to day life.
- observe the changes during a chemical reaction.

Introduction

Have you ever visited Qutub Minar in Delhi? There you can see a rust resistant iron-pillar. It has not rusted for more than 1500 years. But, not all things are unchanged like this. Many things we see in our life are changing. You could have noticed milk turning into curd. How it is happening? We see number of changes in our surrounding. Some of them are physical changes and some of them are chemical changes.

As you have studied earlier, changes like folding and unfolding a paper, drying wet clothes, bending of iron rod are some examples for physical changes. On the other hand, changes like burning of paper, digestion of food, turning of milk into curd and decaying of vegetables are some of the examples for chemical changes. In this lesson, you will study about chemical changes, factors determining chemical changes and the effects of chemical changes.

10.1 Chemical changes

A chemical change is a permanent and irreversible change which produces a new substance. Chemical changes are otherwise called as chemical reactions, because one or more substances (reactants) undergo a reaction to form one or more new substances (products).

$$\text{Reactant(s)} \longrightarrow \text{Product(s)}$$

Activity 1

Adithya wants to classify the following changes as physical or chemical. Can you help him?

1. Melting of ice
2. Ripening of fruits
3. Rusting of iron
4. Spoilage of food
5. Burning of wood
6. Bursting crackers
7. Burning of camphor

Physical Changes	Chemical Changes

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10.1.1 Factors determining Chemical changes

Chemical changes will not occur at all conditions. For a chemical change to take place, certain specific conditions are required. Chemical changes can take place in the following conditions.

a. Contact in physical states
b. Solution of reactants
c. Electricity
d. Heat
e. Light
f. Catalyst

EIH3ZR

a. Contact in physical states

We experience many events in our daily life like burning of matchstick on rubbing and iron materials turning into reddish brown. Why and how these changes happen?

These changes are due to chemical reactions by contact in physical states. Combination of reactants in their naturally occurring states (solids, liquids, gases) is referred as contact in physical states.

- When dry wood comes into contact with fire, it burns with the help of oxygen to form carbon dioxide, which is given out as smoke.
- When a matchstick is rubbed on the sides of a matchbox, a chemical reaction takes place to form heat, light and smoke.
- When quick lime (calcium oxide) comes into contact with water, it forms slaked lime (calcium hydroxide).

Figure 10.1 Burning a match stick

More to know

The head of a matchstick contains potassium chlorate and antimony trisulphide. The sides of the matchbox contain red phosphorous.

From the above reactions, we can conclude that certain chemical reactions take place only when the reactants are brought in contact with each other in their physical states.

Activity 2

Take two test tubes and couple of rust free iron nails. In one test tube pour some water and put an iron nail. Keep the test tube opened for few days. Take another test tube and pour some water along with some coconut oil. Now, place the second iron nail. Leave the set up for a few days. Observe the changes and record them. Which iron nail gets rusted and why?

b. Solution of reactants

When milk is mixed with coffee decoction the colour of the milk and the decoction changes due to chemical reaction. Similarly, when we mix two substances (reactants) in solution form, a chemical reaction takes place between them to form new substances (products). For example, take small amount of solid silver nitrate and sodium chloride in a test tube. Do you observe any change? No, because the reactants in solid state have no recation. Now, you dissolve the same reactants in water in a separate test tubes and mix both the solutions. What do you observe? Silver nitrate solution reacts with sodium chloride solution to form a white precipitate of silver chloride and sodium nitrate solution. From the above reaction, we infer that some chemical reactions proceed only in solution form not in solid form.

c. Electricity

Electricity is essential for our living. We use electricity for cooking, lighting, grinding, watching television etc. Do you know electricity can be used to carry out chemical reactions also? Many chemical reactions which take place with the help of electricity are industrially very important. As you know, water is made of hydrogen and oxygen molecules. When electricity is passed through water which contains small amounts of sulphuric acid, hydrogen and oxygen gases are liberated. Similarly, a concentrated solution of sodium chloride called brine is electrolysed to produce chlorine and hydrogen gases along with sodium hydroxide. This is an important reaction to produce chlorine industrially.

Thus, we can conclude that some chemical reactions proceed only by the passage of electricity. Hence, such reactions are called as **electrochemical reactions** or **electrolysis**.

DO YOU KNOW?

The term electrolysis was introduced by Michael Faraday in the 19th century. The word electrolysis is a combination of two terms 'electron' and 'lysis'. Electron is related to electricity and lysis means decomposition.

d. Heat

Food is important for our survival and also for the survival of many other living beings. Have you ever closely watched your mother cooking food? She boils rice, cooks vegetables, and prepares gravy by heating them over stove. When enough heat is given some chemical reactions take place to convert the raw food (uncooked) items into cooked ones.

You can learn more about this by conducting a reaction in your laboratory.

More to Know

Chemical reactions accompanying evolution of heat are called exothermic reactions. Whereas chemical reactions which involve absorbtion of heat are called endothermic reactions.

Take a small amount of lead nitrate in a dry test tube and heat it gently over a flame. Observe the changes closely. You will hear cracking sound and an evolution of reddish brown coloured gas (nitrogen dioxide). In industries limestone rocks are heated to get quicklime (calcium oxide). Hence, some chemical reactions can be achieved by the supply of heat only. These reactions are called **thermo chemical reactions** or **thermolysis**.

DO YOU KNOW?

Limestone is the raw material for quicklime, slaked lime and cement.

e. Light

What will happen if there is no sunlight? All the living organisms will be affected and there will be no food for us to survive, is n't it? Sunlight is important not only for us but also for plants. As you know photosynthesis ('photo' means light and 'synthesis' means production) is a process in which light energy from the sun is used by the plants to prepare starch from carbon dioxide and water. The sunlight induces the chemical reaction between carbondioxide and water, which finally ends up in the production of starch. Thus, chemical reactions induced by light are called as photochemical reactions.

DO YOU KNOW?

The ultraviolet rays from the sun break ozone (O_3) molecules in the stratosphere into molecular oxygen and atomic oxygen. This atomic oxygen again combines with molecular oxygen to form Ozone.

More to Know

Photochemistry is the branch of chemistry which deals with chemical reactions involving light.

f. Catalyst

Sometimes you are advised by the elders to drink a small amount of 'oma water' after a heavy meal. Do you know, why? This is because oma water makes digestion faster. Likewise, in industries some chemical substances are used to speed up chemical reactions. These substances are called catalysts. For example, metallic iron is used as a catalyst in the manufacture of ammonia using Haber's process. This ammonia is the basic material for the production of urea, an important fertilizer in agriculture. In vanaspati ghee (dalda) preparation, finely divided nickel is used as a catalyst. Thus, speed of certain reactions is influenced by the catalysts and such reactions are called **catalytic reactions**.

Figure 10.2 Urea applied on paddy crops

DO YOU KNOW?

Enzymes and yeasts are called biocatalysts.

Activity 3

Buy some fresh yeast from a grocery shop. Prepare a paste of wheat flour with water in a vessel. Add some yeast and leave the vessel closed for few hours under sunlight. Observe the changes closely. What do you infer?

10.2 Effects of Chemical changes

We know that every chemical reaction requires a specific condition to occur. When chemical reactions take place there will be production of heat, light, sound, pressure etc. and also many other effects.

RF3XPM

10.2.1 Biological Effects

a. Spoilage of food and vegetables

Food spoilage may be defined as any change that causes food unfit for human consumption. The chemical reactions catalysed by the enzymes result in the degradation of food quality in the form of development of bad tastes and odour, deterioration and loss of nutrients.

Examples

- Rotten eggs develop a bad smell due to formation of hydrogen sulphide gas.
- Decaying of vegetables and fruits due to microbes.

b. Rancidity of fishes and meat

Fishes and meat containing high levels of poly unsaturated fatty acids undergo oxidation. It causes bad odour when exposed to air or light. This process is called rancidity.

Fig 10.3 Rancid fish on the shore

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c. Apples and fruits turn brown when cut

Apples and some fruits turn brown due to chemical reaction with oxygen in air. This chemical reaction is called browning. The cells of apples, fruits and other vegetables contain an enzyme called polyphenol oxidase or tyrosinase. When in contact with oxygen it catalyses a biochemical reaction in which the phenolic compounds present in plants become a brown pigment known as melanins.

Fig 10.4 Browning of apple

10.2.2 Environmental Effects

a. Pollution

Our environment provides air to breathe, water to drink and the land to produce food. Due to industrial processes and increasing number of automobiles, our environment is badly affected now-a-days. So, there is an unwanted change in the physical, chemical and biological properties of the environment. This is termed as pollution. The substances which cause these changes are called pollutants. Generally there are three types of pollutions viz air, water and land pollution. Due to increasing human activities, lot of chemical substances are produced artificially which harm all the living and non living things. The types of chemical substances and their effects are given in table below (Table 10.1).

Fig 10.5 Smoke from industries

b. Rusting

What happens to the steel benches and tables during rainy season? They turn into reddish brown. Isn't it? Do you know why? This is because when the iron metal come into contact with water and oxygen, it undergoes a chemical reaction called rusting.

Fig 10.6 Rusted iron barrels

Table 10.1 The types of chemical substances and their effects.

Type of Pollution	Chemical substances	Effects
Air pollution	Carbon dioxide, Carbon monoxide, Oxides of sulphur, Oxides of nitrogen, Chlorofluorocarbons, Methane etc	Acid rain, global warming, respiratory problems etc.
Water pollution	Waste water containing chemical substances Eg. Dyeing industries, Detergents, Oil spillage etc	Decrease in the quality of water, skin diseases etc
Land pollution	Fertilizers like urea, various pesticides, herbicides, solid wastes, plastics etc.	Spoilage of land, cancer, respiratory diseases etc.

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c. Tarnishing of metal articles

Shiny metal surfaces and other articles lose their shining appearance due to chemical reactions on the surface. For example, silver articles become black when exposed to atmospheric air. Similarly, brass vessels which contain copper as one of the constituents develop a greenish layer when exposed to air for a long time. This is due to a chemical reaction between copper and moist air to form basic copper carbonate and copper hydroxide.

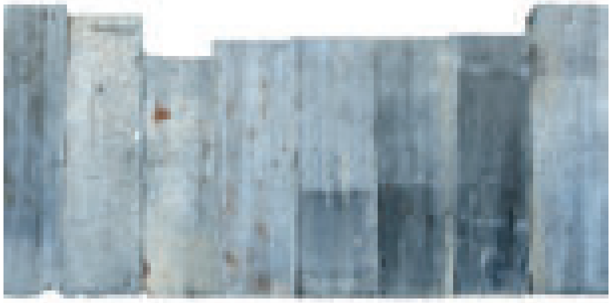

Fig 10.7 Damaged iron sheets

10.2.3 Production of Heat, Light, Sound and Pressure

a. Production of Heat

Have you ever rubbed your palms in winter season to keep yourself warm? Have you noticed the heat produced when you use cycle pump? Similarly some chemical reactions produce heat energy also. Such reactions are called **exothermic reactions**. For example, when you add water to quicklime (calcium oxide), lot of heat is released to produce slaked lime (calcium hydroxide).

Activity 4

Take two clean test tubes. Take sulphuric acid in one test tube and a solution of sodium hydroxide in another tube. Slowly and carefully add sodium hydroxide solution to sulphuric acid. Touch the sides of test tube. What do you feel? What do you infer?

b. Production of Light

When you ignite a candle, you get light as a result of burning. Some chemical reactions produce light. For example, when a piece of magnesium ribbon is burnt in a flame, bright light is produced with heat. Even the fireworks used during festival times produce different coloured lights which are all due to chemical reactions.

c. Production of Sound

When we speak sound is produced. When you hit metals like iron, copper etc., a sound is heard. Some chemical reactions do produce sound when they take place. What happens when you fire crackers during Deepavali? The chemical substances present in the crackers undergo some chemical reactions to produce sound.

Activity 5

Take a clean test tube. Add some dilute hydrochloric acid. Drop a piece of magnesium or a piece of zinc metal. What do you see? Now bring a burning match stick near the mouth of the test tube. What do you hear? What do you infer?

You can hear a pop sound. When metals like zinc or magnesium reacts with dilute acids hydrogen gas is produced. Since hydrogen gas is highly flammable it reacts with oxygen present in air to produce pop sound.

d. Production of Pressure

When you compress hard a balloon having full of air, it will burst. This is due to sudden release of air from the balloon as a result of increased pressure on compression. Some chemical reactions produce gases which increases the pressure when the reaction takes place in a closed container. If the pressure level goes beyond the limit, we get the explosion. Explosives and fireworks burst because of this reason. When they are ignited they explode due to pressure generated by gases from the chemical reactions. Thus, you hear a huge sound.

Points to Remember

- A chemical change is a permanent, irreversible change and it produces a new substance.
- In a chemical reaction reactants produce products.
- The factors determining a chemical reaction are: contact in physical states, solution of reactants, electricity, heat, light and catalyst.
- Rusting is a chemical reaction in which iron objects form hydrated ferric oxide in the presence of oxygen and water.
- Electrolysis is a process in which electricity is used to carry out chemical reactions.
- Photolysis is a process in which light is used to carry out chemical reactions.
- Thermolysis is a process in which heat is used to bring about chemical reactions.
- Chemical substance which is used to speed up a chemical reaction is called as catalyst and the process is called catalysis.
- Chemical reactions cause spoilage of food, vegetables and fruits, acid rain, green house effect and damage to materials.
- Global warming is a dangerous condition in which earth's average temperature rises alarmingly due to various human activities.
- Rancidity is a condition in which the food items develop bad odour due to chemical reactions by microbes.

A-Z GLOSSARY

Biochemical reaction	Chemical reaction involving biological substances.
Catalyst	Substance which alters the speed of a chemical reaction.
Combustion	Burning with oxygen in air.
Enzyme	Catalyzing substance in a biological system.
Fertilizer	Artificial manure/chemically synthesized manure.
Fossil fuel	Fuels like coal and petrol obtained from plants and animals once lived and buried beneath the earth.
Global warming	Rise in earth's average temperature.
Ozone	Oxygen molecule having three oxygen atoms.
Pigments	Colour giving substance/colourants.
Poly unsaturated fatty acids	A long chain carbon based acids present in fats.
Precipitate	A new insoluble substance formed in a chemical reaction.
Product	Substance formed in a chemical reaction.
Reactant	Substance reacting in a chemical reaction.
Spoilage of food	Deterioration of food items.
Yeast	A kind of single celled fungus.

G8BM4E

TEXTBOOK EXERCISE

I. Choose the best answer.

1. Burning of paper is a _________ change.
   a) physical b) chemical
   c) physical and chemical d) neutral
2. Burning of matchstick is an example for chemical reaction caused by _________
   a) contact in physical states
   b) electricity
   c) light d) catalyst
3. _________ undergoes rusting.
   a) Tin b) Sodium
   c) Copper d) Iron
4. The pigment responsible for browning of apples is _________.
   a) hydrated iron (II) oxide b) melanin
   c) starch d) ozone
5. Brine is a concentrated solution of _________.
   a) sodium sulphate b) sodium chloride
   c) calcium chloride d) sodium bromide
6) Limestone contains _________ mainly.
   a) calcium chloride b) calcium carbonate
   c) calcium nitrate d) calcium sulphate
7. Which of the following factor induces electrtolysis?
   a) Heat b) Light
   c) Electricity d) Catalysis
8. In Haber's process of producing ammonia _________ is used as a catalyst.
   a) nitrogen b) hydrogen
   c) iron d) nickel
9. Dissolved gases like sulphur dioxide and nitrogen oxides in rain water causes _________
   a) acid rain b) base rain
   c) heavy rain d) neutral rain
10. _________ is/are responsible for global warming.
    a) Carbon dioxide
    b) Methane
    c) Chlorofluorocarbons
    d) Carbon dioxide, Methane, Chlorofluorocarbons

II. Fill in the blanks.

1. Photosynthesis is a chemical reaction that takes place in the presence of _________.
2. Iron objects undergo rusting when exposed to _________ and _________.
3. _________ is the basic material to manufacture urea.
4. Electrolysis of brine solution gives _________ gases.
5. _________ is a chemical substance which alters the speed of a chemical reaction.
6. _________ is the enzyme responsible for browning of vegetables and fruits.

III. Say true or false. If false, correct the statement.

1. A chemical reaction is a temporary reaction.
2. Decomposition of lead nitrate is an example for a chemical reaction caused by light.
3. Formation of slaked lime from quicklime is an endothermic reaction.

4. CFC is a pollutant.
5. Light energy may come out due to chemical reactions.

IV. Match the following.

a.

Rusting	Photosynthesis
Electrolysis	Haber's process
Thermolysis	Iron
Food	Brine
Catalysis	Decomposition of limestone

b.

Spoilage	Decomposition
Ozone	Biocatalyst
Tarnishing	Oxygen
Yeast	Chemical reaction
Calcium oxide	Food

V. Answer briefly.

1. Define a chemical reaction.
2. Mention the various conditions required for a chemical reaction to occur.
3. Define catalysis.
4. What happens when an iron nail is placed in copper sulphate solution?
5. What is pollution?
6. What is tarnishing? Give an example.
7. What happens to the brine during electrolysis?
8. On heating, calcium carbonate gives calcium oxide and oxygen. Is it an exothermic reaction or an endothermic reaction?
9. What is the role of a catalyst in a chemical reaction?
10. Why photosynthesis is a chemical reaction?

VI. Answer in detail.

1. Explain the environmental effects of chemical reactions?
2. Explain how food items are spoiled by chemical reactions?
3. Explain any three conditions that is required for a chemical reaction to take place. Give example.

VII. Higher order thinking questions.

1. Explain the role of yeast in making cakes and buns in a bakery?
2. Burning of fossil fuels is responsible for global warming. Justify the statement.
3. Discuss how acid rain occurs due to emission of smoke from vehicles and industries?
4. Is rusting good for iron materials? Explain.
5. Do all the fruits and vegetables undergo browning? Explain.
6. Classify the following day to day activities based on chemical reactions by physical contact, solutions of reactants, heat, light, electricity and catalyst.
   a) Burning of crackers during festivals
   b) Fading of coloured clothes on drying under sunlight.
   c) Cooking of eggs.
   d) Charging of batteries.

VIII. Value Based Questions.

1. Kumar is going to build a house. To purchase the iron rods required for construction, he visited an iron and steel shop nearby. The seller showed him some iron rods which are fresh and good. He also showed him little older iron rods which are brownish in appearance. The price of fresh rods is more than the older ones. The seller also gave some offer to older ones. Kumar's friend Ramesh advised him not to buy the cheaper rods.
   a) Is Ramesh right in his suggestion?
   b) Could you explain the reason for his suggestion?
   c) What are the values shown by Ramesh?

2. Palanikumar is a Lawyer. He lives in a luxurious flat. Due to high rent, he wants to shift his residence to a place where he has a chemical industry nearby. There the rent is very cheap and the area is less populated also. His son Rajasekar, studying VIII, does not like this and likes to go to some other place.

   a) Is Rajasekar right in his attitude?

   b) Why did he refuse to go there?

   c) What are the values shown by Rajasekar?

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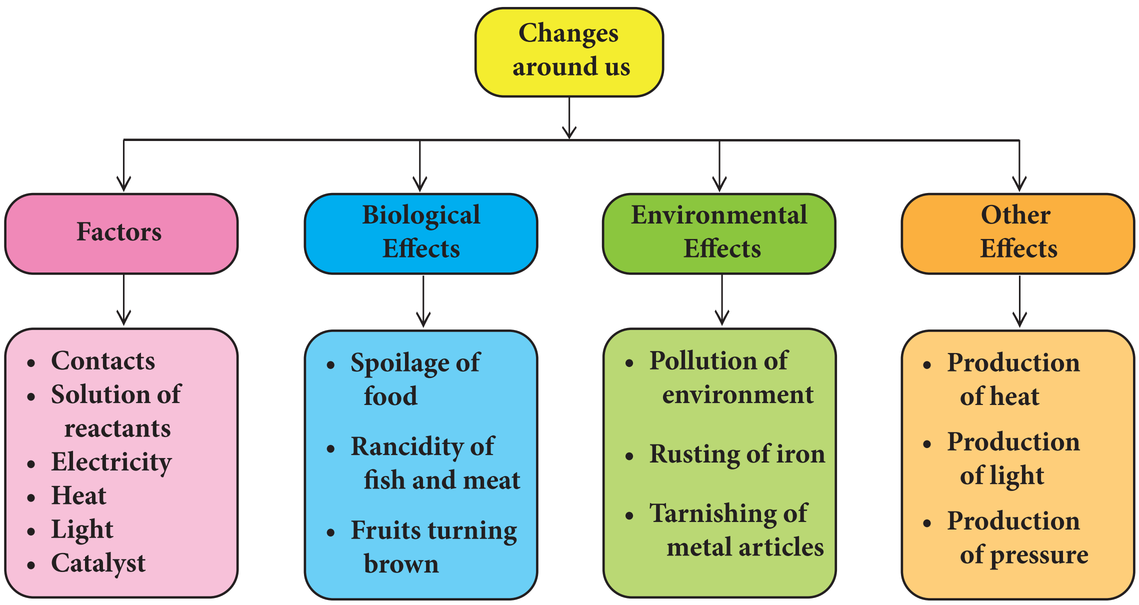
1. Basic chemistry by Karen C.Timberlake and William Timberlake
2. Pradeep's objective chemistry vol-1 by S.N. Dhawan,S.C.Kheterpal,J.R. Mehta

INTERNET RESOURCES

1. https://www.livescience.com
2. w w w.k hanac ademy.org/s cience/ chemistry/chemical reactions

Concept Map



ICT CORNER

Changes around us

This activity enables the students to understand about the Causes and affects of climate change

Steps

- Open the Browser and type the URL link given below (or) Scan the QR Code.
- Select the topic "Causes & affects of climate change"
- Click the title "Causes & affects of climate change"
- To know the various affects of climatic changes

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Web link: https://video.nationalgeographic.com/video/101-videos/0000015d-3cb1- d1cb

(or) scan the QR Code

UNIT 11

AIR

Learning Objectives

After the completion of this lesson, students will be able to:

- know about the occurence and composition of oxygen, nitrogen and carbon dioxide in the atmosphere.
- understand the properties and uses of oxygen, nitrogen and carbon dioxide.
- understand nitrogen fixation.
- identify the causes of green house effect, global warming and acid rain.
- suggest remedial measures for the prevention and control of these effects.

A4P1Y8

Introduction

Air is a mixture of gases that surrounds our planet earth. It is essential for the survival of all the living things. Air contains 78.09% nitrogen, 20.95% oxygen, 0.93% argon, 0.04% carbon dioxide and small amount of other gases. We breathe in oxygen and breathe out carbon dioxide. Plants in turn use carbon dioxde for photosynthesis and release oxygen into the atmosphere. Since men have been cutting down trees for their needs, the amount of carbon dioxide in the atmosphere is increasing. This is responsible for the raising of atmospheric temperature. Industries and vehicles release gases like carbon monoxide and sulphur dioxide into the atmosphere. This has resulted in effects like global warming and acid rain which affect us in many ways. In total, the quality of air is gone in the modern days. In this lesson we are going to study about the effects like green house effect, global warming and acid rain. We will also study about occurrence and properties of the gases oxygen, nitrogen and carbon dioxide.

11.1 Oxygen

All living things in the world need oxygen. We cannot imagine the world without oxygen. Swedish chemist C.W. Scheele first discovered oxygen in 1772. He called the gas **fire air** or **vital life** because it was found to support the process of burning. It was independently discovered by the British scientist Joseph Priestley in 1774. Lavoisier named oxygen. The name oxygen comes from the Greek word 'oxygenes' which means 'acid producer'. It is called so because early chemists thought that oxygen is necessary for producing acids.

11.1.1 Occurrence of Oxygen

Oxygen is the most abundant element on the earth by mass and the third most abundant element after Hydrogen and Helium in the universe. It occurs both in free state and combined state. It is present in free state as diatomic molecule (O_2) in the atmosphere. Most of this has been produced by photosynthesis in which the chlorophyll present in the leaves of plants uses solar energy to produce glucose.

Table 11.1 Percentage of Oxygen

Oxygen in free state		Oxygen in combined state	
Source	**Percentage**	**Source**	**Percentage**
Atmospheric air	21 %	Plants and animals	60 – 70 %
Water	88 – 90 %	Minerals in the form of silicates, carbonates and oxides	45 – 50 %

$$6CO_2 + 6H_2O \xrightarrow{\text{Energy from the Sun}} C_6H_{12}O_6 + 6O_2$$

In combined state it is present in the earth's crust as silicates and metal oxides. It is also found in water on the surface of the earth. Tri atomic molecule (O_3) known as ozone is present in the upper layers of the atmosphere.

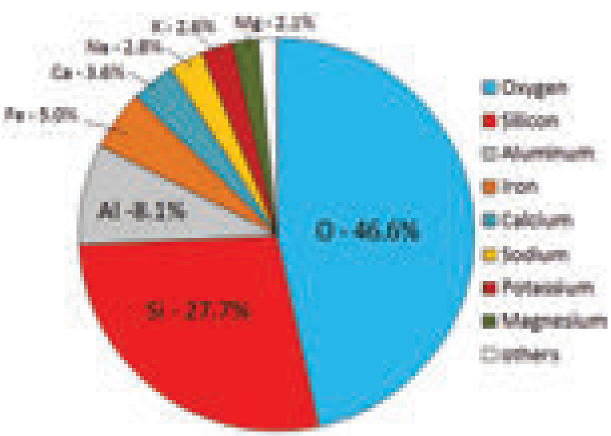

Figure 11.1 Percentage of elements in the Earth's crust

11.1.2 Physical properties of Oxygen

- Oxygen is a colourless, odourless and tasteless gas.
- It is a poor conductor of heat and electricity
- Oxygen dissolves readily in cold water.

> **DO YOU KNOW?** Oxygen is about two times more soluble in water than nitrogen. If it had the same solubility as nitrogen, then less oxygen would be present in seas, lakes and rivers that will make life much more difficult for living organisms.

- It is denser than air.
- It can be made into liquid (liquified) at high pressure and low temperature.
- It supports combustion.

11.1.3 Chemical properties of Oxygen

1. Combustibility

Oxygen is a non-combustible gas as it does not burn on its own. But, it supports the combustion of other substances.

> **DO YOU KNOW?** If oxygen has the capacity to burn itself, striking a match stick will be enough to burn all the oxygen in our planet's atmosphere.

2. Reaction with metals

Oxygen reacts with metals like sodium, potassium, magnesium, aluminium, iron etc., to form their corresponding metal oxides which are generally basic in nature. But the metals differ in their reactivity towards oxygen.

$$\text{Metal} + \text{Oxygen} \longrightarrow \text{Metal oxide}$$

Example

$$\underset{\text{Sodium}}{4Na} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{Sodium oxide}}{2Na_2O}$$

Activity 1

Heat a strip of magnesium ribbon in the flame till it catches fire and introduce it into the jar containing oxygen. It burns with a dazzling bright light and white ash of magnesium oxide is formed.

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Table 11.2 Reactivity of Oxygen with metals

Metal	Temperature	Product formed
K	Room temperature	Potassium Oxide (K_2O)
Mg	Heating slightly	Magnesium Oxide (MgO)
Ca	Heating slightly	Calcium Oxide (CaO)
Fe Cu Ag	High temperature	Iron Oxide (Fe_3O_4) Cupric Oxide (CuO) Silver Oxide (Ag_2O)
Au Pt	Even at high temperature	No action

3. Reaction with non metals

Oxygen reacts with various non-metals like hydrogen, nitrogen, carbon, sulphur, phosphorus etc., to give corresponding non metallic oxides, which are generally acidic in nature.

Non-metal + Oxygen ⟶ Non-metallic oxide

Example

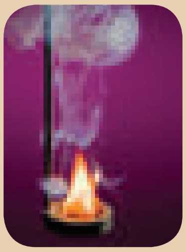
$$\underset{\text{Carbon}}{C} + \underset{\text{Oxygen}}{O_2} \longrightarrow \underset{\text{Carbon dioxide}}{CO_2}$$

Table 11.3 Reaction of Oxygen with non metals

Non metal	Products formed
C	Carbon dioxide (CO_2)
N	Nitric oxide (NO)
S	Sulphur dioxide (SO_2)
P	Phosphorus trioxide (P_2O_3) or Phosphorus pentoxide (P_2O_5)

Activity 2

Heat a small piece of phosphorous and introduce it into the oxygen jar. Phosphorous burns with suffocating smell and gives phosphorous pentoxide (white fumes).



4. Reaction with Hydrocarbons

Hydrocarbons (compounds containing C and H) react with oxygen to form carbon dioxide and water vapour. E.g. Wood, Petrol, Diesel, LPG, etc. When they burn in oxygen, they produce heat and light energy. Hence they serve as fuel.

$$\text{Hydrocarbon} + O_2 \longrightarrow CO_2 + \underset{\text{vapour}}{\text{Water}} + \underset{\text{energy}}{\text{Heat}} + \text{Light}$$

5. Rusting

The process of conversion of iron into its hydrated form of oxide in the presence of air and moisture (humid atmosphere) is called rusting. Rust is hydrated ferric oxide.

$$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$$

$$Fe_2O_3 + x\,H_2O \longrightarrow \underset{\text{(rust)}}{Fe_2O_3 \cdot x\,H_2O}$$

(x is the number of water molecules which is variable)

11.1.4 Uses of Oxygen

- It is used as oxy-acetylene cylinder for cutting and welding metals.
- It is used to remove carbon impurities from steel.

Figure 11.2 Uses of Oxygen

- Plants and animals use oxygen from the air for respiration.
- It is used as rocket fuel.
- It is used for artificial respiration by scuba divers, mountaineers, astronauts, patients etc.
- Mixed with powdered charcoal it is used as explosives.
- It is used in the synthesis of methanol and ammonia.

11.2 Nitrogen

Nitrogen is one of the most important elements. Animals and plants need nitrogen for their growth. All living organisms (including us) contain nitrogen. It is an essential element present in proteins and nucleic acids which are the 'building blocks' of all living things. It was first isolated from the air by Daniel Rutherford in 1772. The name 'nitrogen' is derived from the Greek words 'nitron' and 'gene' meaning 'I produce nitre'. Nitre is potassium nitrate compound of nitrogen. Antoine Lavoisier suggested the name *azote*, from the Greek word meaning 'no life'.

11.2.1 Occurrence of Nitrogen

Nitrogen is the fourth most abundant element in the human body. It accounts for about three percent of the mass of the human body. It is thought to be the seventh most abundant element in the universe. Titan, the largest moon of Saturn, has an atmosphere made up of 98% Nitrogen. Nitrogen occurs both in free state and combined state. Nitrogen exists in free state in the atmospheric air as dinitrogen (N_2). It is present in volcanic gases and gases evolved by burning of coal. Nitrogen is present in combined state in the form of minerals like nitre (KNO_3) and chile salt petre ($NaNO_3$). It is present in organic matters such as protein, enzymes, nucleic acid etc.

11.2.2 Physical properties of Nitrogen

- It is a colourless, tasteless and odourless gas.
- It is slightly lighter than air.
- It is slightly soluble in water.
- Nitrogen becomes a liquid at low temperature and looks like water.
- When it freezes, it becomes a white solid.
- It is neutral to litmus like oxygen.

11.2.3 Chemical properties of Nitrogen

1. Chemical reactivity

Nitrogen is inactive at ordinary conditions. It combines with many elements at high temperature and pressure or in the presence of catalyst.

2. Combustion

Nitrogen is neither combustible nor a supporter of combustion. So nitrogen in the air moderates the rate of combustion.

3. Reaction with metals

Nitrogen reacts with metals like lithium, calcium, magnesium etc., at high temperature to form their corresponding metal nitrides.

$$\text{Metal} + \text{Nitrogen} \xrightarrow{\Delta} \text{Metal nitride}$$

Example

$$\underset{\text{Calcium}}{3Ca} + \underset{\text{Nitrogen}}{N_2} \xrightarrow{\Delta} \underset{\text{Calcium nitride}}{Ca_3N_2}$$

4. Reaction with non metals

Nitrogen reacts with non-metals like hydrogen, oxygen etc., at high temperature to form their corresponding nitrogen compounds.

$$\text{Non-metal} + \text{Nitrogen} \xrightarrow{\Delta} \text{Nitrogen compound}$$

Example

$$\underset{\text{Hydrogen}}{3H_2} + \underset{\text{Nitrogen}}{N_2} \xrightarrow{\Delta} \underset{\text{Ammonia}}{2NH_3}$$

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11.2.4 Uses of Nitrogen

- Liquid nitrogen is used as a refrigerant.
- It provides an inert atmosphere for conducting certain chemical reactions.
- It is used to prepare ammonia (by Haber's process) which is then converted into fertilizers and nitric acid.
- Nowadays it is used as a substitute for compressed air in tyres.
- It is used for filling the space above mercury in high temperature thermometer to reduce the evaporation of mercury.
- Many explosives such as TNT (Trinitrotoluene), nitroglycerin, and gun powder contain nitrogen.
- It is used for the preservation of foods, manufacturing of stainless steel, reducing fire hazards, and as part of the gas in incandescent light bulbs.

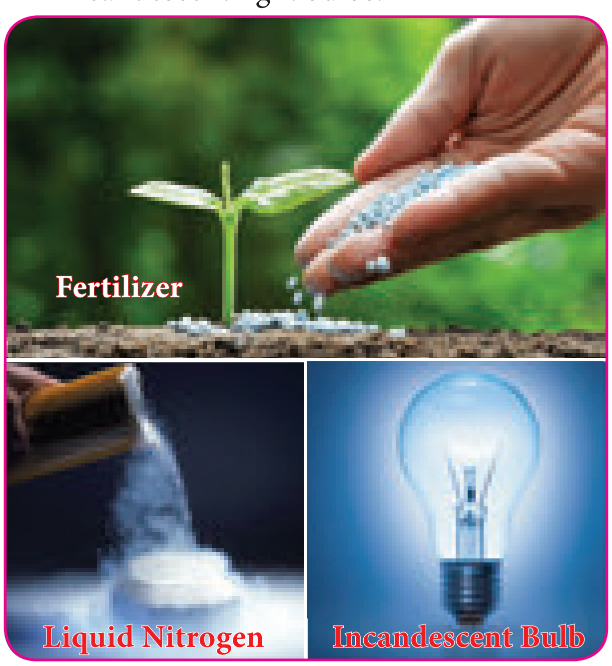
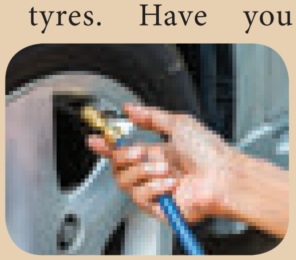


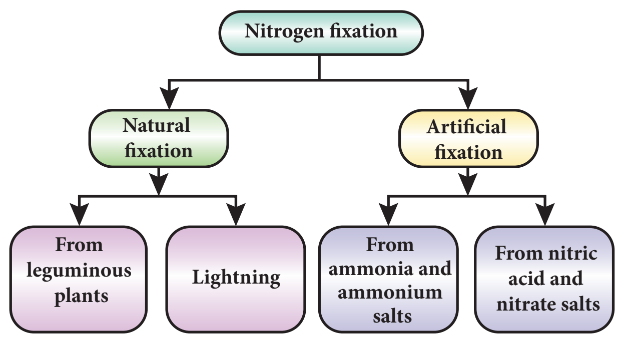
Figure 11.3 Uses of Nitrogen

DO YOU KNOW? Now-a-days nitrogen is used as a substitute for compressed air in tyres. Have you noticed it? Why do people prefer nitrogen instead of compressed air in tyres?



11.2.5 Nitrogen fixation

Nitrogen gets circulated in the air, soil and living things as the element itself or in the form of its compounds. Just as there is a circulation of carbon in nature so also there is a circulation of nitrogen. It is essential for the proper growth of all plants. The plants cannot make use of the elemental nitrogen from the air as such. The plants require soluble compounds of nitrogen. Thus, plants depend on other processes to supply them with nitrates. Any process that converts nitrogen in the air into a useful nitrogen compound is called nitrogen fixation. Fixation of nitrogen is carried out both naturally and by man.



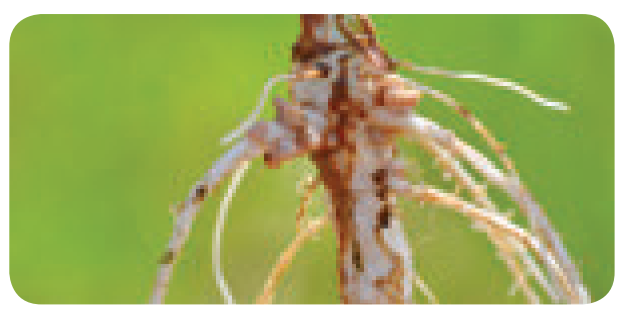


Figure 11.4 Nitrogen fixation in leguminous plants

11.3 Carbon dioxide

Carbon dioxide is a chemical compound in which one carbon and two oxygen atoms are bonded together. It is a gas at room temperature. It is represented by the formula CO_2. It is found in the earth's atmosphere and it sends back the solar energy which is reflected by the surface of the earth, to make it possible for living organisms to survive. When carbon dioxide accumulates more in the atmosphere it produces harmful effects.

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11.3.1 Occurrence of Carbon dioxide

Carbon dioxide is present in air to the extent of about 0.03% by volume. It is evolved by the plants and animals during respiration and is produced during fermentation reactions. Much of the naturally occurring CO_2 is emitted from the magma through volcanoes. CO_2 may also originate from the bio degradation of oil and gases. Carbon dioxide emitted by human upset the natural balance of the carbon cycle. Man-made CO_2 in the atmosphere has increased global temperatures which is warming the planet. While CO_2 derived from fossil-fuel is a very small component of the global carbon cycle, the extra CO_2 is cumulative because the natural carbon exchange cannot absorb all the additional CO_2.

11.3.2 Physical properties of Carbon dioxide

- Carbon dioxide is a colourless and odourless gas.
- It is heavier than air.
- It does not support combustion.
- It is fairly soluble in water and turns blue litmus slightly red. So it is acidic in nature.
- It can easily be liquified under high pressure and can be solidified. This solid form of CO_2 is called dry ice which undergoes sublimation.

DO YOU KNOW?

The process of conversion of solid into vapour without reaching liquid state is called sublimation.

11.3.3 Chemical properties of Carbon dioxide

1. Combustibility

It is non-combustible gas and not a supporter of combustion.

2. Reaction with metals

Lighter metals like sodium, potassium and calcium, combine with CO_2 to form corresponding carbonates whereas magnesium gives its oxide and carbon.

Example

$$4Na + 3CO_2 \longrightarrow 2Na_2CO_3 + C$$

Sodium → Sodium carbonate

$$2Mg + CO_2 \longrightarrow 2MgO + C$$

Magnesium → Magnesium oxide

3. Reaction with sodium hydroxide (Alkali)

Sodium hydroxide (base) is neutralized by carbon dioxide (acidic) to form sodium bicarbonate (salt) and water.

$$NaOH + CO_2 \longrightarrow NaHCO_3 + H_2O$$

Sodium bicarbonate

4. Reaction with Lime water (Calcium hydroxide)

When a limited amount of CO_2 is passed through lime water, it turns milky due to the formation of insoluble calcium carbonate.

$$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$$

Calcium carbonate

When an excess amount of CO_2 is passed through lime water, it first turns milky and the milkyness disappears due to the formation of soluble calcium hydrogen carbonate, $Ca(HCO_3)_2$.

DO YOU KNOW?

Venus' atmosphere consists of roughly 96-97% carbon dioxide. Because of the amount of carbon dioxide present, the surface of Venus continually retains heat and as such, the surface temperature of Venus is roughly 462°C, making it the hottest planet in our solar system.

11.3.4 Uses of Carbon dioxide

- CO_2 is used to prepare soft drinks or aerated drinks.
- It is used in fire extinguishers
- It is used in the manufacturing of sodium carbonate by Solvay process.

- Solid carbon dioxide, called as dry ice is used as a refrigerant. The gas is so cold that moisture in the air condenses on it, creating a dense fog which is used in stage shows and movie effects.
- It is used along with ammonia in the manufacture of fertilizers like urea.
- CO_2 can be used in the preservation of food grains, fruits etc.

Figure 11.5 Solid carbon dioxide

> **DO YOU KNOW?** Aerated water is nothing but carbon dioxide dissolved in water under pressure. This is also called 'soda water'.

11.4 Green House Effect and Global Warming

The solar radiation is absorbed by the surface of land and ocean. In turn, they release infra red radiation or heat into the atmosphere. Certain gaseous molecules present in the atmosphere absorb the infra red rays and reradiate the heat in all directions. Hence, these gases maintain the temperature of earth's surface. The gases which absorb these radiations are called **green house gases** and this effect is called **green house effect**.

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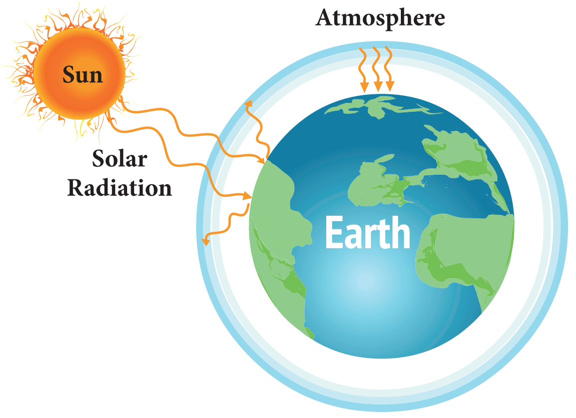

Figure 11.6 Greenhouse effect

The green house gases are CO_2, N_2O, CH_4, CFC (Chlorofluoro carbon) etc. The increase in the levels of these gases results in the gradual increase of temperature of the earth's surface. This green house effect is caused due to increase in the air pollutants and it results in the average increase of temperature of the atmosphere. This is called as **Global warming**.

11.4.1 Effects of Global warming

The following are the effects of global warming.

- Melting of ice cap and glaciers.
- Increase in frequency of floods, soil erosion and unseasonal rains.
- Loss of biodiversity due to the extinction of coral reefs and other key species.
- Spreading of waterborne and insectborne diseases.

11.4.2 Preventive measures

In order to save the earth and its resources we need to take certain measures. Some of the measures are given below.

- Reducing in the use of fossil fuels.
- Controlling deforestation.
- Restricting the use of CFCs.
- Planting more trees.
- Reducing, reusing and recycling resources.
- Using renewable energy resources.

11.5 Acid rain

Rain water is actually the purest form of water. However, pollutants such as oxides of nitrogen (N_2O, NO_2) and sulphur (SO_2, SO_3) in the air released by factories, burning fossil fuels, eruption of volcanoes etc., dissolve in rain water and form nitric acid and sulphuric acid which adds up to the acidity of rain water. Hence, it results in acid rain.

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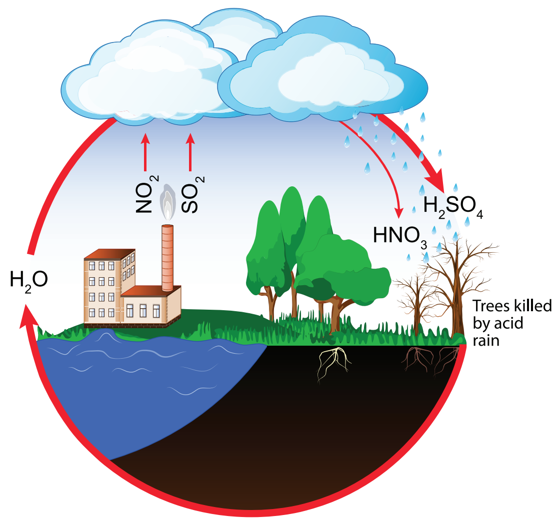


Figure 11.7 Acid rain

> **DO YOU KNOW?** Acid rain has pH less than 5.6 whereas pH of pure rain water is around 5.6 due to dissolution of atmospheric CO_2 in it.

11.5.1 Effects of Acid rain

Acid rain affects us in many ways. Some of the consequences are given below.

- It irritates eyes and skin of human beings.
- It inhibits germination and growth of seedlings.
- It changes the fertility of the soil, destroys plants and aquatic life.
- It causes corrosion of many buildings, bridges etc.

11.5.2 Preventive measures

Acid rain and its effects can be controlled by the following ways.

- Minimizing the usage of fossil fuel such as petrol, diesel etc.,
- Using CNG (**C**ompressed **N**atural **G**as).
- Using non-conventional source of energy.
- Proper disposal of the industrial wastes.

Points to Remember

- Oxygen exists in nature as silicates, carbonates, oxides and water. It also exists in free state as part of air in the atmosphere.
- Oxygen is a colourless and odourless gas. It dissolves sparingly in water. It is denser than air.
- Metals like magnesium, iron and sodium burn in oxygen and give basic oxides.
- Bacteria convert atmospheric nitrogen directly into soluble nitrogen compounds.
- Though nitrogen is inactive at ordinary condition, it combines with many elements at high temperature and pressure or in the presence of catalyst.
- Carbon dioxide cannot exist as a liquid at atmospheric pressure. It occurs as carbonates in nature.
- Carbon dioxide is acidic in nature and turns lime water milky. It is used in fire extinguisher.
- Global warming refers to an average increase in the temperature of the atmosphere or simply it is the warming of the earth.
- The green house gases are carbon dioxide, methane, nitrous oxide, chlorofluoro carbons, etc.

A-Z GLOSSARY

Atmosphere	Gaseous jacket that surrounds the earth.
Fixation of nitrogen	Process that converts nitrogen in the air into a nitrogen compounds.
Global warming	An average increase in the temperature of the atmosphere.
Green house effect	Trapping of radiation from the sun by green house gases in the atmosphere that leads to rise in the earth's atmospheric temperature.
Haber's process	Synthesis of ammonia from nitrogen and hydrogen with the help of catalyst under 500 atm pressure and 550˚C temperature.

Oxygenes	A Greek word meaning 'acid producers' from which the name 'Oxygen' is derived.
Soda water	A form of water produced when carbon dioxide is dissolved in water under pressure.
Sublimation	Process of conversion of solid directly to vapour without reaching liquid state.

Z3N6F8

TEXTBOOK EXERCISES

I. Choose the best answer.

1. Which of the following is true about oxygen?
   a) Completely burning gas
   b) Partially burning gas
   c) Doesn't support burning
   d) Supports burning

2. Aerated water contains
   a) air b) oxygen
   c) carbon dioxide d) nitrogen

3. Solvay process is a method to manufacture
   a) lime water b) aerated water
   c) distilled water d) sodium carbonate

4. Carbon dioxide with water changes
   a) blue litmus to red
   b) red litmus to blue
   c) blue litmus to yellow
   d) doesn't react with litmus

5. Which of the following is known as azote?
   a) Oxygen b) Nitrogen
   c) Sulpher d) Carbon dioxide

II. Fill in the blanks.

1. ____________ is called as vital life.
2. Nitrogen is ____________ than air.
3. ____________ is used as a fertilizer.
4. Dry ice is used as a ____________.
5. The process of conversion of iron into hydrated form of oxides is called ____________.

III. Match the following.

Nitrogen	Respiration in living animals
Oxygen	Fertilizer
Carbon dioxide	Refrigerator
Dry ice	Fire extinguisher

IV. Answer briefly.

1. Mention the physical properties of oxygen.
2. List out the uses of nitrogen.
3. Write about the reaction of nitrogen with non metals.
4. What is global warming?
5. What is dry ice? What are its uses?

V. Answer in detail.

1. What happens when carbon dioxide is passed through lime water? Write the equation for this reaction.
2. Name the compounds produced when the following substances burn in oxygen.
   a) Carbon b) Sulphur
   c) Phosphorous d) Magnesium
   e) Iron f) Sodium
3. How does carbon dioxide react with the following?
   a) Potassium b) Lime water
   c) Sodium hydroxide
4. What are the effects of acid rain? How can we prevent them?

VI. Higher Order Thinking Questions.

1. Soda bottle bursts sometimes when it is opened during summer. Why?
2. It is said that sleeping beneath the tree during night is not good for health. What is the reason?
3. Why does the fish die when it is taken out of water?
4. How do astronauts breathe when they go beyond earth's atmosphere?

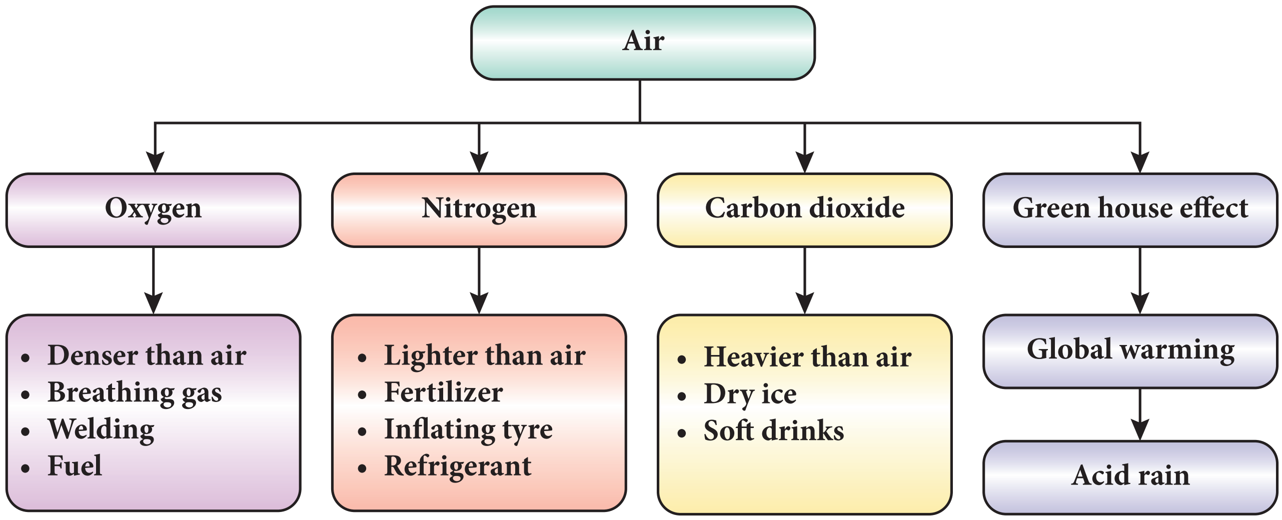
REFERENCE BOOKS

1. Environmental Science - Timothy O Riordan Second edition
2. Basic of atmospheric science - A. chandrasekar
3. Text book of Air pollution and its control - S.C. Bhatia

INTERNET RESOURCES

1. www.chemicool.com
2. www.nationgeographic.com
3. www.environmentalpollutioncenters.org

Concept Map



ICT CORNER

AIR

Through this activity you will know about carbon emission, climate change, global average temperature etc.

Step 1

- Open the Browser and type the URL given below.
- Click onany one of the items to know about carbon emission, climate change, global average temperature, sea level etc.
- For example, click on the "**Climate Time Machine**" a popup screen will open. In that you can able to see carbon emission global average sea level, temperature, sea ice etc.
- When you click global average sea level, you will find year wise sea level.

Browse in the link: https://climatekids.nasa.gov/menu/play/

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UNIT 12

ATOMIC STRUCTURE

N9B5H7

Learning Objectives

After the completion of this lesson, students will be able to:

- understand the advantages and limitations of Dalton's atomic theory.
- distinguish the fundamental particles and their properties.
- get an idea about Thomson's atom model and its limitations.
- calculate the valency of different elements.
- write the chemical formula and molecular formula of compounds.
- balance the chemical equations.
- state the laws of chemical combinations.

Introduction

Every substance in our surrounding is made up of unique elements. There are 118 elements identified worldwide so far. Out of these elements, 92 elements occur in the nature and the remaining elements are synthesised in the laboratories. Copper, Iron, Gold and Silver are some of the elements found in the nature. Elements like Technetium, Promethium, Neptunium and Plutonium are synthesised in the labaratories. Each element is made up of similar, minute particles called atoms. For example, the element gold is made up of gold atoms which determine its characteristics. The word atom is derived from the Greek word **atomos**. **Tomos** means smallest divisible particle and atomas means smallest indivisible particle. Ancient Greek philosophers like Democritus, have spoken about atoms. Even our Tamil poet Avvaiyar has mentioned about atoms in her poem while describing Thirukkural (அணுவைத் துளைத்து ஏழ் கடலைப்புகட்டிக் குறுகத் தரித்த குறள்). But, none of them have scientific base. The first scientific theory about atom was given by John Dalton. Followed by him, J.J.Thomson and Rutherford have given their theory about atom. In this lesson, we will study how atomic theories evolved at different times. We will also study about valency, molecular formula, rules for naming chemical compounds and balancing chemical equations.

12.1 Dalton's Atomic Theory

John Dalton provided a basic theory about the nature of matter. He proposed a model of atom known as Dalton's atomic theory in 1808 based on his experiments. The main postulates of Dalton's atomic theory are:

- All the matters are made up of extremely small particles called atoms (Greek philosopher Democritus used the same name for the smallest indivisible particles).
- Atoms of the same element are identical in all aspects (size, shape, mass and properties).

- Atoms of different elements have different sizes and masses, and possess different properties.
- Atoms can neither be created nor be destroyed. i.e., atom is indestructible.
- Atoms of different elements may combine with each other in a fixed simple ratio to form molecules.
- An atom is the smallest particle of matter that takes part in a chemical reaction.

DO YOU KNOW?

John Dalton, son of a poor weaver, began his career as a village school teacher at the age of 12. He became the principal of the school seven years later. In 1793, he moved to Manchester to teach Physics, Chemistry and Mathematics in a college. He proposed his atomic theory in 1803. He carefully recorded each day, the temperature, pressure and amount of rainfall from his youth till the end. He was a meticulous meteorologist.

12.1.1 Advantages of Dalton's Atomic Theory

- Dalton's theory explains most of the properties of gases and liquids.
- This explains the law of chemical combination and the law of conservation of mass (They are explained at the last section).
- This theory helps to recognize the molecular differences of elements and compounds.

12.1.2 Limitations of Dalton's Atomic Theory

- Atom is no longer considered as the smallest indivisible particle.
- Atoms of the same element have different masses (Isotopes).
- Atoms of the different elements may have same masses (Isobars).
- Substances made up of same kind of atoms may have different properties (Ex. Coal, Graphite and Diamond are made up of carbon atoms but they differ in their properties).

12.2 Fundamental Particles

In 1878, Sir William Crookes, while conducting an experiment using a discharge tube, found certain visible rays travelling between two metal electrodes. These rays are known as Crookes' Rays or Cathode Rays. The discharge tube used in the experiment is now referred as Crookes tube or more popularly as Cathode Ray Tube **(CRT)**.

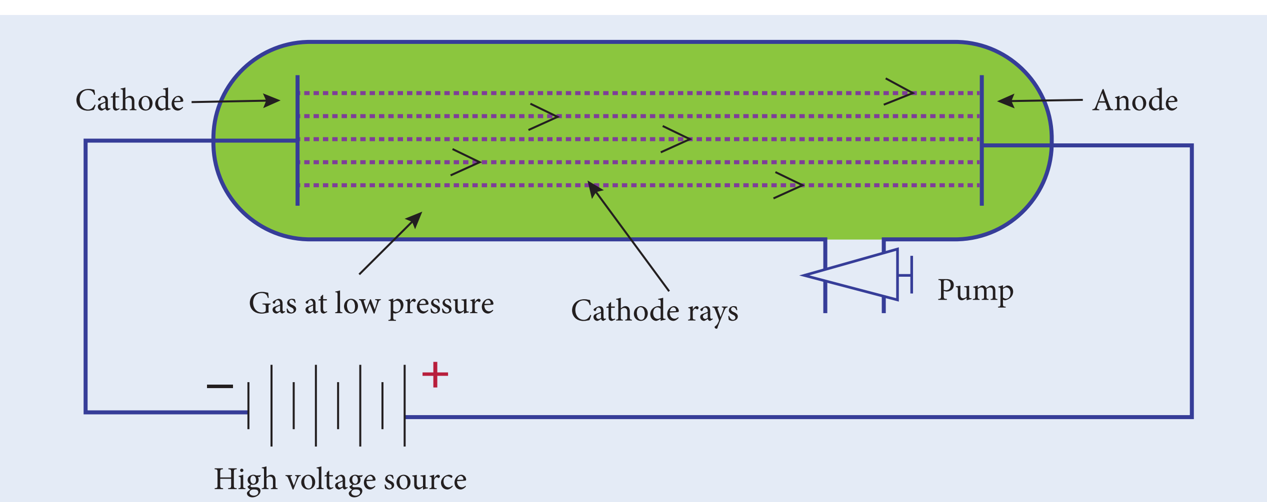

Figure 12.1 Cathode Ray Tube

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Cathode Ray Tube is a long glass tube filled with gas and sealed at both the ends. It consists of two metal plates (which act as electrodes) connected with high voltage. The electrode which is connected to the negative terminal of the battery is called the cathode (negative electrode). The electrode connected to the positive terminal is called the anode (positive electrode). There is a side tube which is connected to a pump. The pump is used to lower the pressure inside the discharge tube.

> **DO YOU KNOW?** Electricity, when passes through air, removes the electrons from the gaseous atoms and produces cations. This is called electrical discharge.

12.2.1 Discovery of Electrons

When a high electric voltage of 10,000 volts or more is applied to the electrode of a discharge tube containing air or any gas at atmospheric pressure, no electricity flows through the air. However, when the high voltage of 10,000 volts is applied to the electrodes of discharge tube containing air or any gas at a very low pressure of about 0.001 mm of mercury, a greenish glow is observed on the walls of the discharge tube behind anode. This observations clearly show some invisible ray coming from the cathode. Hence, these rays are called cathode rays. Later, they were named as **electrons**.

> **DO YOU KNOW?** The fact that air is a poor conductor of electricity is a blessing in disguise for us. Imagine what would happen if air had been a good conductor of electricity. All of us would have got electrocuted, when a minor spark was produced by accident.

Properties of Cathode rays

- Cathode rays travel in straight line from cathode towards anode.
- Cathode rays are made up of material particles which have mass and kinetic energy.
- Cathode rays are deflected by both electric and magnetic fields. They are negatively charged particles.
- The nature of the cathode rays does not depend on the nature of the gas filled inside the tube or the cathode used.

> **DO YOU KNOW?** In television tube cathode rays are deflected by magnetic fields. A beam of cathode rays is directed toward a coated screen on the front of the tube, where by varying the magnetic field generated by electromagnetic coils, the beam traces a luminescent image.

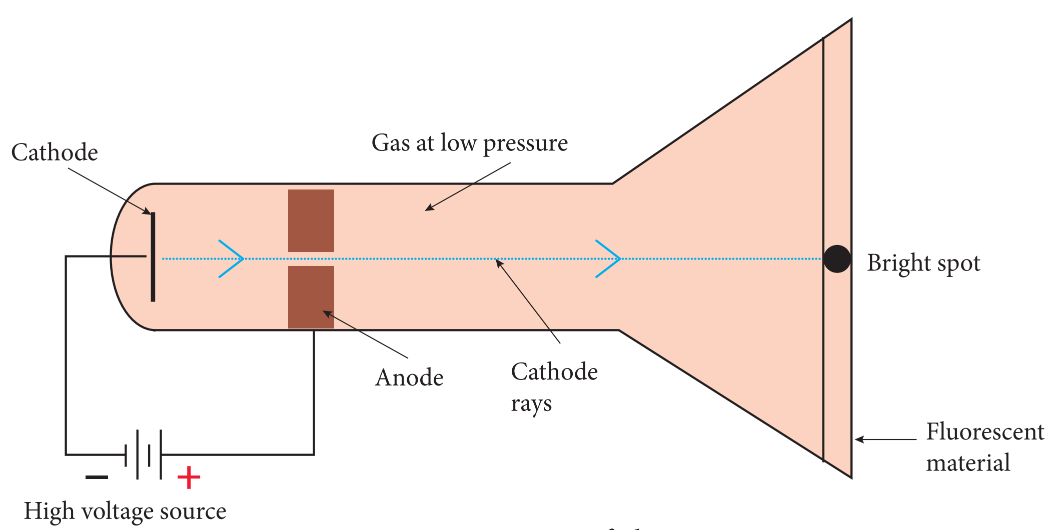

Figure 12.2 Emission of Electrons

12.2.2 Discovery of Protons

The presence of positively charged particles in the atom has been precisely predicted by Goldstein based on the conception that the atom being electrically neutral in nature, should necessarily possess positively charged particles to balance the negatively charged electrons.

Goldstein repeated the cathode ray experiment by using a perforated cathode. On applying a high voltage under low pressure, he observed a faint red glow on the wall behind the cathode. Since these rays originated from the anode, they were called anode rays or canal rays or positive rays. Anode rays were found as a stream of positively charged particles.

> **DO YOU KNOW?** When invisible radiation falls on materials like zinc sulphide, they emit a visible light (or glow). These materials are called fluorescent materials.

Properties of Anode rays

- Anode rays travel in straight lines.
- Anode rays are made up of material particles.
- Anode rays are deflected by electric and magnetic fields. Since, they are deflected towards the negatively charged plate, they consist of positively charged particles.
- The properties of anode rays depend upon the nature of the gas taken inside in the discharge tube.
- The mass of the particle is the same as the atomic mass of the gas taken inside the discharge tube.

> **DO YOU KNOW?** When hydrogen gas was taken in a discharge tube, the positively charged particles obtained from the hydrogen gas were called protons. Each of these protons are produced when one electron is removed from one hydrogen atom. Thus, a proton can be defined as an hydrogen ion (H^+).
>
> $$H \rightarrow H^+ + e^-$$

12.2.3 Discovery of Neutrons

At the time of J.J.Thomson, only two fundamental particles (proton and electron) were known. In the year 1932, James Chadwick discovered another fundamental particle, called neutron. But, the proper position of these particles in an atom was not clear till Rutherford described the structure of atom. You will study about Rutherford's atom model in your higher classes.

Properties of Neutrons

- Neutron carries no charge. It is a neutral particle.
- It has mass equal to that of a proton, that is 1.6×10^{-24} grams.

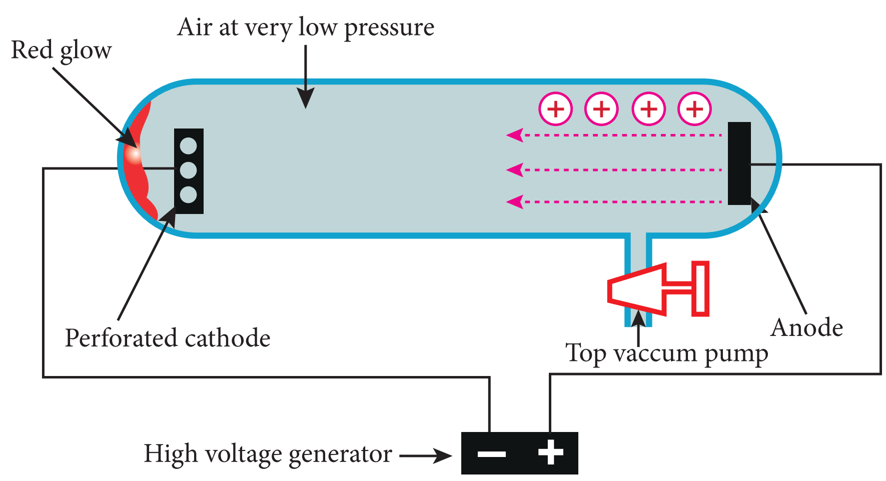

Figure 12.3 Emission of Protons

Table 12.1 Properties of Fundamental particles.

Particle	Mass	Relative charge
Electron (e)	9.1×10^{-28} grams	−1
Proton (p)	1.6×10^{-24} grams	+1
Neutron (n)	1.6×10^{-24} grams	0

Activity 1

Collect more information about the properties of fundamental particles and prepare a chart.

12.3 Thomson's Atom Model

J.J. Thomson, an English scientist, proposed the famous atom model in the year 1904, just after the discovery of electrons.

Thomson proposed that the shape of an atom resembles a sphere having a radius of the order of 10^{-10} m. The positively charged particles are uniformly distributed with electrons arranged in such a manner that the atom is electrically neutral. Thomson's atom model was also called as the plum pudding model or the watermelon model. The embedded electrons resembled the seed of watermelon while the watermelon's red mass represented the positive charge distribution. The plum pudding atomic theory assumed that the mass of an atom is uniformly distributed all over the atom.

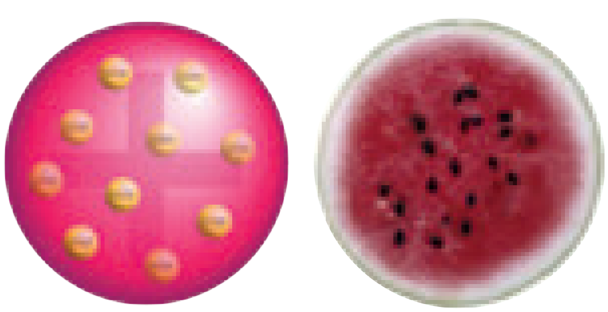

Figure 12.4 Thomson's Atom model

12.3.1 Limitations of Thomson's Atom model

Thomson's atom model could successfully explain the electrical neutrality of atom. However, it failed to explain the following.

1. Thomson's model failed to explain how the positively charged sphere is shielded from the negatively charged electrons without getting neutralised.
2. This theory explains only about the protons and electrons and failed to explain the presence of neutral particle neutron.

12.4 Valency

In order to understand valency of elements clearly, we need to learn a little about Rutherford's atomic model here. According to Rutherford, an atom consists of subatomic particles namely, proton, electron and neutrons. Protons and neutrons are found at the centre of an atom, called nucleus. Electrons are revolving around the nucleus in a circular path, called orbits or shells. An atom has a number of orbits and each orbit has electrons. The electrons revolving in the outermost orbit are called valence electrons.

The arrangement of electrons in the orbits is known as **electronic configuration**. Atoms of all the elements will tend to have a stable electronic configuration, that is, they will tend to have either two electrons (known as duplet)

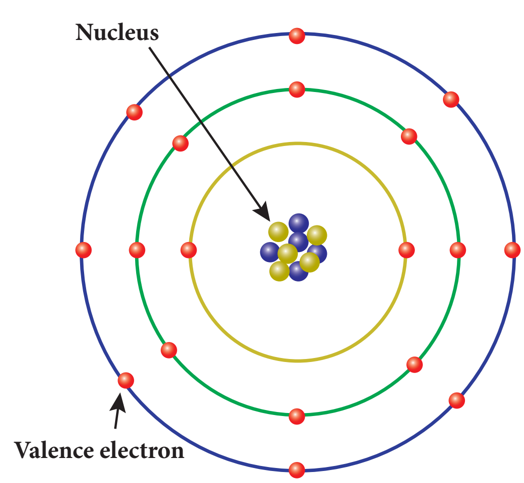

Figure 12.5 Arrangement of electrons in atom

or eight electrons (known as octet) in their outermost orbit. For example, helium has two electrons in the outermost orbit and so it is chemically inert. Similarly, neon is chemically inert because, it has eight electrons in the outermost orbit.

The valence electrons in an atom readily participate in a chemical reaction and so the chemical properties of an element are determined by these electrons. When molecules are formed, atoms combine together in a fixed proportion because each atom has different combining capacity. This combining capacity of an atom is called valency. Valency is defined as the number of electrons lost, gained or shared by an atom in a chemical combination so that it becomes chemically inert.

12.4.1 Types of Valency

As we saw earlier, an atom will either gain or lose electrons in order to attain the stable electronic configuration. In order to understand valency in a better way, it can be explained in two ways depending on whether an atom gains or losses electrons.

Atoms of all metals will have 1 to 3 electrons in their outermost orbit. By loosing these electrons they will have stable electronic configuration. So, they lose them to other atoms in a chemical reaction and become positively charged. Such atoms which donate electrons are said to have positive valency. For example, sodium atom (Atomic number: 11) has one electron in its outermost orbit and in order to have stability it loses one electron and becomes positively charged. Thus, sodium has positive valency.

All non-metals will have 3 to 7 electrons in the outermost orbit of their atoms. In order to attain stable electronic configuration, they need few electrons. They accept these electrons from other atoms in a chemical reaction and become negatively charged. These atoms which accept electrons are said to have negative valency. For example, chlorine atom (Atomic number: 17) has seven electrons in its outermost orbit. By gaining one electron it attains stable electronic configuration, like inert gas electronic configuration. Thus, chlorine has negative valency.

12.4.2 Valency with respect to atoms

Valency of an element is also determined with respect to other atoms. Generally, valency of an atom is determined with respect to hydrogen, oxygen and chlorine.

a. Valency with respect to Hydrogen

Since hydrogen atom loses one elctron in its outermost orbit, its valency is taken as one and it is selected as the standard. Valencies of the other elements are expressed in terms of hydrogen. Thus, valency of an element can also be defined as the number of hydrogen atoms which combine with one atom of it. In hydrogen chloride molecule, one hydrogen atom combines with one chlorine atom. Thus, the valency of chlorine is one. Similarly, in water molecule, two hydrogen atoms combine with one oxygen atom. So, valency of oxygen is two.

Since some of the elements do not combine with hydrogen, the valency of the element is also defined in terms of other elements like chlorine or oxygen. This is because almost all the elements combine with chlorine and oxygen.

Table 12.2 Valency of atoms

Molecule	Element	Valency
Hydrogen chloride (HCl)	Chlorine	1
Water (H_2O)	Oxygen	2
Ammonia (NH_3)	Nitrogen	3
Methane (CH_4)	Carbon	4

b. Valency with respect to Chlorine

Since valency of chlorine is one, the number of chlorine atoms with which one

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atom of an element can combine is called its valency. In sodium chloride (NaCl) molecule, one chlorine atom combines with one sodium atom. So, the valency of sodium is one. But, in magnesium chloride ($MgCl_2$) valency of magnesium is two because it combines with two chlorine atoms.

c. Valency with respect to oxygen

In another way, valency can be defined as double the number of oxygen atoms with which one atom of an element can combine because valency of oxygen is two. For example, in magnesium oxide (MgO) valency of magnesium is two.

12.4.3 Variable Valency

Atoms of some elements combine with atoms of other elements and form more than one product. Thus, they are said to have different combining capacity. These atoms have more than one valency. Some cations exhibit more than one valency. For example, copper combines with oxygen and forms two products namely cuprous oxide (Cu_2O) and cupric oxide (CuO). In Cu_2O, valency of copper is one and in CuO valency of copper is two. For lower valency a suffix –ous is attached at the end of the name of the metal. For higher valency a suffix –ic is attached at the end of the name of the metal. Sometimes Roman numeral such as I, II, III, IV etc. indicated in parenthesis followed by the name of the metal can also be used.

Table 12.3 Metals with variable valencies

Element	Cation	Names
Copper	Cu^{+}	Cuprous (or) Copper (I)
	Cu^{2+}	Cupric (or) Copper (II)
Iron	Fe^{2+}	Ferrous (or) Iron (II)
	Fe^{3+}	Ferric (or) Iron (III)
Mercury	Hg^{+}	Mercurous (or) Mercury (I)
	Hg^{2+}	Mercuric (or) Mercury (II)
Tin	Sn^{2+}	Stannous (or) Tin (II)
	Sn^{4+}	Stannic (or) Tin (IV)

12.5 Ions

In an atom, the number of protons is equal to the number of electrons and so the atom is electrically neutral. But, during chemical reactions atoms try to attain stable electronic configuration (duplet or octet) either by gaining or losing one or more electrons according to valency. When an atom gains an electron it has more number of electrons and thus it carries negative charge. At the same time when an atom loses an electron it has more number of protons and thus it carries positive charge. These atoms which carry positive or negative charges are called ions. The number of electrons gained or lost by an atom is shown as a superscript to the right of its symbol. When an atom loses an electron, '+' sign is shown in the superscript and '–' sign is shown if an electron is gained by an atom. Some times, two or more atoms of different elements collectively lose or gain electrons to acquire positive or negative charge. Thus we can say, an atom or a group of atoms when they either lose or gain electrons, get converted into ions or radicals.

12.5.1 Types of Ions

Ions are classified into two types. They are cations and anions.

Cations

If an atom loses one or more electrons during a chemical reaction, it will have more number of positive charge on it. These are called cations (or) positive radicals. Sodium atom loses one electron to attain stability and it becomes cation. Sodium ion is represented as Na^{+}.

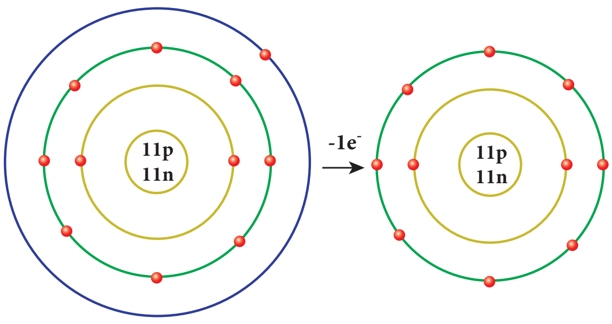

Figure 12.6 Electronic configuration of Sodium

Anions

If an atom gains one or more electrons during a chemical reaction, it will have more number of negative charge on it. These are called anions or negative radicals. Chlorine atom attains stable electronic configuration by gaining an electron. Thus, it becomes anion. Chlorine ion is represented as Cl^-.

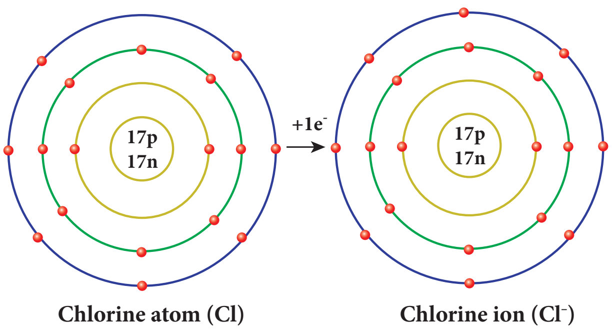

Figure 12.7 Electronic configuration of Chlorine

12.5.2 Different valent ions

During a chemical reaction, an atom may gain or lose more than one electron. An ion or radical is classified as monovalent, divalent, trivalent or tetravalent when the number of charges over it is 1,2,3 or 4 respectively. Based on the charges carried by the ions, they will have different valencies.

Valency of Anions (negative radicals) and Cations (positive radicals)

The valency of an anion or cation is a number which expresses the number of hydrogen atoms or any other monovalent atoms (Na,K,Cl….) which combine with them to give an appropriate compound. For example, two hydrogen atoms combine with one sulphate ions (SO_4^{2-}) to form sulphuric acid (H_2SO_4). So, the valency of SO_4^{2-} is 2. One chlorine atom (Cl) combines with one ammonium ion (NH_4^+) to form NH_4Cl. So, the valency of NH_4^+ is 1. Valencies of some anions and cations and their corresponding compounds are given below.

> **Activity 2**
>
> Classify the following ions into monovalent, divalent and trivalent.
>
> Ni^{2+}, Fe^{3+}, Cu^{2+}, Ba^{2+}, Cs^{+}, Zn^{2+}, Cd^{2+}, Hg^{2+} Pb^{2+}, Mn^{2+}, Fe^{2+}, Co^{2+}, Sr^{2+}, Cr^{3+}, Li^{+}, Ca^{2+}, Al^{3+}

Table 12.4 Valencies of some anions

Compound	Name of the anion	Formula of anion	Valency of anion
HCl	Chloride	Cl^-	1
H_2SO_4	Sulphate	SO_4^{2-}	2
HNO_3	Nitrate	NO_3^-	1
H_2CO_3	Carbonate	CO_3^{2-}	2
H_3PO_4	Phosphate	PO_4^{3-}	3
H_2O	Oxide	O^{2-}	2
H_2S	Sulphide	S^{2-}	2
NaOH	hydroxide	OH^-	1

Table 12.5 Valencies of some cations

Compound	Name of cation	Formula of cation	Valency of cation
NaCl	Sodium	Na^+	1
KCl	Potassium	K^+	1
NH_4Cl	Ammonium	NH_4^+	1
$Mg\,Cl_2$	Magesium	Mg^{2+}	2
$CaCl_2$	Calcium	Ca^{2+}	2
$Al\,Cl_3$	Aluminium	Al^{3+}	3

12.6 Chemical formula or Molecular formula

Chemical formula is the shorthand notation of a molecule (compound). It shows the actual number of atoms of each element present in a molecule of a substance. Certain steps are followed to write down the chemical formula of a substance. They are given below.

Step1: Write down the symbols of elements/ ions side by side so that the positive

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radical is on the left and the negative radical is on the right hand side.

Step2: Write the valencies of the two radicals above their symbols to the right in superscript (Signs '+' and '-' of the ions are omitted).

Step3: Reduce the valencies to simplest ratio if needed. Otherwise interchange the valencies of the elements/ions. Write these numbers as subscripts. However, '1' appearing on the superscript of the symbol is omitted.

Thus, we arrive the chemical formula of the compound.

Let us derive the chemical formula for calcium chloride.

Step 1: Write the symbols of calcium and chlorine side by side.

Ca Cl

Step 2: Write the valencies of calcium and chlorine above their symbols to the right.

Ca^2 Cl^1

Step 3: Interchange the valencies of elements.

Ca Cl^2

Thus the chemical formula for calcium chloride is $\mathbf{CaCl_2}$

Activity 3

Write the chemical formula of the compounds.

Compound	Symbols with valencies	Simplest ratio if any	Chemical formula
Magnesium chlorinde			
Sodium hydroxide			
Calcium oxide			
Aluminium sulphate			
Calcium phosphate			

12.7 Naming chemical compounds

A chemical compound is a substance formed out of more than one element joined together by chemical bond. Such compounds have properties that are unique from that of the elements that formed them. While naming these compounds specific ways are followed. They are given below.

1. In naming a compound containing a metal and a non-metal, the name of the metal is written first and the name of the non-metal is written next after adding the suffix-'ide' to its name.

Examples:

NaCl - Sodium chloride

Ag Br - Silver bromide

2. In naming a compound containing a metal, a non-metal and oxygen, name of the metal is written first and name of the non-metal with oxygen is written next after adding the suffix- 'ate' (for more atoms of oxygen) or –ite (for less atoms of oxygen) to its name.

Examples:

$Na_2\ SO_4$ - Sodium sulphate

$Na\ NO_2$ - Sodium nitrite

3. In naming a compound containing two non-metals only, the prefix mono, di, tri, tetra, penta etc. is written before the name of non- metals.

Examples:

SO_2 - Sulphur dioxide

N_2O_5 - Dinitrogen pentoxide

Activity 4

Write the names of the chemical compounds.

Chemical Compound	Name
SO_3	
$Na_2\ SO_3$	
PCl_5	
$CaCl_2$	
$Na\ NO_3$	
BaO	

12.8 Chemical Equation

A chemical equation is a short hand representation of a chemical reaction with the help of chemical symbols and formulae. Every chemical equation has two components: reactants and products. Reactants are the substances that take part in a chemical reaction and the products are the substances that are formed in a chemical reaction.

12.8.1 Steps in writing the skeleton equation

Before writing the balanced equation of a chemical reaction, skeletal equation is written. The following are the steps involved in writing the skeletal equation.

1. Write the symbols and formulae of each of the reactants on the left hand side (LHS) and join them by plus (+) sign.
2. Follow them by an arrow (→) which is interpreted as gives or forms.
3. Write on the right hand side (RHS) of arrow the symbols and formulae for each of the products.
4. If the product is a gas it should be represented by upward arrow (↑) and if it is a precipitate it should be represented by downward arrow(↓).

   Example: $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2\uparrow$
5. The equation thus written is called as skeleton equation (unbalanced equation).

12.8.2 Balancing chemical equation

According to law of conservation of mass, the total mass of all the atoms forming the reactants should be equal to that of all the atoms forming the products. This law will hold good only when the number of atoms of all types of elements on both sides is equal. A balanced chemical equation is one in which the total number of atoms of any element on the reactant side is equal to the total number of atoms of that element on the product side.

There are many methods of balancing a chemical equation. Trial and error method (direct inspection), fractional method and odd number-even number method are some of them. While balancing a chemical equation following points are to be borne in mind.

1. Initially the number of times an element occurs on both sides of the skeleton equation should be counted.
2. An element which occurs least number of times in reactant and product side must be balanced first. Then, elements occuring two times, elements occuring three times and so on in an increasing order must be balanced.
3. When two or more elements occur same number of times, the metallic element is balanced first in preference to non-metallic element. If more than one metal or non-metal is present then a metal or non-metal with higher atomic mass (refer periodic table to find the atomic mass) is balanced first.
4. The number of molecules of reactants and products are written as coefficient.
5. The formula should not be changed to make the elements equal.
6. Fractional method of balancing must be employed only for molecule of an element (O_2,H_2,O_3,P_4,...) not for compound (H_2O, NH_3,...)

Now let us balance the equation for the reaction of hydrogen and oxygen which gives water. Write the word equation and balance it.

Step1: Write the word equation.

Hydrogen + Oxygen → Water

Step2: Write the skeleton equation.

$H_2 + O_2 \rightarrow H_2O$

Step3: Select the element which is to be balanced first based on the number of times an element occurs on both sides of the skeleton equation.

Element	H	O
Number of times particular element occurs on both sides	2	1

Step4: In the above case, both elements occur one time each. Here, preference must be given to oxygen because it has higher atomic mass (refer periodic table).

Step5: To balance oxygen, put 2 before H_2O on the right hand side (RHS).

$$H_2 + O_2 \rightarrow 2H_2O$$

Step6: To balance hydrogen, put 2 near hydrogen (H_2) on the left hand side (LHS).

$$2H_2 + O_2 \rightarrow 2H_2O$$

(H = 4 0 = 2) (H = 4 0 = 2)

Now, on both sides number of hydrogen atoms is four and oxygen atoms is two. Thus, the chemical equation is balanced.

12.8.3 Information conveyed by a balanced chemical equation

A balanced chemical equation gives us both qualitative and quantitative information. It gives us qualitative informations such as the names, symbols and formulae of the reactant molecules taking part in the reaction and those of the product molecules formed in the reaction. We also can get quantitative information like the number of molecules/atoms of the reactants and products that are taking part in the reaction. However, a chemical equation does not convey the following.

i. Physical state of the reactants and the products.
ii. Heat changes (heat liberated or heat absorbed) accompanying the chemical reaction.
iii. Conditions such as temperature, pressure, catalyst etc., under which the reaction takes place.
iv. Concentration (dilute or concentrated) of the reactants and products.
v. Speed of the reaction.

12.9 Laws of chemical combinations

By studying quantitative measurements of many reactions, it was observed that the reactions taking place between various substances are governed by certain laws. They are called as the 'Laws of chemical combinations'. They are given below.

1. Law of conservation of mass
2. Law of constant proportion
3. Law of multiple proportions
4. Gay Lussac's law of gaseous volumes

In this lesson, we will study about the first two laws. You will study about Law of multiple proportions and Gay Lussac's Law of gaseous volumes in standard IX.

12.9.1 Law of conservation of mass

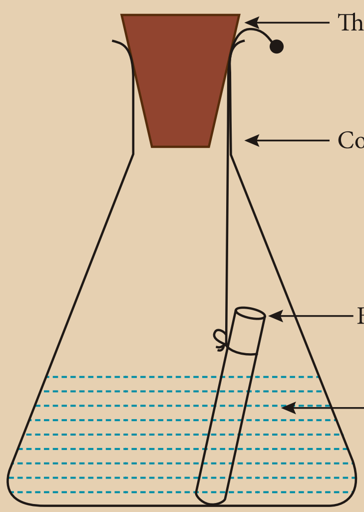
The law of conservation of mass which relates the mass of the reactants and products during the chemical change was stated by a French chemist **Lavoisier** in 1774. It states that **during any chemical change, the total mass of the products is equal to the total mass of the reactants**. In other words the law of conservation of mass means that mass can neither be created nor be destroyed during any chemical reaction. This law is also known as **Law of indestructibility of mass**.

Activity 5

Take some ice cubes in an air tight container and note the weight of the container with ice cubes. Wait for a while for the ice cubes to become water. It is a physical change ie., ice cubes melt and they are converted into liquid. Now weigh the container and compare the weight before and after the melting of ice cubes. It remains the same. Hence it is proved that during a physical change, the total mass of matter remains the same.

Activity 6

Prepare 5% of barium chloride (5g of $BaCl_2$ in 100 ml of water) and sodium sulphate solutions separately. Take some solution of sodium sulphate in a conical flask and some solution of barium chloride in a test tube. Hang the test tube in the conical flask. Weigh the flask with its contents. Now mix the two solutions by tilting and swirling the flask. Weigh the flask after the chemical reaction is occurred. Record your observation. It can be seen that the weight of the flask and the contents remains the same before and after the chemical change. Hence, it is proved that during a chemical change, the total mass of matter remains the same.



Consider the formation of ammonia (Haber's process) from the reaction between nitrogen and hydrogen

N_2	+	$3H_2$	$\rightarrow$	$2NH_3$
28g		6g		34g

During Haber's process the total mass of the reactant and the product are exactly same throughout the reaction.

Now, it is clear that mass is neither created nor destroyed during physical or chemical change. Thus, law of conservation of mass is proved.

12.9.2 Law of constant proportions

Law of constant proportions was proposed by the scientist **Joseph Proust** in 1779. He states that **in a pure chemical compound the elements are always present in definite proportions by mass**. He observed all the compounds with two or more elements and noticed that each of such compounds had the same elements in same proportions, irrespective of where the compound came from or who prepared it. For example, water obtained from different sources like rain, well, sea, and river will always consist of the same two elements hydrogen and oxygen, in the ratio 1:8 by mass. Similarly, the mode of preparation of compounds may be different but their composition will never change. It will be in a fixed ratio. Hence, this law is also known as 'Law of definite proportions'.

Points to Remember

- An atom consists of elementary particles like proton, electron and neutron.
- The discharge tube used in the experiment is now referred as Crookes tube or Cathode Ray Tube **(CRT)**. It is a long glass tube filled with gas and sealed at both the ends.
- Different atoms have different combining capacities. The combining capacity of an atom is known as its **valency**.
- Chemical formula is the short hand notation of a molecule of a substance (compound). It shows the actual number of atoms of each element in a molecule of a substance.
- In naming a compound containing a metal and a non-metal, the name of the metal is written first and the name of the non-metal is obtained by adding the suffix-ide to its name.
- Balancing chemical equation is necessary, so that law of conservation of mass may be obeyed.
- The law of conservation of mass states that during any chemical change, the total mass of the products is equal to the total mass of the reactants.

A-Z GLOSSARY

Anode	The positively charged electrode or an electron acceptor.
Cathode	The negatively charged electrode or an electron donor.
Chemical formula	It is a representation of a substance using symbols for its constituent elements.
Discharge tube	A tube containing charged electrodes and filled with a gas in which ionisation is induced by an electric field.
Ion	An atom or molecule with a net electric charge due to the loss or gain of one or more electrons.
Molecular formula	It is a formula giving the number of atoms of each of the elements present in one molecule of a specific compound.
Precipitate	An insoluble solid that emerges from a liquid solution.
Product	A substance that is formed as the result of a chemical reaction.
Reactant	A substance that takes part in and undergoes change during a reaction.
Valency	The combining power of an element, especially as measured by the number of hydrogen atoms it can displace or combine with.

TEXTBOOK EXERCISES

J1D1C7

1. Choose the best answer.

1. The same proportion of carbon and oxygen in the carbon dioxide obtained from different sources proves the law of ___________
   a) reciprocal proportion
   b) definite proportion
   c) multiple proportion
   d) conservation of mass

2. Cathode rays are made up of
   a) neutral particles
   b) positively charged particles
   c) negatively charged particles
   d) None of the above

3. In water, hydrogen and oxygen are combined in the ratio of ________by mass.
   a) 1:8 b) 8:1 c) 2:3 d) 1:3

4. Which of the following statements made by Dalton has not undergone any change?
   a) Atoms cannot be broken.
   b) Atoms combine in small, whole numbers to form compounds.
   c) Elements are made up of atoms.
   d) All atoms of an elements are alike

5. In all atoms of an element
   a) the atomic and the mass number are same.
   b) the mass number is same and the atomic number is different.
   c) the atomic number is same and the mass number is different
   d) both atomic and mass numbers may vary.

II. Fill in the blanks.

1. _____________ is the smallest particle of an element.

2. An element is composed of ____________ atoms.
3. An atom is made up of ____________, ____________ and ____________.
4. A negatively charged ion is called ____________, while positively charged ion is called ____________
5. ____________ is a negatively charged particle (Electron/Proton).
6. Proton is deflected towards the _________ charged plate (positively, negatively).

III. Match the following.

Law of conservation of mass	Sir William Crookes
Law of constant proportion	James Chadwick
Cathode rays	Joseph Proust
Anode rays	Lavoisier
Neutrons	Goldstein

IV. Answer briefly.

1. State the law of conservation of mass.
2. State the law of constant proportions.
3. Write the properties of anode rays.
4. Define valency of an element with respect to hydrogen.
5. Define the term ions or radicals.
6. What is a chemical equation?
7. Write the names of the following compounds.

   a) CO b) N_2O c) NO_2 d) PCl_5

V. Answer the following.

1. Find the valency of the element which is underlined in the following formula.

   a) $\underline{Na}Cl$ b) $\underline{C}O_2$ c) $\underline{Al}(PO_4)$
   d) $\underline{Ba}(NO_3)_2$ e) $\underline{Ca}Cl_2$

2. Write the chemical formula for the following compounds

   a) Aluminium sulphate b) Silver nitrate
   c) Magnesium oxide d) Barium chloride

3. Write the skeleton equation for the following word equation and then balance them.

a) Carbon + Oxygen → Carbon dioxide
b) Phosphorus + Chlorine → Phosphorus pentachloride.
c) Sulphur + Oxygen → Sulphur dioxide
d) Magnesium + hydrogen chloride → Magnesium chloride + Hydrogen

4. Balance the following chemical equation.

   a) $Na + O_2 \rightarrow Na_2O$
   b) $Ca + N_2 \rightarrow Ca_3N_2$
   c) $N_2 + H_2 \rightarrow NH_3$
   d) $CaCO_3 + HCl \rightarrow CaCl_2 + CO_2 + H_2O$
   e) $Pb(NO_3)_2 \rightarrow PbO + NO_2 + O_2$

VI. Higher Order Thinking Questions.

1. Why does a light paddle wheel placed in the path of cathode rays begin to rotate, when cathode rays fall on it?
2. How can we prove that the electrons carry negative charge?
3. Ruthresh, Hari, Kanishka and Thahera collected different samples of water from a well, a pond, a river and underground water. All these samples were sent to a testing laboratory. The test result showed the ratio of hydrogen to oxygen as 1:8.

   a) What conclusion would you draw from the above experiment?
   b) Which law of chemical combination does it obey?

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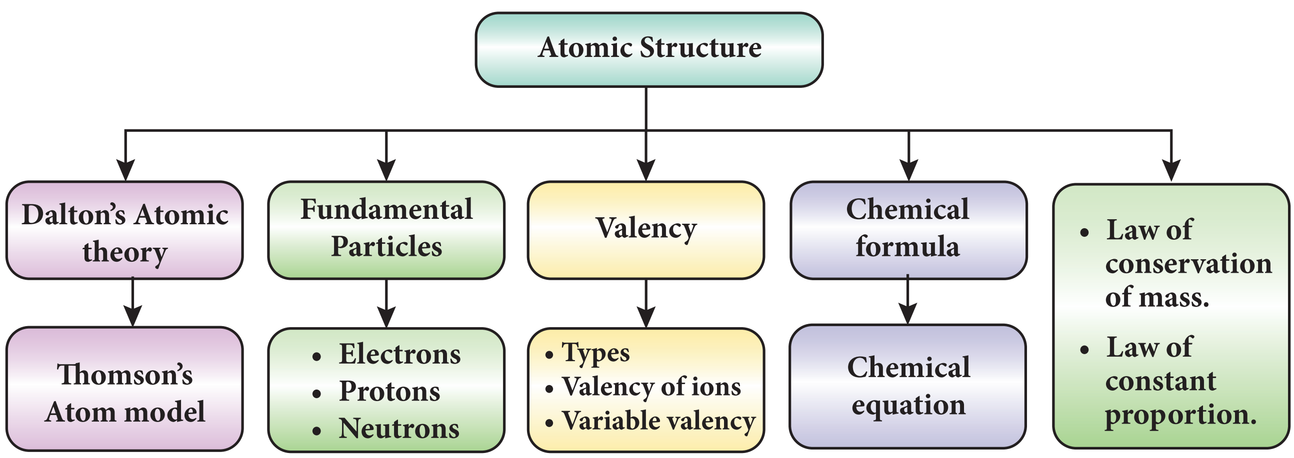
INTERNET RESOURCES

1. https://www.chem4kids.com
2. https://courses.lumenlearning.com/boundless-chemistry/chapter/the-structure-of-the-atom/
3. https://www.khanacademy.org/science/biology/chemistry--of-life/elements-and-atoms/e/atomic-structure

Concept Map



ICT CORNER — ATOMIC STRUCTURE

Through this activity you will learn the atomic structure through Interactive games

Step 1

- Open the Browser and type the URL given below.
- You can see Protons Neutrons and Electrons Atom games.
- Click the first game, you will see the periodic table. Start the quiz and answer it.
- Likewise explore the next game and play it.

B359_8_SCIENCE_EM

URL: https://www.wartgames.com/themes/science/atomicstructure.html

UNIT 13

WATER

W5X8E9

Learning Objectives

After the completion of this lesson, students will be able to:

- understand the importance, properties and uses of water.
- write the chemical equations for the reaction of water.
- explain water treatment methods.
- discuss about different methods of softening water.
- know about the causes and consequences of water pollution.
- list out the ways by which water pollution may be controlled.

Introduction

நீர்இன்று அமையாது உலகெனின் யார்யார்க்கும்
வான்இன்று அமையாது ஒழுக்கு — குறள்

Thirukkural says, without water there would be no life on the earth. Just like other living organisms, we also need water to survive. We need water for so many activities like cooking, washing, cleaning and irrigation. Water resources are getting depleted nowadays because of growing demand from increasing populations and lifestyle changes. There is also a reduction in the supply of water due to pollution of water sources and climate change which contributes to the rising variability in rainfall. We all depend on water for our living and so every individual is responsible for saving water. In this lesson, we will learn about the sources, properties and uses of water and also about water pollution and water treatment methods.

13.1 Composition

Three fourths of our planet earth is filled with water. Water exists in three states namely solid, liquid and gas. Water on the surface of the earth is found mainly in oceans (97.25%), polar ice caps and glaciers (2.05%) and the remaining is in lakes, rivers and aquifers - ground water. Even our body is made up of water (65%) but it is not apparent. Water is a chemically stable compound. Its chemical name is dihydrogen monoxide (H_2O). It can be broken up into hydrogen (H_2) and oxygen (O_2) when an electrical current is passed through it. The process of breaking down of water molecules by the passage of electric current is known as electrolysis of water.

13.1.1 Electrolysis of Water

Electrolysis of water can be easily demonstrated with the help of an experiment. In this experimental set up, a glass beaker fixed with two carbon electrodes is filled with water upto one third of its volume. The positive carbon electrode acts as anode and the negative carbon electrode acts as cathode. Two test tubes are placed on the electrodes as shown in Figure 13.1.

The electrodes are connected to a battery and current is passed until the test tubes are

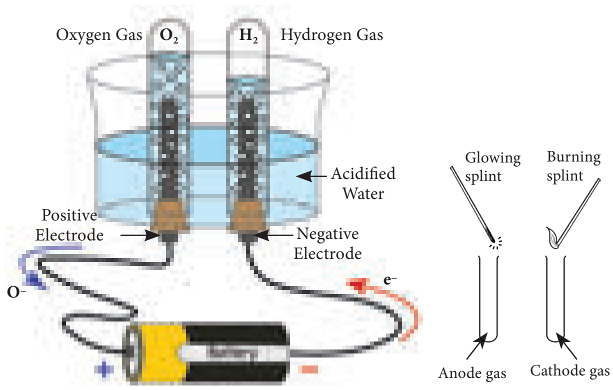


Figure 13.1 Electrolysis of Water

filled with a particular gas. If the gas collected is tested using a burning splint we can notice that the gas in cathode side burns with a popping sound when the extinguish splint is brought near the mouth of the test tube. This property is usually shown by hydrogen gas and so it is confirmed that the gas inside the test tube is hydrogen. The burning splint placed near the anode side burns more brightly confirming that it is oxygen gas. This experiment shows that water is made up of hydrogen and oxygen. The ratio of hydrogen and oxygen is 2:1. Hence, for every two volumes of hydrogen collected at the cathode, there is one volume of oxygen collected at the anode.

$$2H_2O \xrightarrow{\text{Electrolysis}} 2H_2\uparrow + O_2\uparrow$$

Activity 1

Take some anhydrous copper (II) sulphate powder and place it in a watch glass. Add water drop by drop to the anhydrous copper (II) sulphate. Do you notice any colour change in the powder? You can notice the powder turning blue. It is a test for water.

13.1.2 Preparation of Water

Water was first prepared in 1781 by an English scientist Henry Cavendish. He discovered hydrogen gas when active metals reacted with sulphuric acid. The hydrogen gas released was highly inflammable and burnt to form a colourless product called water.

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2\uparrow$$

$$2H_2 + O_2 \longrightarrow 2H_2O$$

Water is also produced by the reduction of metal oxide by hydrogen, burning of hydrogen in air and burning of hydrocarbons in air. Respiration of plants and animals also releases water.

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + \mathbf{6H_2O} + \text{Energy}$$

Glucose Oxygen Carbon dioxide Water

Do you know?

Henry Cavendish was a British philosopher, scientist, chemist, and physicist. Cavendish is noted for his discovery of hydrogen. He called it inflammable air. He mixed metals with strong acids and created hydrogen. He created carbon dioxide also by combining metals with strong bases.

13.1.3 Laboratory preparation of water

The apparatus used for the preparation of water in the laboratories is as shown in Figure 13.2. In this method, pure hydrogen gas is passed through anhydrous calcium chloride to absorb water vapour, if present. Dry hydrogen coming out of the opening is burnt with sufficient supply of air. The burnt hydrogen gas forms droplets of water, when it comes in contact with the cold flask. Distilled water without any dissolved matter is obtained by this method.

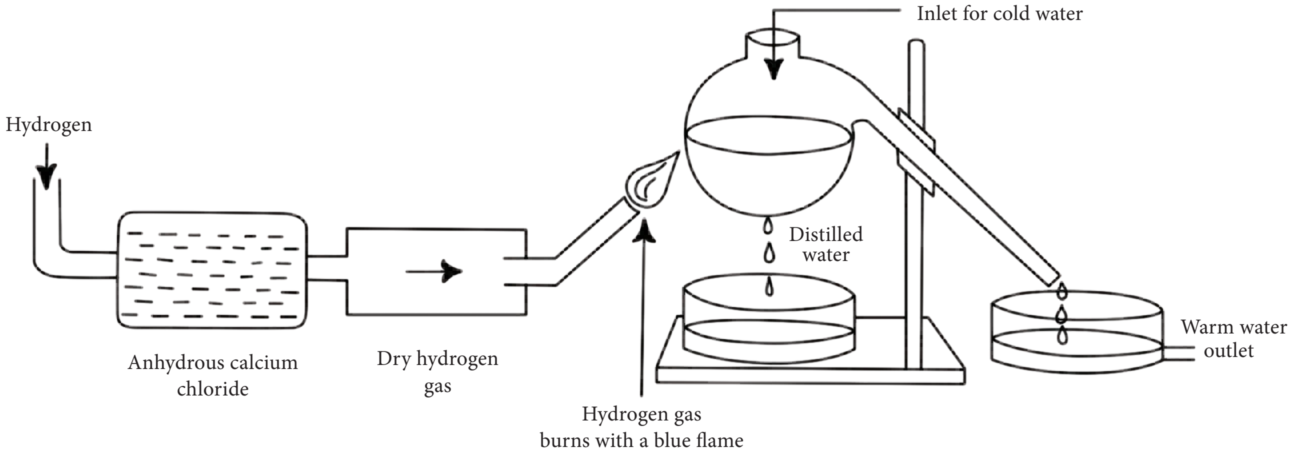


Figure 13.2 Preparation of Water

13.2 Properties of Water

Water has some important properties which are familiar to us. But these properties are unique to water. Some of the physical and chemical properties are explained below.

13.2.1 Physical properties

a. Nature

Pure water is a clear and transparent liquid. It is colourless, odourless and tasteless.

b. Boiling point

The boiling point of water is 100°C at one atmospheric pressure (1 atm). At this temperature, water boils and changes into steam. The boiling point of water increases with increase in pressure. For example, when a pressure cooker is heated, a high pressure is built inside it. The high pressure increases the boiling point of water. Thus, water remains a liquid at a higher temperature (> 100°C) in the cooker. This cooks the food faster.

DO YOU KNOW?

Pure water has the following physical properties.

- Pure water boils at 100°C at one atmospheric pressure.
- Pure water freezes at exactly 0°C at one atmospheric pressure.
- Pure water has a density of 1 gm/cm³

c. Freezing point

Water freezes at 0°C and forms ice. Thus, the freezing point of water is 0°C. The freezing point of water decreases with increase in pressure.

DO YOU KNOW?

When the skaters move on ice, they exert pressure on it. This pressure lowers the freezing point. As a result, the ice melts underneath the skate and allows the skaters to glide across the ice with little effort. When the skaters move forward, pressure is decreased and the water re-freezes to ice again.

d. Density

When ice cubes are put in a glass of water at room temperature, they float on the surface of the water. This is because ice is lighter than water. It means that the density of ice is lower than that of water. When the winter temperature is below 0°C, the water in the lake will start freezing. The frozen ice will float at the top and cover the lake. Since ice is a bad conductor of heat it does not allow heat to pass through it. So, the water below the ice remains in liquid form, where most of the aquatic life lives. This enables the aquatic animals and plants to survive even in extreme cold conditions. Density of water at different temperature is given in Table 13.1.

Figure 13.3 Ice floating on water

Table 13.1 Density of water at different temperature

Temperature	Density
0°C	0.91 g/cc (ice)
0°C	0.97 g/cc (water)
4°C	1 g/cc
> 4°C	< 1 g/cc

*** 1CC = 1 cm^3 = 1mL**

e. Anomalous expansion of water

For the same mass of ice and of water, the volume of ice is more than that of water. It is an unusual physical property of water. In the Himalayas the temperature can go down even below 0°C. The water in the water pipes will freeze at this temperature to ice. If the pipes are not strong they can crack, develop leaks or even burst. This is because freezing of water will cause an expansion in the volume.

f. Latent heat of fusion of ice

Take some ice cubes in a beaker and place a therometer in it. Now heat the beaker. The therometer will not register any rise in temperature till all the ice melts. The question arises where does the heat energy go if there is no rise in temperature. The heat energy is utilised in changing the state of ice from solid to liquid. The amount of heat energy required by ice to change into water is called latent heat of fusion of ice. Ice has the highest latent heat of fusion, i.e., 80 calories/g. or 336 J/g.

DO YOU KNOW?

The freshness of fish and meat can be maintained by placing them in contact with ice. With its larger latent heat, ice is able to absorb a large quantity of heat from the fish as it melts. Thus, food can be kept at a low temperature for an extended period of time.

g. Latent heat of vaporization of water

When water attains the temperature of 100°C, it starts changing its state from liquid to gaseous state. However, the temperature of water does not rise above 100°C. It is because the supplied heat energy only changes the state of the boiling water. This heat energy is stored in steam and is commonly called latent heat of vaporization of steam. The steam has the highest latent heat of vaporization and its value is 540 calories/g or 2268 J/g.

h. Specific heat capacity

The amount of heat that is needed to raise the temperature of a unit mass of a substance by 1°C is called specific heat capacity of that substance.

The specific heat capacity of water is very high. One gram of water requires 1 calorie of heat to raise its temperature by 1°C. Due to its high specific heat capacity, water takes time to become hot as well as to cool down. Thus, water can absorb a lot of heat and retain it for a longer time. This property of water is used to cool engines. Water is circulated around car engine using the radiator pump and the heat is absorbed. Thus the engine is protected from getting too hot.

Figure 13.4 Water as coolant in car engines

13.2.2 Chemical properties

a. Action towards litmus paper

Pure water is neutral and it shows no action towards litmus paper.

b. Stability

Water is a very stable compound. It does not decompose into elements, when heated to ordinary temperatures. However, if it is heated to 200°C, 0.02% of water decomposes to form hydrogen and oxygen gas.

$$2H_2O \xrightarrow{2000° C} 2H_2 + O_2$$

c. Catalytic nature

Water acts as a catalyst in a number of reactions. Perfectly dry hydrogen and chlorine gases do not react in the presence of sunlight. However in the presence of traces of water, the reaction takes place with explosion to produce hydrogen chloride.

$$H_2 + Cl_2 \xrightarrow[\text{Sunlight}]{\text{Moisture}} 2HCl$$

d. Reaction with metals

Water reacts with some metals. Metals such as sodium, potassium and calcium react vigorously with water at room temperature. Sodium reacts with water to form hydrogen gas and sodium hydroxide solution. Due to the heat evolved in this reaction the hydrogen gas catches fire and burns.

$$2Na + 2H_2O \longrightarrow 2NaOH + H_2$$

Activity 2

Fill a trough with water. Cut a small piece of sodium with a knife and carefully drop it in the water. Sodium reacts with water and darts across the surface of water. A flame produced is also seen near the surface.

Magnesium is little more sluggish. It reacts with hot water and gives hydrogen and magnesium hydroxide solution.

$$Mg + 2H_2O \longrightarrow Mg(OH)_2 + H_2\uparrow$$

Many other metals react with water to form oxides and hydroxides. Iron is one such metal which forms iron oxide, called rust. Iron is used in many buildings, factories, bridges, ships and vehicles. The slow and gradual rusting of iron is called corrosion.

DO YOU KNOW?

Copper does not react with water at any temperature. That is why it is used for making pipes and boilers.

e. Reaction with non-metals

Red hot carbon (coke) reacts with steam to produce water gas (Carbon monoxide + H_2).

$$C + H_2O \xrightarrow{1000°C} CO\uparrow + H_2\uparrow$$

Chlorine gas dissolves in water and produces hydrochloric acid.

$$2Cl_2 + 2H_2O \xrightarrow{\text{Sunlight}} 4HCl + O_2\uparrow$$

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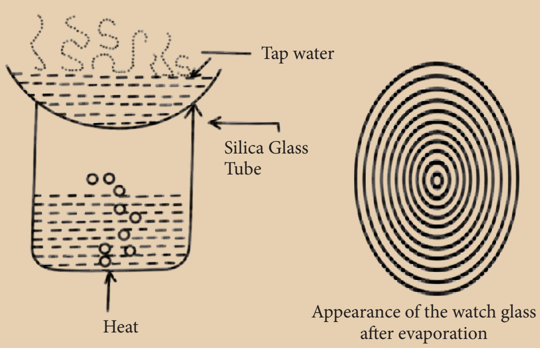
13.3 Water - A Universal Solvent

A solvent is a substance which dissolves other substances (solute). For example, in a salt solution, water is the solvent and salt is the solute. Water has a unique property to dissolve more substances than any other solvents. It can dissolve solids such as salt and sugar, liquids such as honey and milk and gases such as oxygen and carbon dioxide in it. Therefore, it is called as universal solvent.

Activity 3

Place a sample of tap water on a clean watch glass and place it over a beaker containing water, as shown in the figure. Boil the water in the beaker. When all the water has evaporated from the watch glass, remove it from the burner and let it cool. What do you see on the watch glass?



You can see a number of concentric rings of solid matter deposited on the watch glass. These are the dissolved solids left behind after the evaporation of water. Salts, minerals and impurities are the solids dissolved in water. Dissolved salts are important for the following reasons.

- They are essential for the growth and development of plants.
- They add taste to water.
- They supply the essential minerals needed for our bodies.
- Most of the chemical reactions important for our living take place in the cells of our body with the help of water.

DO YOU KNOW? Tap water, river water and well water contain dissolved solids but rainwater and distilled water do not contain dissolved solids. Hence concentric rings are not formed in the rain water and distilled water after evaporation.

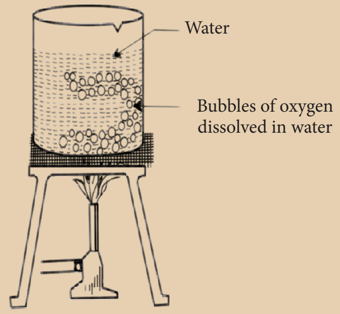
Apart from solids and minerals, air is also dissolved in water. Air is present in dissolved state in all natural sources of water. The solubility of oxygen in water is higher than the solubility of nitrogen. Air dissolved in water contains approximately 35.6% oxygen along with nitrogen and carbon dioxide. Air being dissolved in water is important for the following reasons.

- Air dissolved in water is important for the living organisms to survive.
- Fish extracts the oxygen from the water and expels water through the gills. Fish can survive in water only through the dissolved oxygen present in water.
- Aquatic plants make use of dissolved carbon dioxide for photosynthesis
- Carbon dioxide dissolved in water reacts with limestone to form calcium bicarbonate. Marine organisms such as snails, oysters, etc., extract calcium carbonate from calcium bicarbonate to build their shells.

Figure 13.5 Aquatic organisms

Activity 4

Take a beaker and fill it half with fresh tap water and heat it. You will see small bubbles appearing on the side of the beaker long before the water reaches its boiling point. These bubbles are oxygen gas dissolved in water.

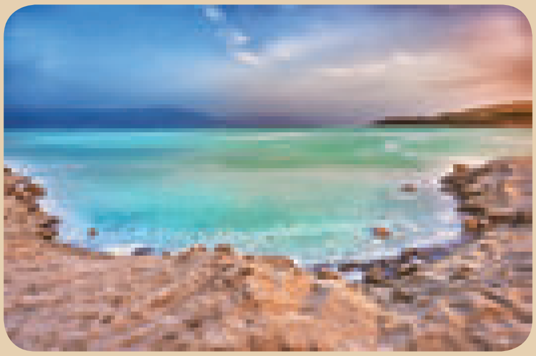


13.4 Potable Water

Imagine you are swimming in the sea and by accident you swallow some sea water. How would you feel? You would probably feel like vomiting! The sensation of feeling nauseous is because of a lot of salt in the water. Every litre of sea water contains 35 grams of dissolved salts

DO YOU KNOW?

The salinity of water is more in the Dead sea. It is actually a salt lake as it has a single source of water and is not connected to the ocean. It is landlocked and this causes the water to evaporate. This has led to a steady increase in its degree of salinity. Now the salinity is so high such that the marine life cannot survive in it. This is why it is called the Dead sea.



most commonly known as sodium chloride (NaCl). Such water is called saline water. It is not suitable for drinking and is said to be non-potable water.

The water suitable for drinking is called potable water. Every litre of potable water contains 1- 2 grams of dissolved salts, mainly common salt. In addition to the common salt, there are small amounts of calcium (Ca), magnesium (Mg), potassium (K), copper (Cu) and zinc (Zn). The minerals in water give it a certain taste. In addition, these minerals are useful for our body's metabolism. Potable water also contains dissolved gases.

13.4.1 Characteristics of Potable Water

The following are the characteristics of potable water.

- Potable water should be colourless and odourless.
- It should be transparent.
- It should be free from harmful micro-organisms such as bacteria, virus and protozoa.
- It should be free from impurities such as suspended solids.
- It should contain some minerals and salts, necessary for our body and some dissolved gases to add taste.

Activity 5

Take two pots with similar plants. Water one of the plants with tap water and the other with sea water. Record your findings and note the difference observed.

13.4.2 Purification of Water

Out of the total fresh water available on the earth, only 1% is present in water bodies such as rivers and lakes and the rest is frozen in glaciers and polar-regions.

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Water from these water bodies is unfit for drinking, cooking, washing or bathing because it contains suspended and dissolved impurities. It also contains micro-organisms such as bacteria. If this water is consumed without purifying, it can cause water-borne diseases such as typhoid and cholera. Therefore, water should be treated and purified before it reaches our home. In conventional water treatment plants (Figure 13.6), water is subjected to different processes for purification. These processes are discussed here.

DO YOU KNOW?

Every year 4.6 million children die due to diarrhea. Access to clean water improves hygiene and health.

Sedimentation

Water from lakes or rivers is collected in large sedimentation tanks. There, it is allowed to stand undisturbed so that suspended impurities settle down at the bottom of the tank. Sometimes, a chemical substance such as potash alum is added to water, to speed up the process of sedimentation. This process is called loading. The particles of potash alum combine with the suspended impurities and make them settle down at a faster rate.

Filtration

Water from the sedimentation tanks is then, pumped to the filtration tanks. Filtration tanks contain filter beds made up of gravel, sand, pebbles, activated charcoal and concrete. Water passes through these layers and becomes free from any remaining dissolved or suspended impurities completely.

Sterilisation

The filtered water is treated chemically to remove the remaining germs or bacteria. This process is called sterilisation. The chemicals that are used in this process are chlorine and ozone. The water from filtration tanks is pumped into chlorination tanks, where chlorine is added to remove harmful bacteria and other germs. The process of adding chlorine, in adequate amounts, to water is called chlorination. Ozonisation is a process in which water is treated with ozone gas to kill the germs present in it.

The sterilisation of water can also be done by exposing it to air and sunlight. Oxygen from the air and sunlight destroy the germs present in water. Aeration is the process in which air under pressure is blown into filtered water. This also helps to kill the germs.

DO YOU KNOW?

RO purifiers are the purifiers that can remove the dissolved impurities and germs. They also improve the taste of water. RO stands for the name of the technology, 'reverse osmosis', used in these purifiers. Some RO purifiers also have a UV (ultraviolet) unit that destroys the germs present in water.

13.4.3 Hardness of Water

We use soaps and detergents to wash clothes. They form lather with water that quickens the process of removal of dirt from the clothes. Water contains a number of dissolved salts and minerals. When these salts are present in very small quantities in water,

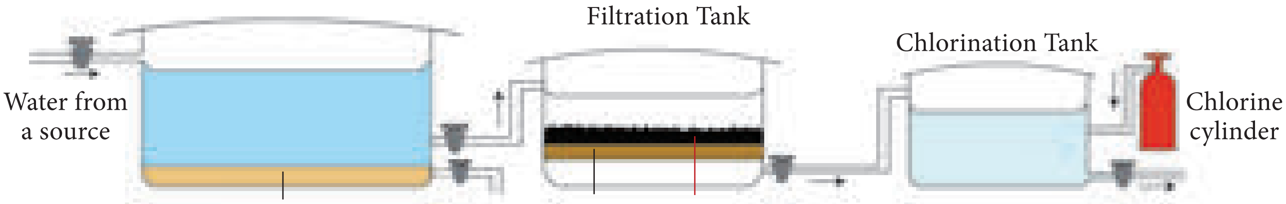

Figure 13.6 Water treatment stages

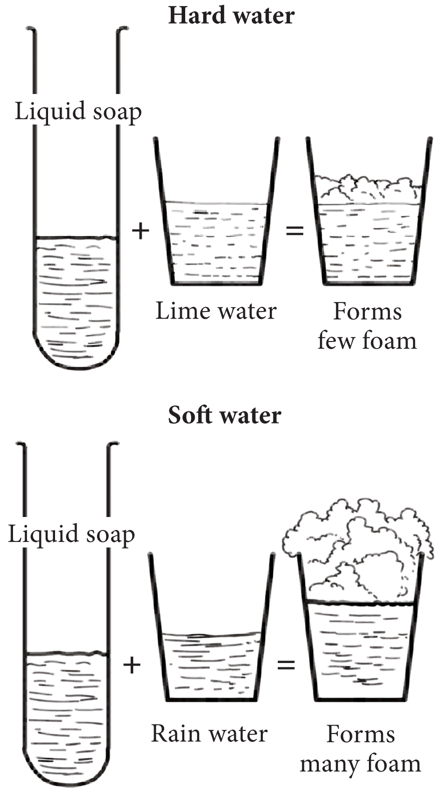

Figure 13.7 Hard water and soft water forming foam

it is called soft water. In this water, soaps or detergents form lather easily (Fig. 13.7).

Sometimes, minerals and salts are present in water in such a large quantity that soaps or detergents form a thick precipitate called scum instead of forming lather. This makes the removal of dirt further difficult. Such water is called hard water. Hardness of water is due to the presence of dissolved salts of calcium and magnesium. Hardness may be temporary or permanent. Temporary hardness is due to the presence of carbonate and bicarbonate salts of calcium and magnesium, and permanent hardness results due to the presence of chloride and sulphate salts of calcium and magnesium.

a. Disadvantages of hard water

- It is not good for washing clothes. It forms scum with soap and detergents, which makes the soap ineffective and also spoils the clothes further.
- It damages the utensils and containers in which it is stored and forms a hard layer.
- It forms scales on the machine parts used in industries and decreases their efficiency (Fig. 13.8).
- It results in stomach ailments if consumed for a long period.

Figure 13.8 Scales on the machine pipes

Activity 6

Take samples of water from different sources (like a tube well, a lake, a pond or a river) and pour equal quantities of each sample of water into different test tubes. Measure the height of water in each test tube with a scale. Add one or two drops of liquid soap to each test tube.

Shake each test tube five times and observe the height of the lather in each sample. Record your observations in the table. Which water is soft? Which water is hard? Can you say why?

Samples of water (Source)	Height of lather
Tap water	
Well water	
Pond water	
River water	

b. Removal of hardness

Different methods are followed to remove the hardness from water depending on whether it is temporary hardness or permanent hardness. Some of them are explained below.

Boiling

Temporary hardness is easily removed from water by boiling. When heated, the calcium hydrogen carbonate decomposes producing insoluble calcium carbonate. The insoluble carbonates are then filtered and removed from water. This makes the hard water soft and fit for use.

Adding washing soda

Washing soda is used to remove permanent hardness of water. Adding washing soda converts chlorides and sulphates into insoluble carbonates. These insoluble carbonates are removed by filtration.

Ion – exchange

Another method used to remove the hardness of water is to pass it through a column of ion-exchange resins where calcium and magnesium ions get replaced by sodium ions. This converts hard water into soft water.

Distillation

Temporary and permanent hardness both can be removed by the method of distillation. The water obtained after distillation is called distilled water. It is the purest form of water.

DO YOU KNOW? Distilled water and boiled water have no taste. The pleasant taste of drinking water is due to the presence of dissolved substances which include air, carbon dioxide and minerals.

13.5 Water Pollution

Contamination of water bodies as a result of human activities is known as water pollution. Contamination of water bodies occur when harmful substances such as chemicals, sewage and waste are released into them. It produces physical, chemical and biological change in the quality of water. It degrades the water quality and renders it toxic to living organisms. Drinking polluted water has serious negative effects on human health.

Figure 13.9 Polluted water body

13.5.1 Water Resource in Tamil Nadu

Fresh water resources are the sources of water that are useful to society for domestic, agricultural or industrial uses. These include surface and groundwater. Examples of surface water include rivers, reservoirs, lakes and tanks. There are 17 major river basins in Tamil Nadu with 61 reservoirs and approximately 41,948 tanks. Lakes and tanks are traditionally used in Tamil Nadu to collect rainfall during the monsoon which can be used throughout the year. Groundwater sources are called aquifers. Aquifers are layers below the ground made of coarse sand and gravel that contain spaces allowing rainwater collection. The use of groundwater is possible through open wells and bore wells.

DO YOU KNOW? About 90% of the available surface water has already been tapped mainly for agriculture and irrigation.

13.5.2 Sources of water pollution

When you look around you can see polluted water bodies in your surroundings. You can see lot of unwanted and harmful substances such as waste and sewage thrown into them. These substances are called pollutants. These pollutants are released by various activities from different sources. In general, sources of water pollution are classified as natural sources and man-made sources. Some of the sources of water pollution are explained below.

a. Household detergents

Household and cleaning detergents are a major cause of water pollution. Synthetic (non-biodegradable) detergents have chemicals that do not break down and can end up polluting both surface and groundwater. Excessive use of detergents adversely affects fish and other organisms. Some shampoo, face wash, shower gel and toothpaste have small round pieces of plastic added to them. These are called microbeads. They are added for different reasons like scrubing and cleaning your skin, polishing your teeth etc. When we use products with microbeads, they go down our drain and pollute water bodies. Fish and other animals feed them by accident and get sick.

Activity 7

Take a shampoo, shower gel or other product you think might have micro-beads in it. Mix two tablespoons of this in a glass of water and stir it well. Pour the water in a black t-shirt filtering the micro-beads out.

b. Domestic Sewage

Wastewater that is disposed of from households is known as domestic sewage. Domestic sewage should be treated before being disposed of into water bodies like river, lake, etc. Untreated sewage contains impurities such as organic matter from food waste, toxic chemicals from household products and it may also contain disease-causing microbes.

DO YOU KNOW? The largest source of water pollution in India is untreated sewage. On an average, a person uses 135 litres of water per day for washing clothes, cooking, bathing, etc.

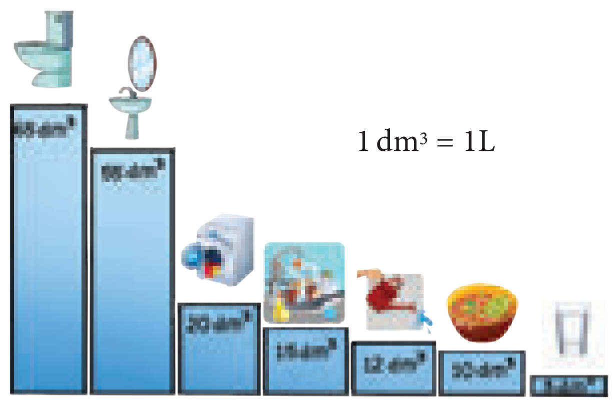

Figure 13.10 Domestic water consumption

c. Domestic waste and plastics

Solid waste including plastics are disposed of or end up in water bodies such as lakes, rivers and the ocean. Plastics block drains spreading vector borne diseases such as malaria and dengue. Waste in water bodies, negatively impact aquatic life.

Figure 13.11 Plastics in domestic wastes

DO YOU KNOW?

Plastic sheets are used in agriculture to grow vegetables. At the end of the season, these plastic sheets are ploughed back into the soil. The plastic sheets break into tiny pieces and get eaten by earth worms, which is harmful to their health and that of soil.

d. Agricultural activities

Fertilizers, pesticides and insecticides used in agriculture can dissolve in rainwater and flow into water bodies such as rivers and lakes. This causes an excess of nutrients such as nitrates and phosphates as well as toxic chemicals in water bodies. It is called Eutrophication. These sunstances can also be harmful to aquatic life.

Figure 13.12 Agricultural waste

e. Industrial waste

Many industries release toxic wastes such as lead, mercury, cyanides, cadmium, etc. If this waste is unregulated and is released into water bodies it has huge impact on humans, plants, animals and aquatic life.

Figure 13.13 Waste water from industries

f. Oil spills

There are large crude oil and natural gas reserves below the sea bed. With the increasing exploration of crude oil in the oceans, accidents in drilling and transporting oil have also increased. Oil spills cause water pollution which is harmful to aquatic life. The oil which remains floating on the water surface blocks sunshine, reduces the dissolved oxygen in water and suffocates marine organisms.

Figure 13.14 Oil spills

g. Thermal pollution

Large amount of water is used for cooling purposes in thermal and nuclear power plants and many industries. Water used for cooling purposes is discharged back to a river or to original water source at a raised temperature and sometimes with chemicals. This causes rise in temperature and decreases the amount of oxygen dissolved in water, which adversely affects the aquatic life.

13.5.3 Common pollutants

Pollutants are generally classified as domestic pollutants, agricultural pollutants and industrial pollutants. The sources and effects of various water pollutants are shown below in Table 13.1.

Table 13.1 Types of Pollutants

Pollutants	Sources	Effects
Domestic		
Sodium sulphates and phosphates	Detergents	In humans they cause developmental, reproductive and neuro toxicity and endocrine disruption. Phosphates make bacteria and algae grow faster, and use up all the dissolved oxygen. This leads to a decrease in animal and plant diversity.
Plastic fibres and microbeads	Plastic clothing and hair, beauty and skin products	These end up in water bodies such as lakes, rivers and the ocean. Here they attract toxic chemicals. Marine animals often eat them as they confuse them as their natural source of food and the toxins can move up the food chain.
Agriculture		
DDT (Dichloro Diphenyl Trichloro ethane)	Insecticides	If affects the central nervous system of insects, animals and humans. It accumulates in the food chain and impacts the top predators the most.
Nitrates and phosphates	Fertilisers	Bacteria and algae grow faster and they use up all the dissolved oxygen and this leads to a decrease in animal and plant diversity.
Industrial		
Lead, Mercury, Cadmium, Chromium and Arsenic	Chemical, textile and leather industries and leachate from open dumping of solid waste	Toxic to animals, plants and bacteria in the water. Pollutes potable ground water. Negatively impacts human health.

DO YOU KNOW?

Micro-plastics can be found in almost every freshwater source. They have been found from the freezing waters of the Arctic and Antarctic to the bottom of the deep-sea floor upto 5,000 meters deep. Micro-plastics have been found in bottled water and tap water around the world.

13.6 Controlling Water Pollution

Water is precious and it is essential for all living organisms. But today almost every water body is polluted with waste ranging from plastics to toxic substances. All of us can take immediate steps to save our precious water bodies from pollution. Some simple ideas to avoid water pollution are given below:

- Use detergents that are biodegradable and avoid those that contain toxic chemicals.
- Wear clothing that is made from natural fibres such as cotton and avoid wearing synthetic fibres such as nylon, polyester etc.
- Do not throw waste such as plastics into water bodies. Always separate your

waste into recyclable, non-recyclable and biodegradable so that it does not cause pollution.

- Domestic waste water should be treated properly, and all harmful substances should be removed from it, so it can be reused for flushing toilets and gardening.
- Use bio-pesticides (natural pest control) instead of chemical pest control.
- Use compost made from cow dung, garden waste and kitchen waste as a fertiliser.
- Water released from industries should be treated before being discharged or recycled for industrial purpose.

Points to Remember

- Next to air, water is the most important resource for our survival.
- Water contains hydrogen and oxygen as its constituent elements. Its molecular formula is H_2O.
- Water is broken down into its constituent elements by electrolysis. During electrolysis hydrogen and oxygen are obtained in the ratio 2:1
- Water has a maximum density of 1 g/cc at 4°C. At temperatures below and above 4°C, water has a density of less than 1 g/cc. This unique property of water helps in the survival of aquatic life in winters and summers.
- Sea water contains many minerals and salts dissolved in it and so it is said to be saline.
- Water freezes at 0°C and boils at 100°C.
- Water is a universal solvent as it can dissolve many substances.
- Water that is used for drinking is called potable water.
- Water has dissolved gases which are used by aquatic life for respiration and photosynthesis.
- Hardness of water is due to the presence of dissolved salts of calcium and magnesium.
- Water pollution is the result of dumping untreated domestic solid waste and sewage, agricultural waste, industrial effluents into lakes, rivers, etc.

A-Z GLOSSARY

Electrolysis	Breaking down of substances by the passage of electric current.
Potable water	Water used for drinking.
Saline water	Water containing sodium chloride (common salt).
Sterilization	Addition of chemicals to kill the microorganisms present in water.
Eutrophication	Over growth of algae in water bodies due to excessive fertilizers.
Specific heat capacity	Amount of heat that is needed to raise the temperature of a unit mass of a substance by 1°C.
Latent heat of fusion	Amount of heat energy required by ice to change into water.
Aeration	The process in which air under pressure is blown into filtered water.
Water pollution	Addition of unwanted waste materials to the water.
Domestic sewage	Wastewater that is disposed of from households.
Water conservation	Saving water for the use in future.

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TEXTBOOK EXERCISES

I. Choose the correct answer.

1. Water changes to ice at

a) 0^0C b) 100^0C

c) 102^0C d) 98^0C

2. Solubility of carbon dioxide in water is high when the

a) pressure is low

b) pressure is high

c) temperature is high

d) None of the above

3. The gas collected at the cathode on electrolysis of water is

a) oxygen b) hydrogen

c) nitrogen d) carbon dioxide

4. Which of the following is a water pollutant?

a) Lead b) Alum

c) Oxygen d) Chlorine

5. Permanent hardness of water is due to the presence of _________

a) sulphates and chlorides

b) dust particles

c) carbonates and bicarbonates

d) other soluble particles

II. Fill in the blanks.

1. Water is colourless, odourless and _________
2. The boiling point of water is _________
3. Temporary hardness of water can be removed by _________ of water.
4. The density of water is maximum at _________
5. Loading speeds up the process of _________

III. State true or false. If false, correct the statement.

1. Sewage should be treated well before being discharged it into water bodies.
2. Sea water is suitable for irrigation as it contains dissolved salts.
3. Excessive use of chemical fertilizers depletes the soil and causes water pollution.
4. The density of water will not change at all temperature?
5. Soap lathers well in hard water.

IV. Match the following.

Universal solvent	Water pollutant
Hard water	Kills germs
Boiling	Ozonisation
Sterilization	Water
Sewage	Stomach ailments

V. Give reasons for the following.

1. Alum is added to water in sedimentation tanks.
2. Water is a universal solvent.
3. Ice floats on water.
4. Aquatic animals can breathe in water.
5. Sea water is unfit for drinking.
6. Hard water is not good for washing utensils.

VI. Define the following.

1. Freezing point
2. Boiling point
3. Specific heat capacity
4. Latent heat of fusion
5. Potable water

VII. Answer in brief.

1. Name the gas evolved at cathode and anode when water is electrolysed. State their ratio by volume.
2. State the importance of dissolved oxygen and carbon dioxide in water.
3. What are the causes of temporary hardness and permanent hardness of water?
4. Explain specific latent heat of vaporization of water.
5. What are the methods of removing hardness of water?

VIII. Answer in detail.

1. How is water purified at a water purification plant?
2. What is permanent hardness of water? How can it be removed?
3. What is Electrolysis? Explain the electrolysis of water.
4. Explain the different ways by which water gets polluted.

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INTERNET RESOURCES

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2. http://www.un.org/cyberschoolbus/waterquiz/waterquiz4/index.asp
3. http://www.explainthatstuff.com/waterpollution.html

WATER IS PRECIOUS!
DO NOT WASTE IT, RECYCLE IT, TREAT IT,
SAVE EVERY DROP THAT YOU CAN!

Concept Map