UNIT

1

Introduction to Chemistry

Learning Outcomes

Children will be able to:

- *discuss the importance of Chemistry in daily life and its role in different industries and life processes;*
- *list important applications of Chemistry in day to day life;*
- *list some industrial applications of Chemistry;*
- *discuss the bio-sketches of some great scientists and their works;*
- *appreciate the patience, perseverance, sacrifices and ethical conduct of scientists.*

Chapter Outlines

- Introduction
- Definition of Chemistry
- Importance of Chemistry
- Scope of Chemistry
  - Supply of Food
  - Cosmetics
  - Clothing
  - Medicines
  - Industries
- Development of Chemistry
  - Alchemy
  - Alchemists
  - Protochemistry
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- Properties of Matter
  - Notable Chemists: Their Contribution to Chemistry
- Apparatus Used in Chemistry Laboratory
  - Test Tube
  - Beaker
  - Test-tube Holder
  - Test-tube Stand
  - Flasks
  - Iron Stand
  - Tripod Stand
  - Wire Gauze
  - Bunsen Burner
  - Thistle Funnel
  - Delivery Tube
  - Beehive Shelf
  - Funnel
  - Measuring Apparatuses
  - Gas Jar

INTRODUCTION

Since ancient times, people have been fascinated by the nature and surroundings. On the basis of knowledge gained by them, new ideas and concepts were established which led to the development of science.

The word '**Science**' is derived from Latin word *scientia* which means knowledge (Fig. 1).

Thus, science is the systematic knowledge concerned with the observations and experimentation which one explained logically by rules, patterns or principles.

The three main branches of Science are Physics, Chemistry and Biology.

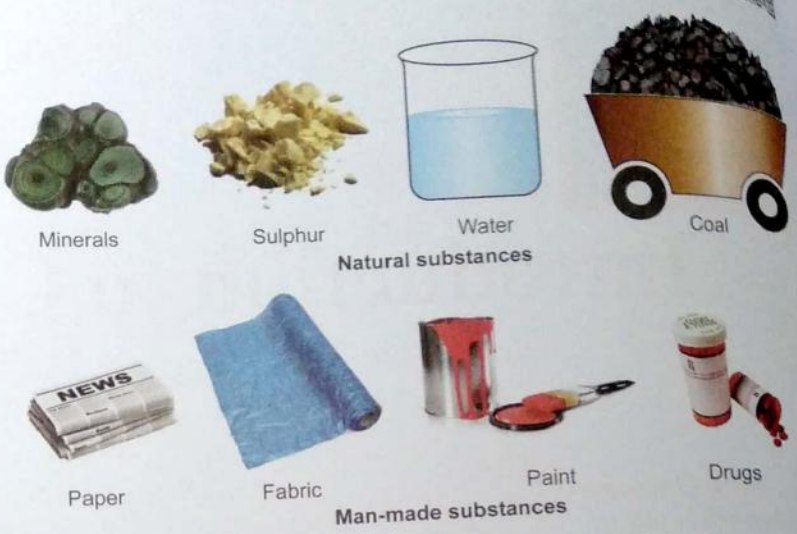


Fig. 1. Some natural and man-made substances

DEFINITION OF CHEMISTRY

- Chemistry is the branch of Science which deals with the composition, properties and interaction of matter with other substances.
- There are three main branches of Chemistry—
  1. Physical Chemistry: It deals with the relationship between physical properties of substances and their chemical composition and transformations.
  2. Inorganic Chemistry: It deals with the study of elements and compounds (*i.e.*, metals and non-metals)
  3. Organic Chemistry: It deals with the study of specific carbon compounds made up of mainly carbon and hydrogen.

IMPORTANCE OF CHEMISTRY

- Chemistry plays an important role in our daily life. It has helped us to meet all our daily requirements for a better and comfortable life (Fig. 2).
- All of us depend upon chemistry for food, health, medicines, textiles, transport, communication, recreation and several other activities.
- We use many chemical products in our daily life such as pencil, rubber, ink, shampoo, perfumes, toothpaste, deodorants, medicines, cosmetics, fuels etc.

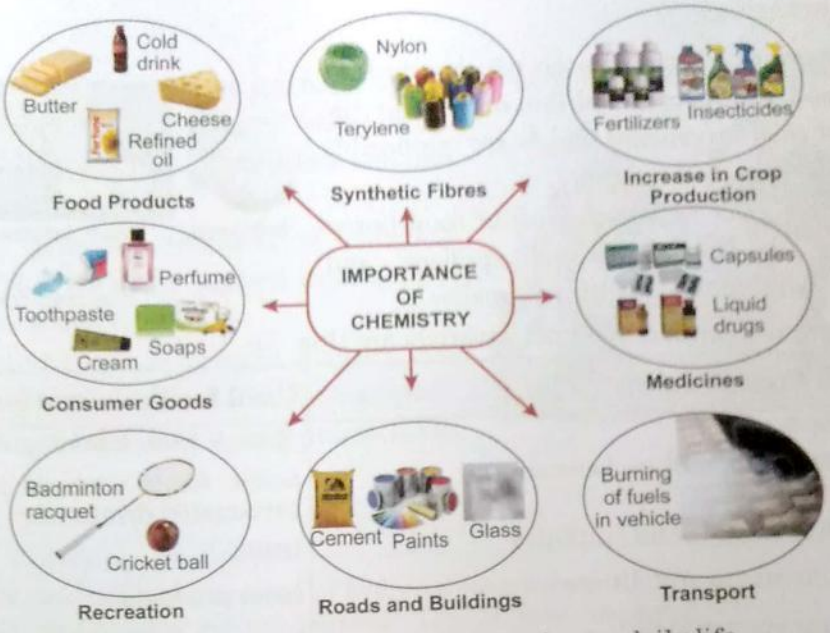


Fig. 2. Requirements of chemistry in our daily life

SCOPE OF CHEMISTRY

Chemistry plays a very significant role in every aspect of life. Some important applications of chemistry are summarised below:

A. SUPPLY OF FOOD

Chemistry is playing an active role in providing food to the fast increasing population of the world. Moreover with increase in life standards, there has been increase in the quality and variety of food. Chemistry has helped us to achieve these goals in the following ways:

1. Fertilizers

These are the chemicals which are added to the soil to improve the fertility of the soil and supply plant nutrients which are essential for growth of plants (Fig. 3). Their use has led to increase in the yield of crops and fruits.

Examples: Urea (non-explosive and solid), phosphatic fertilizer (super phosphates) and ammonium nitrate. Liquid fertilizers consist of aqueous solutions of ammonia or ammonium nitrate.

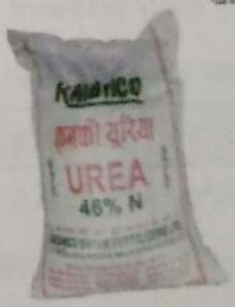


Fig. 3. Fertilizer (urea)

2. Pesticides

These are chemicals added to the soil to kill pests. They include:

- Insecticides: These chemicals are used to kill the insects which are responsible to destroy crops, *e.g.*, DDT, BHC etc.
- Fungicides: These chemicals are used to destroy the fungi (smut) which also destroy crops (Fig. 4).
- Herbicides: The chemicals used for killing weeds (unwanted plants) which grow along with the crops, *e.g.*, triazines.

Fig. 4. Spraying of insecticides, fungicides

3. Food Preservatives

- Food preservatives are chemicals which are added to the food products to inhibit or prevent the growth of microorganisms which are responsible for their spoilage and rancidity.
- Food preservatives reduce the risk of food borne infections, decrease microbial spoilage and preserve freshness and nutritional quality.
- Some common chemical food preservatives are (Fig. 5):

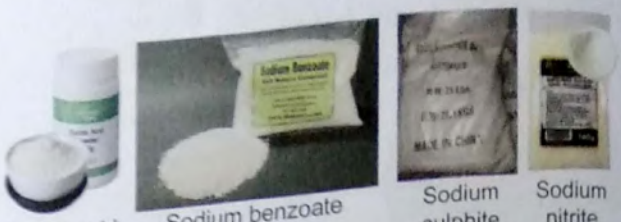


Fig. 5. Common food preservatives

S. No.	Food Preservatives	Used for Preservation of
1.	Sorbic acid	cheese, wine, baked goods
2.	Benzoic acid, sodium benzoate	acidic foods such as jams, juices, pickles, carbonated drinks etc.
3.	Sulphur dioxide and sulphites	fruits
4.	Sodium nitrite and nitrates	meat products
5.	Sulphur compounds	beverages, wines etc.

- Besides above food preservatives, traditional food preservatives, like sugar and salt are also used.

4. Food Processing

- Food processing is the process of changing raw food materials into more readily usable form.
- Food processing combines raw food ingredients to produce marketable food products that can be easily prepared and served by the consumer.

Advantages and Disadvantages of Food Processing

S. No.	Advantages	Disadvantages
1.	We get food materials out of season.	Processed foodstuffs often lose nutrients and weight.
2.	Storage period increases.	Milled and polished rice results in loss of iron and Vitamin B.
3.	It prevents spoilage of foodstuff.	The original taste changes to some extent.
4.	It enables the availability of food material at distant places.	

- Food processing methods that are used to preserve foods include (Fig. 6):
  - (i) Refrigeration and freezing
  - (ii) Canning
  - (iii) Dehydration
  - (iv) Freeze-drying
  - (v) Pickling
  - (vi) Pasteurization
  - (vii) Fermentation

Fig. 6. Food processing techniques

B. COSMETICS

- Cosmetics are the substances or products which are used to enhance or change the appearance or fragrance of the body. Many of the cosmetics are used for applying to the face and hair (Fig. 7).
- Cosmetics are generally mixtures of chemical compounds which are either derived from natural sources or from synthetic sources.
- Common cosmetics include lipsticks, mascara, eye-shadow, skin-cleansers, skin lotions, shampoos, perfume, talcum powder, hair styling products etc.

Fig. 7. Cosmetics

Do You Know?

Talc or talcum is a clay mineral composed of hydrated magnesium silicate (contains elements magnesium, silicon, oxygen). Talc is used in many industries including paper making, plastic, paint and coatings, rubber, food, electric cable, pharmaceuticals, cosmetics and ceramics (Fig. 8). As a powder it absorbs moisture and helps to cut down on friction, making it useful for keeping skin dry and helping to prevent rashes.

Fig. 8. Talcum powder

Ingredients in Cosmetics

S. No.	Chemical Ingredients	Function
1.	Water	Acts as solvent to dissolve other water soluble ingredients.
2.	Titanium dioxide	Natural pigment which provides white colouration to coloured ingredients and is mild sun protector.
3.	Oxides of zinc and iron	Provide variation in colour zinc oxide gives anti inflammatory properties to the cosmetics.
4.	Emulsifiers	Provide texture to creams and lotions.
5.	Preservatives	Improve shell life and inhibit the growth of microorganisms.

C. CLOTHING

In addition to natural fibres like cotton, wood, jute, silk, etc., chemistry has also helped in the production of synthetic fibres such as nylon, terylene, polyester etc.

1. Terylene

It is a synthetic polyester fibre or fabric formed by addition polyester to natural fibre like cotton (Fig. 9).

Fig. 9. Synthetic clothes like terylene, nylon

It is elastic in nature, easy to clean, and crease resistant. It is used in garment fabrics, nonwoven carpets, rain coats, ropes, nets etc.

2. Other Synthetic Fabrics

- Rayon is a regenerated cellulose fibre which is used in carpets (blended with wool) and bed sheets (blended with cotton).
- Nylon is an artificial synthetic fibre and is used in fabrics, ropes, hooks, brushes etc.
- These synthetic fibres are more durable, attractive, comfortable and cheap than that of cotton fibres.

Do You Know?

In ancient times, people used the bark, big leaves of trees or animal skins and furs to cover themselves but about 40000 years ago, with the invention of sewing needle, people started stiching fabrics to make clothes. The materials used for clothing is called fabric which are made up of yarns. The strands of yarns are made up of still thinner strands called fibres. Natural fibres are obtained from plants and animals, *e.g.*, cotton, jute, wool etc. But synthetic fibres are obtained from man-made chemicals, *e.g.*, nylon, polyester, terylene etc. The fibres are converted into yarn by spinning and then into fabrics by weaving or knitting.

D. MEDICINES

Chemistry has contributed towards better health by the discovery of various drugs to combat various diseases (Fig. 10). Medicines are natural or synthetic substances which treat or prevent diseases.

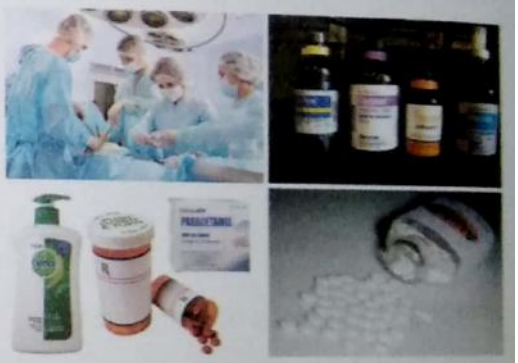


Fig. 10. Use of chemicals in medicines

Analgesics

Analgesics are used to reduce pain of different kinds, *e.g.*, aspirin.

Aspirin: 1. It is used to cure pain, fever and inflammation.
2. It lowers the risk of heart attack by preventing the formation of blood clots.
3. Its side effect may include—stomach ulcers, upset stomach, etc.

Antipyretics

Antipyretics are used to lower body temperature in high fever, *e.g.*, paracetamol.

Paracetamol: 1. It is used to cure mild to moderate pain and fever.
2. Its high dose may cause liver problems.
3. It may also be used in low back pain, headache and for dental use.

Antiseptics

Antiseptics are the chemicals used for stopping bacterial infection of wounds, *e.g.*, dettol, tincture iodine etc.

Anaesthetics

Anaesthetics are chemical compounds which are used for inducing unconsciousness for performing painless surgical operations.

Antacids

They are used to reduce the excessive acid in stomach *e.g.*, sodium bicarbonate, magnesium hydroxide etc.

Antibiotics

These chemicals are used to fight bacterial infections. *e.g.*, Penicillin.

E. INDUSTRIES

- Chemistry has played an important role towards the development of many industries. A large number of industries such as manufacture of cleansing agents (soaps and detergents), cement, glass, plastics, paints, stain removers, varnishes, fertilizers etc., are based on chemical processes (Fig. 11).
- Chemistry has led to the production of new materials like micro alloys, carbon fibres, optical fibres etc.

Fig. 11. Chemical industry

1. Cleansing Agents

Soaps: Soaps are chemical substances which are made by heating vegetable oils or animal fats with sodium or potassium hydroxide.

- They are used with water for cleaning and washing.

Detergents: Detergents are water soluble synthetic cleansing agents which are prepared from petroleum products.

- They are used for removing dirt and grease from porous surfaces (such as clothes, fabrics) and non-porous surfaces (such as metals, plastics etc).

Do You Know?

- Soaps are made from animal or plant fats but detergents are made from petrochemicals.
- Soaps have lesser cleaning action than detergents (Fig. 12).
- Soaps are not able to form lather with hard water and are not able to clean the cloth in hard water but detergents form lather with hard water and clean the clothes in them.
- Soaps are less biodegradable but detergents are more biodegradable.

Fig. 12. Soap and detergent

Stain Removals

- It is the process of removing a mark or spot left by one substance on a specific surface like a fabric with the help of a solvent (Fig. 13). Examples:

S. No.	Substance	Stain
1.	Lemon juice	contains citric acid and is used for removing stains from fabrics.
2.	Hydrogen peroxide	a mild bleaching agent and is also effective in removing stains.
3.	Glycerine	softens stains on wool.
4.	Sodium hydroxide	dissolves grease and oil and is preferred as a drain cleaner.
5.	Boiling water	softens fruit juice stains on a fabric.

Stain on fabrics

Stain remover

Fig. 13. Stain and stain remover

DEVELOPMENT OF CHEMISTRY

ALCHEMY

- Alchemy is the ancient art of trying to achieve wisdom and immortality through the manipulation of elements.
- The origin of Alchemy is believed to begin in Greece or Egypt (Fig. 14).
- Alchemy combined science, magic, philosophy and religion but today it is considered as pseudo science.

Fig. 14. Alchemy

ALCHEMISTS

- Alchemists were people who were predecessors of modern chemists.
- The main goal of Alchemists was the transmutation of ordinary metals into gold using philosopher's stone (an illusionary substance).
- Alchemists believed that when philospher's stone would be heated with iron and copper, it would convert into gold. This substance could give people a long and healthy life or let them live forever.
- Alchemists would not succeed in finding any such substance but they succeeded in developing some techniques that led to the development of chemistry (Fig. 15).
- Some of the techniques developed by Alchemists are as follows:
  1. They extracted metals from their ores like zinc and phosphorus.
  2. Mixing different metals to form alloys like making bronze from tin and copper.
  3. Making artificial pearls, glass and glass beads.
  4. Making dyes used in textiles and painting.

Fig. 15. Alchemist

PROTOCHEMISTRY

- Alchemy is considered as pre-chemistry or proto-chemistry (Fig. 16).
- Through alchemy we have got herbal remedies, alloys and most importantly a desire to manipulate the world around us.

Fig. 16. Protochemistry

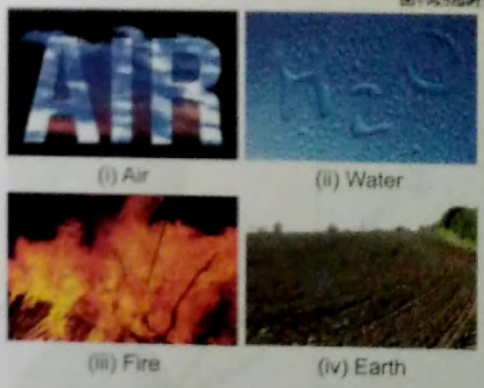
ARISTOTLE

- Aristotle believed that everything was made of a combination of four elements (Fig. 17).
- If you could figure out the exact ratio of each element in an object, you could recreate it.

Fig. 17. Aristotle

PROPERTIES OF MATTER

- In ancient times, Greeks believed in four basic elements (Fig. 18 i-iv).
- These basic elements were:
  (i) Air
  (ii) Water
  (iii) Fire
  (iv) Earth
- Besides above basic elements, an invisible substance making up the space called 'Aether' was also present.
- Aether provided the medium for light to travel.



(i) Air (ii) Water (iii) Fire (iv) Earth

Fig. 18 i-iv. Four basic elements

NOTABLE CHEMISTS: THEIR CONTRIBUTION TO CHEMISTRY

S. No.	Chemists	Year	Contribution to Chemistry
1.	Joseph Priestley (1733–1804) 	1774	Discovered oxygen by heating mercury (II) oxide.

S. No.	Chemists	Year	Contribution to Chemistry
2.	Antoine Lavoisier (1743–1794) 	1777 1778 1783	First recognized the elementary nature of sulphur and water as a compound. Recognised and named oxygen. Recognised and named hydrogen. He is known as the Father of 'Modern Chemistry'.
3.	John Dalton (1766–1844) 	1808	Proposed the 'Atomic theory' which states that: • Matter is made up of tiny particles called atoms. • Atoms are indivisible. Atoms of same element are identical in all respects.
4.	Mendeleev (1834–1907) 	1869	• Arranged the elements in the increasing order of atomic weights in the periodic table. • Discovered periodic law
5.	Van Helmont (1579–1644) 	1630	Discovered carbon dioxide by heating charcoal in air in 1630.
6.	Glauber (1604–1668) 	1648	Prepared hydrogen chloride gas by the reaction of sodium chloride (salt) and concentrated sulphuric acid around 1648.

APPARATUS USED IN CHEMISTRY LABORATORY

1. TEST TUBE

- It is a cylindrical glass tube closed at one end.
- It is used for carrying out chemical tests (Fig. 19).

Fig. 19. Test tube

- A hard glass test tube made of pyrex is called a '**boiling tube**'. It is used for heating substances at high temperature (Fig. 20).

Fig. 20. Hard glass tube

2. BEAKER

- It is a glass container with flat bottom and a pouring tip.
- It is used for mixing pouring and heating solutions (Fig. 21).

Fig. 21. Beaker

3. TEST-TUBE HOLDER

- It is a metal strip with a wooden handle.
- It is used for holding a test tube because the wooden holder being a poor conductor of heat makes holding the holder easy (Fig. 22).

Fig. 22. Test-tube holder

4. TEST-TUBE STAND

- It is a wodden or plastic stand with holes at its upper part.
- It is used for keeping the test tubes straight through the holes during the experiment (Fig. 23).

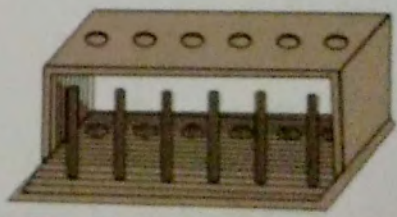


Fig. 23. Test-tube stand

5. FLASKS

Flasks are of various shapes used for varied purposes.

(a) Round Bottom Flask

- It is a flask with round shaped bottom.
- It is used for gas preparation as heat is uniformly distributed throughout on heating (Fig. 24).

Fig. 24. Round bottom flask

(b) Flat Bottom Clask

- It is a flask with flat bottom.
- It is used for gas preparation where heating is not required and uniform distribution of heat is not required (Fig. 25).

Fig. 25. Flat bottom flask

(c) Conical flask

- It features a flat bottom, a conical body and a cylindrical neck (Fig. 26).
- It is used for storage of various liquids and for mixing of different solutions.

Fig. 26. Conical flask

(d) Retort

- It is a round glass vessel with a long neck bent downwards.
- It is used for carrying out distillation of liquids (Fig. 27).

Fig. 27. Retort

6. IRON STAND

- It consists of an iron platform with an iron rod and one or two clamps.
- It is used for suspending and holding apparatus (Fig. 28).

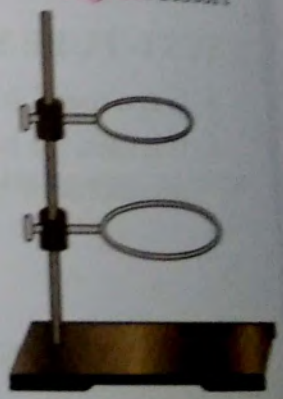


Fig. 28. Iron stand

7. TRIPOD STAND

- Tripod stand is made up of an equilateral iron triangle with three legs.
- It is used for keeping glass ware like beaker, flask etc., for heating (Fig. 29).

Fig. 29. Tripod stand

8. WIRE GAUZE

- Wire gauze is a rectangular wire mesh with an asbestos at its centre on which glass apparatus is kept for heating (Fig. 30).
- It prevents the glass apparatus from craking and ensures uniform distribution of heat.

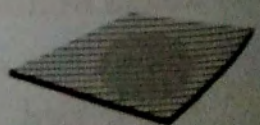


Fig. 30. Wire gauze

9. BUNSEN BURNER

- It consists of a burner tube, an air regulator and a base.
- It is used for heating purpose and LPG is used as a fuel in it (Fig. 31).

Fig. 31. Bunsen burner

10. THISTLE FUNNEL

- It consists of a long glass tube with a broad inlet at the top. Its lower end dips below the solution in order to prevent the escaping out of the gases.
- Its main function is to add the reactant into the flask (Fig. 32).

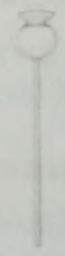


Fig. 32. Thistle funnel

11. DELIVERY TUBE

- It is a thin hollow glass tube of various shapes.
- It is used for connecting one apparatus to another and transfer of gases (Fig. 33).

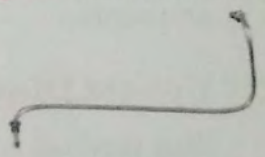


Fig. 33. Delivery tube

12. BEEHIVE SHELF

- Beehive shelf is provided with two outlets.
- It is used for collecting the gases by the downward displacement of water. Gas jar is kept over it to collect the gas (Fig. 34).

Fig. 34. Beehive shelf

13. FUNNEL

- It is a cone-shaped wide glass vessel drawn into a narrow neck.
- It is used in filtration and for transferring liquids to containers (Fig. 35).

Fig. 35. Funnel

14. MEASURING APPARATUSES

- They have fixed volumes for measurement.

(a) Pipette

It measures liquid by sucking the liquid from the top up to the marked level and closing the open end with the thumb (Fig. 36).

(b) Burette

It measures liquid by pouring the liquid from the top of the apparatus up to marked level. The liquid is drawn out by opening the tap below.

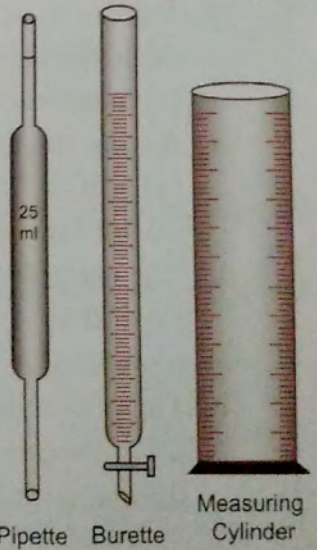


Fig. 36. Measuring apparatuses

(c) Measuring Cylinder

It is a graduated glass cylinder of different capacities and is used for measuring the volume of liquids.

15. GAS JAR

- Gas jar is a cylindrical vessel made of hard glass and has a lid.
- It is used for collecting gases by different methods (Fig. 37).

(a) Downward Displacement of Water

The gas is collected over water by displacing water it is used for gases which are insoluble or slightly soluble in water *e.g.*, nitrogen, oxygen etc.

(b) Downward Displacement of Air

This method is used for collecting water soluble gases and those which are lighter than air *e.g.*, ammonia.

(c) Upward Displacement of Air

This method is used for collecting those gases which are heavier than air and are soluble in water. *e.g.*, hydrogen chloride, sulphur dioxide etc.

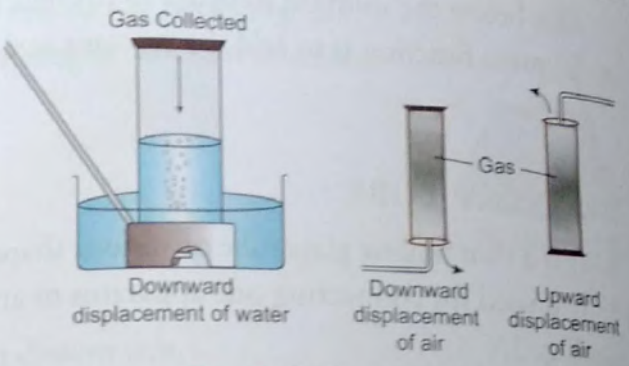


Fig. 37. Collection of gas

CHECK YOUR PROGRESS!

Tick (✓) the correct option:

1. Fertilizers are added to the soil to:
   (a) increase the fertility (b) kill the fungi
   (c) decrease the fertility (d) both (a) and (b)
2. An example of fertilizer is:
   (a) urea (b) DDT
   (c) benzoic acid (d) sodium nitrite
3. Triazine is an example of:
   (a) herbicide (b) insecticide
   (c) fungicide (d) food preservative
4. Among the following, the food preservative is:
   (a) BHC (b) sulphur dioxide
   (c) calcium super phosphate (d) DDT
5. The example of a synthetic fibre is:
   (a) cotton (b) wool
   (c) silk (d) nylon
6. The pain relieving drug is known as:
   (a) antiseptic (b) antipyretic
   (c) analgesic (d) anaesthetic

7. Priestley discovered:
   (a) oxygen (b) nitrogen
   (c) hydrogen (d) carbon dioxide
8. A pesticide which kills or inhibits the growth of unwanted plants is known as:
   (a) herbicide (b) insecticide
   (c) termicide (d) fungicide
9. A non-explosive solid fertilizer which is an important source of nitrogen is:
   (a) ammonium nitrate (b) urea
   (c) phosphatic fertilizer (d) potassium nitrate
10. A water soluble cleaning agent which forms lather even with hard water is:
   (a) soap (b) detergent
   (c) stain remover (d) cleanser
11. A glass apparatus which measures liquid by sucking the liquid at one end upto the marked level and then pouring it out is:
   (a) burette (b) measuring cylinder
   (c) funnel (d) pipette
12. A long glass apparatus closed at one end used for collecting gases is:
   (a) gas jar (b) beehive shelf
   (c) measuring cylinder (d) refort

IMPORTANT POINTS TO REMEMBER

- Chemistry is the branch of science which deals with the composition, properties and interaction of matter with other substances.
- Major contribution of chemistry are in the fields of medicine, agriculture, textiles and industries.
- Fertilizers are chemicals which improve the fertility of soil on their addition to the soil, *e.g.*, urea.
- Insecticides, fungicides and herbicides kill the insects, fungi and weeds respectively.
- Food preservatives are added to the food products to prevent them from being spoiled by microorganisms. Some common food preservatives are benzoic acid, sorbic acid, sugar etc.
- Food processing methods such as dehydration, refrigeration, canning, pasteurization, pickling etc., are used to preserve cooked food products and changes into more usable form.
- Cosmetics are the substances which are able to increase and change the appearance of the body especially face and hair. Some common cosmetic products are lipsticks, talcum powder, shampoos etc.
- The natural fibres include cotton, wool, jute etc., but terylene, nylon etc., are examples of synthetic fibres.
- Analgesics are pain reliever drugs but antipyretics reduce the body temperature.
- Soaps and detergents are cleansing agents but detergents work better in hard water.
- Alchemists attempted to convert cheap metal into gold using philosopher stone.
- Some great chemists such as Mendeleev, Lavoisier, Dalton etc., contributed to chemistry through their great discoveries and inventions.
- Lavoisier recognised and named oxygen and later hydrogen in 1783. John Dalton gave his atomic theory and Mendeleev arranged the various elements in a periodic manner.
- Some important apparatuses used in chemistry laboratory are test tubes, beaker, flasks test tube holder, tripod stand, wire gauze, bunsen burner, gas jar, funnel and measuring apparatus.

WORKSHEET

TYPE I: OBJECTIVE TYPE QUESTIONS

A. Write 'True or 'False' for the following statements.

1. Insecticides are sprayed to the plants to kill weeds.
2. Fungicides are the chemicals used to destroy the insects.
3. Food preservatives are added to the food products to protect them from sunlight.
4. Dehydration is one of the methods of food processing.
5. Talcum powder is composed of hydrated magnesium silicate.
6. Anaesthetics are the drugs given to the patients suffering from fever.
7. Soaps are able to form lather with hard water.
8. Priestley discovered oxygen gas.
9. The material used for clothing is called natural fibre.
10. Silk is an example of natural fibre.
11. The philosopher's stone was a stone with magical powers.
12. Alchemy today is taken as pseudo science.
13. Glauber first prepared hydrogen chloride gas by the reaction of common salt with concentrated sulphuric acid.
14. Downward displacement of air is used for collecting water insoluble gases.
15. Wire gauze ensures uniform distribution of heat during heating of a substance.

B. Choose a word from the box to complete each sentence.

antipyretic	weeds	fertilizers	gold
antacid	sugar	benzoic acid	sorbic acid
salt	terylene	talc	atomic theory
indivisible	synthetic	titanium dioxide	

1. Herbicides are used to kill the ..... which destroy the crops.
2. ..... are the chemicals used to increase the fertility of soil.
3. Alchemists attempted to convert cheap metals to ..... using philosopher stone.
4. ..... and ..... are traditional food preservatives.
5. ..... is an example of synthetic fibre.
6. Dalton proposed the ..... according to which atoms are ..... .
7. ..... is used as preservative for pickles and jams.
8. Nylon and polyester are ..... fibres.
9. ..... are used to reduce body temperature.
10. ..... is helpful in reducing the excessive acid in stomach.
11. ..... is a natural pigment powder in cosmetics which provides mild sun protection.
12. ..... in talcum powder absorbs moisture, keeps skin dry and prevents rashes.

C. Choose the correct option.

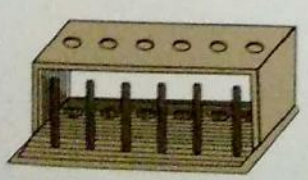
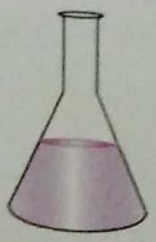
1. Herbicides are the chemicals which kill:
   (a) insects (b) smut (c) weeds (d) bacteria
2. Sulphur dioxide is a chemical food preservative which is generally used to preserve:
   (a) baked foods (b) fruits (c) meats (d) jams
3. Sodium benzoate is used to preserve the:
   (a) basic foods (b) acidic foods (c) meats (d) baked goods
4. Antiseptics are used to:
   (a) lower body temperature (b) reduce pain
   (c) stop bacterial infection (d) cause unconsciousness

5. The atomic model was given by:
(a) Mendeleev (b) Rutherford (c) Dalton (d) Lavoisier
6. Alchemists attempted to convert cheap metals to:
(a) silver (b) copper (c) gold (d) iron
7. The father of modern chemistry is:
(a) Lavoisier (b) Priestley (c) Dalton (d) Mendeleev
8. Who created the periodic table of elements?
(a) Mendeleev (b) Priestley (c) Dalton (d) Glauber
9. Apparatus used for measuring large volume of liquid is:
(a) burette (b) pipette (c) graduated cylinder (d) beaker
10. Which of the following is used as a stain remover?
(a) Benzoic acid (b) Sulphur dioxide (c) Hydrogen peroxide (d) Urea
11. A medicine useful in reducing a heart attack is:
(a) Paracetamol (b) sodium bicarbonate (c) aspirin (d) penicillin
12. A substance which dissolves grease and oil and is preferred as a drain cleaner is:
(a) sodium hydroxide (b) glycerine (c) lemon juice (d) hydrogen peroxide
13. Soaps are made from:
(a) petrochemicals (b) plant fats (c) animal or plant fats (d) animal fats
14. A medicine which on taking a high dose may affect the liver is:
(a) antacid (b) aspirin (c) paracetamol (d) antibacterial
15. A harmful effect of aspirin may include:
(a) headache (b) fever (c) heart attack (d) stomach ulcers

D. Match the Statements in Column I with those in Column II.

S. No.	Column I		Column II
1.	Insecticide	(a)	Aspirin
2.	Antipyretic	(b)	Triazines
3.	Herbicide	(c)	Paracetamol
4.	Food preservative	(d)	Classification of elements
5.	Natural fibre	(e)	Discoverer of oxygen
6.	Food processing	(f)	Talcum powder
7.	Analgesic	(g)	Sorbic acid
8.	Mendeleev	(h)	Cotton
9.	Cosmetics	(i)	Pasteurization
10.	Priestley	(j)	Terylene
11.	Synthetic fibre	(k)	DDT
12.	Cleansing agent used in hard water	(l)	Rayon
13.	A stain remover which is also a mild bleaching agent	(m)	Detergent
14.	A synthetic fabric used in bedsheets when blended with cotton	(n)	Hydrogen peroxide

E. Match the Apparatus A to J shown below with their Names 1 to 10 given below:

A  B  C  D  E 

F

G

H

I

J

1. Pipette
2. Thistle funnel
3. Retort
4. Funnel
5. Test-tube stand
6. Burette
7. Beaker
8. Conical flask
9. Flat bottom flask
10. Wire gauze.

TYPE II: SUBJECTIVE TYPE QUESTIONS

1. What is chemistry? Mention any four major fields of contribution of chemistry to mankind.
2. Explain the following terms with an example:
   (i) Fertilizers (ii) Insecticides
   (iii) Food preservatives (iv) Antipyretics
   (v) Stain removers
3. Differentiate between:
   (i) Insecticide and herbicide
   (ii) Food processing and food preservatives
   (iii) Analgesics and antipyretics
   (iv) Natural and synthetic fibres
4. Name any three eminent chemists and their contribution to the development of chemistry.
5. What do you mean by cosmetics? Write the constituents of talcum powder. Mention its one use.
6. Mention any two advantages and two disadvantages of food processing.
7. How are soaps different from detergents? Explain with the help of their properties. Give a reason why detergents are superior to soaps?
8. Give reasons for the followings:
   (i) Ordinary soap is not useful in hard water.
   (ii) Titanium dioxide is used as important ingredient in cosmetics.
   (iii) Food preservatives are added to food or beverages.
   (iv) Polyester is added to cotton to give terylene.
   (v) Nitrogen is collected by downward displacement of water.
   (vi) Water is one of the basic ingredients of most of the cosmetics.
9. State main function of the following glass apparatus:
   (i) Beaker (ii) Round bottom flask (iii) Test-tube
   (iv) Funnel (v) Thistle funnel (vi) Pipette
10. State the method used for collecting the following gases:
    (i) Ammonia (ii) Oxygen (iii) Nitrogen
    (iv) Sulphur dioxide (v) Hydrogen chloride.

UNIT 2

Elements, Compounds and Mixtures

Learning Outcomes

Children will be able to:

- *define elements as made up of identical atoms;*
- *classify elements as metals and non-metals on the basis of their properties;*
- *define compound and mixture and discuss the points of difference between the two;*
- *use symbols of elements and molecular formulae of the compounds to represent their names as short hand notations;*
- *separate different components of samples of some mixtures;*
- *discuss the reasons for opting for a particular technique for separation of components of the mixture.*

Chapter Outlines

INTRODUCTION

We find various objects like clothes, utensils, food items, books, water, gases etc. around us. They are all examples of matter because all of them occupy space and have mass. Our body is also made up of matter.

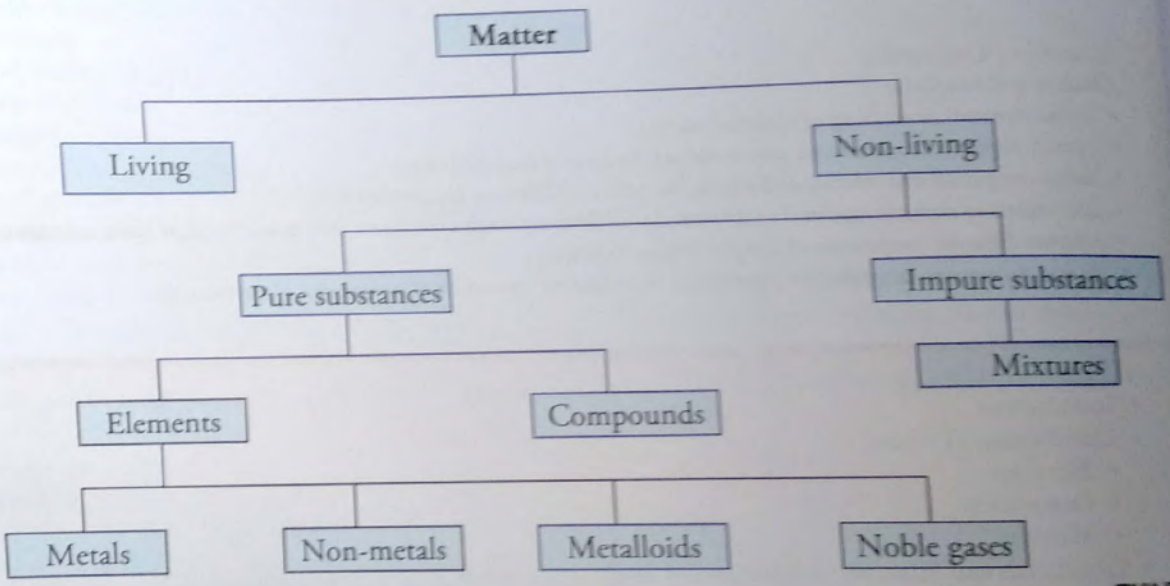
Do You Know?

Heat, light, sound and radio waves are not matter because they do not have any mass and do not occupy space.

CLASSIFICATION OF MATTER

Matter can be classified in two ways. On the basis of physical state, they are classified as solids, liquids and gases. On the basis of chemical constitution, matter can be classified as elements, compounds and mixtures.

Elements and compounds are considered as pure substances but mixtures are considered as impure substances.

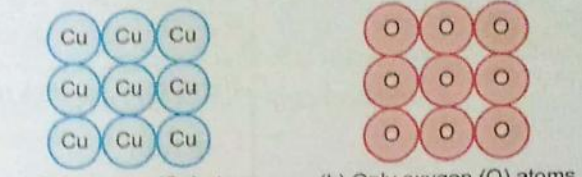


ELEMENTS

- An element is a pure substance which is made up of one kind of atoms only.
- An element cannot be broken into two or more simpler substances by any physical or chemical methods.
- Examples: Iron powder, sulphur powder, zinc granules, copper, oxygen etc. (Fig. 1)
- All of them are elements because although they are different from one another in their physical appearance but all of them are made up of identical atoms.

Fig. 1. Samples of iron powder, sulphur powder and zinc granules

- There are 118 elements known at present and out of these, 94 elements occur naturally on the earth whereas the remaining 24 elements have been prepared artificially by the scientists (Fig. 2a-b).



(a) Only copper (Cu) atoms (b) Only oxygen (O) atoms

Fig. 2 a-b. Atoms of elements

Basic Unit of an Element: Atom

Atom

It is the smallest particle of an element which may or may not exist on its own. An atom is further divisible into (Fig. 3):

A. Nucleus: The centre of an atom contains
Protons: Positively charged particles and
Neutrons: Particles carrying no charge.

B. Orbits: Surround the nucleus in which negatively charged particles *i.e.*, electrons revolve.

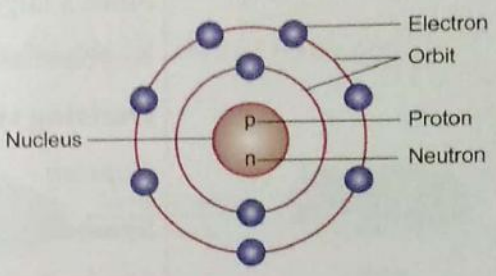


Fig. 3. An atom

Symbols of Elements

- An atom of an element is denoted by a symbol.
- A symbol is the short form of 'abbreviated name' of the element.
- A symbol distinguishes one element from another element.
- A symbol is the characteristic feature of that element.

Do You Know?

- Oxygen is the most abundant element (46.5% by weight) in the earth's crust followed by silicon (28.0%) and aluminium (8.1%).
- Iron is present in haemoglobin (a pigment in blood).
- Magnesium is present in chlorophyll (in plants).

Representation of a Symbol


Fig. 4. John Dalton

John Dalton (1807) suggested figurative symbols for the atoms of elements (Fig. 4).


Hydrogen Nitrogen Oxygen Phosphorus Sulphur

This method was discarded because it was tedious and non-practical.

Berzelius (1814) suggested the representation of elements with symbols (Fig. 5).


Fig. 5. Berzelius

First letter of the name of element

Hydrogen	Carbon	Sulphur
Symbol: H	**Symbol:** C	**Symbol:** S

Method not approved completely—

Since two elements can have the same first lettter-*e.g.*,

Carbon Calcium

Representation of elements by—

First two letters of the name of element

Calcium — **Symbol:** Ca

Aluminium — **Symobl:** Al

Cobalt — **Symbol:** Co

Method approved—

Since a large number of symbols could be written in this manner.

Representation of elements by—

Deriving symbols from their Latin names

Cuprum — **Symbol:** Cu

Natrum — **Symbol:** Na

Plumbum — **Symbol:** Pb

Cu = Copper
Na = Sodium
Pb = Lead

Method approved—

Since symbols derived from Latin names are widely used.

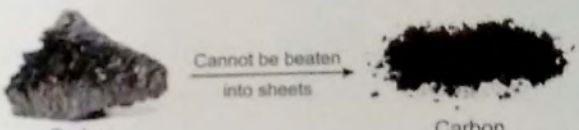
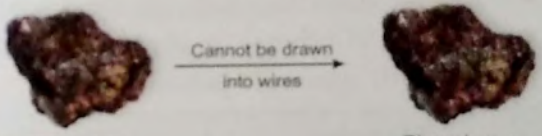
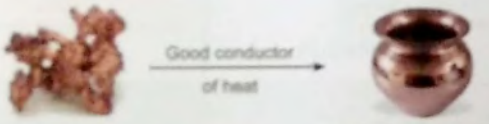
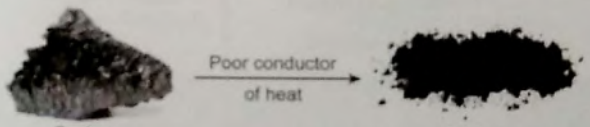
Table 1: Symbols of Some Metallic Elements with their Latin Name

S. No.	Metals	Atomic Number	Latin name
1.	Potassium	K	*Kalium*
2.	Sodium	Na	*Natrium*
3.	Calcium	Ca	*Calx*
4.	Magnesium	Mg	*Magnesia*
5.	Aluminium	Al	*Alumen*
6.	Zinc	Zn	*Zinken*
7.	Iron	Fe	*Ferrum*
8.	Lead	Pb	*Plumbum*
9.	Copper	Cu	*Cuprum*
10.	Mercury	Hg	*Hydragyrum*
11.	Silver	Ag	*Argentum*
12.	Platinum	Pt	—
13.	Gold	Au	*Aurum*

Classification of Elements

Elements are classified into:

- Metals
- Non-metals
- Metalloids
- Noble gases

Metals	Non-metals
Have lustre or shine (exception-sodium)  Gold shines	**Do not have lustre** *i.e.*, non-lusturous. (Exception-Iodine)  Sulphur does not shine
Are malleable *i.e.*, can be beaten into sheets.  Aluminium Aluminium sheet	**Are non-malleable** *i.e.*, cannot be beaten into sheets.  Carbon Carbon
Are ductile *i.e.*, can be drawn into wires.  Copper Copper wire	**Are non-ductile** *i.e.*, cannot be drawn into wires.  Phosphorus Phosphorus
Are good conductors of heat and electricity.  Copper Copper utensil	**Are non-conductors** of heat and electricity. (Exception-Graphite)  Carbon Carbon

- **Metalloids:** Elements which show properties of both metals and non-metals, *e.g.*, boron.
- **Noble gases:** Unreactive, inert elements present in traces in air, *e.g.*, helium, neon, argon.

Periodic Table

Till date 118 elements have been discovered so far. A systematic and simple arrangement of these elements was needed at the time of their discovery. This arrangement of elements was done in the form of a table called 'periodic table'.

- The elements in the periodic table are arranged in their atomic numbers.
- Atomic number of an element is the number of protons or electrons (as both are equal) in an atom of an element.

For example: Hydrogen atom has one electron, so that its atomic number is one and it has placed first in the periodic table.

- Elements in the periodic table are arranged in horizontal rows called 'periods' and vertical columns called groups (Fig. 6).

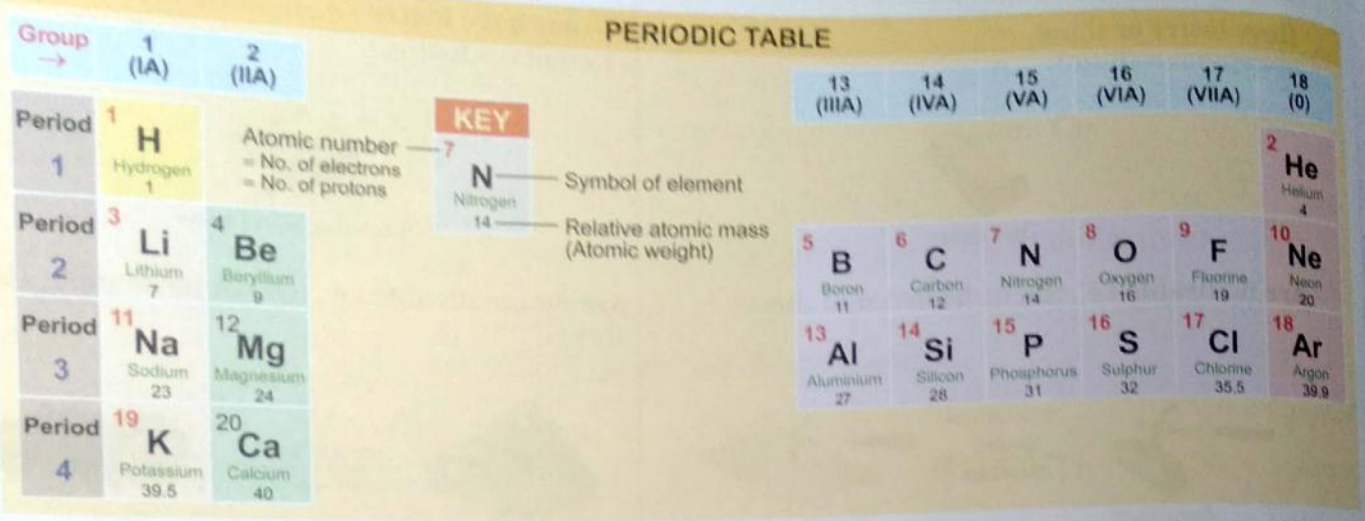


Fig. 6. The periodic table-showing elements of the first four periods-atomic number 1 to 20.

- All the elements in the same group have similar chemical properties.
- **All non-metallic elements** are placed on the-right of the periodic table. *e.g.*, N, O, F.
- **All metallic elements** are placed on the-left of the periodic table. *e.g.*, Li, Na, Mg.
- **All noble gases** are placed at the-extreme right of the periodic table. *e.g.*, He, Ne, Ar

Metals	Metalloids	Non-metals	Noble Gases
Lithium	Boron	Carbon	Helium
Beryllium	Silicon	Nitrogen	Neon
Sodium		Oxygen	Argon
Magnesium		Fluorine	
Potassium		Phosphorus	
Calcium		Sulphur	
		Chlorine	

Table 2: Names, Symbols and Atomic Numbers of First Twenty Elements

Name	Symbol	Atomic Number
Hydrogen	H	1
Helium	He	2
Lithium	Li	3
Beryllium	Be	4
Boron	B	5
Carbon	C	6
Nitrogen	N	7
Oxygen	O	8
Fluorine	F	9
Neon	Ne	10
Sodium	Na	11

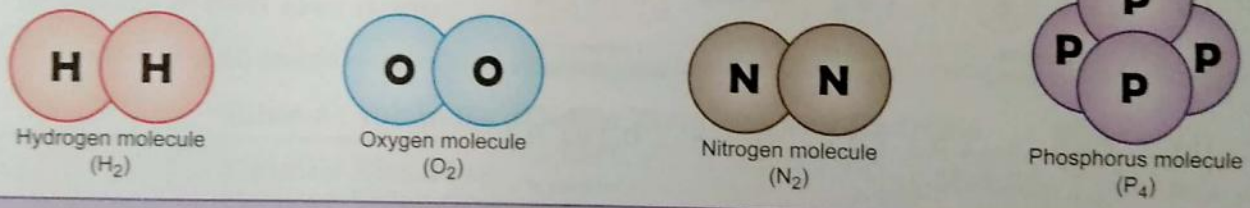
Name	Symbol	Atomic Number
Magnesium	Mg	12
Aluminium	Al	13
Silicon	Si	14
Phosphorus	P	15
Sulphur	S	16
Chlorine	Cl	17
Argon	Ar	18
Potassium	K	19
Calcium	Ca	20

Molecules

- Atoms of the same element or different elements combine to form a 'molecule'.
- Molecule is the smallest unit or particle of a substance which can exist independently and can have the physical and chemical properties of that substance.

Atoms of the Same Element Forming a Molecule

- Atomicity is the number of atoms present in one molecule of the element.
- **Diatomic molecules:** *e.g.*, Hydrogen (H_2), Nitrogen (N_2), Oxygen (O_2).
- **Polyatomic molecules:** *e.g.*, Ozone (O_3), Phosphorus (P_4).



Hydrogen molecule (H_2) | Oxygen molecule (O_2) | Nitrogen molecule (N_2) | Phosphorus molecule (P_4)

CHECK YOUR PROGRESS!

Tick (✓) the correct option:

1. The impure substance among the following is:
   (a) element (b) compound (c) mixture (d) none of these
2. The number of elements known at present is:
   (a) 102 (b) 109 (c) 118 (d) 124
3. The most abundant element by weight in earth's crust is:
   (a) aluminium (b) oxygen (c) silicon (d) nitrogen
4. The elements having the properties of ductility and malleability are known as:
   (a) metalloids (b) non-metals (c) metals (d) noble gases
5. The symbol of sodium is:
   (a) K (b) S (c) Na (d) So
6. All the metallic elements in the periodic table are placed at the:
   (a) extreme right (b) left side (c) right side (d) extreme left
7. Nitrogen molecule is:
   (a) monoatomic (b) diatomic (c) polyatomic (d) none of these

8. The element present in haemoglobin is:
(a) magnesium (b) calcium (c) iron (d) potassium

9. Chlorophyll in plants contains:
(a) iron (b) magnesium (c) cobalt (d) oxygen

10. Which of the following is not a metal?
(a) Boron (b) Sodium (c) Potassium (d) Calcium

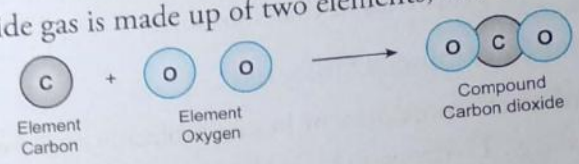
11. Latin name for iron is:
(a) *kalium* (b) *natrium* (c) *ferrum* (d) *cuprum*

12. The noble gases in the periodic table are placed at:
(a) the extreme left (b) the middle (c) the extreme right (d) left and right both

COMPOUNDS

A compound is a pure substance made up of two or more elements chemically combined in a fixed proportion.

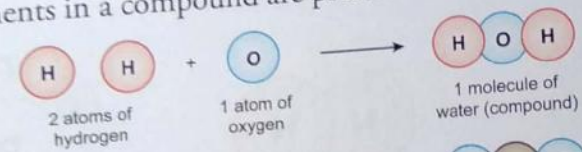
For example: Carbon dioxide gas is made up of two elements, *i.e.*, carbon and oxygen.



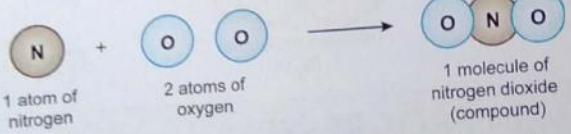
Characteristics of a Compound

- Elements in a compound are present in definite proportion. It is pure and homogeneous.

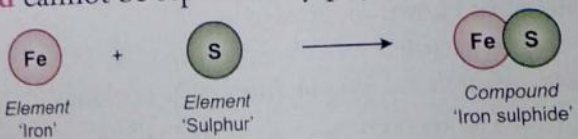
(a)



(b)



- Compounds have properties entirely different from the properties of elements from which they are made.
For example: Hydrogen and oxygen are gases but water is a liquid.
- **Elements in a compound** cannot be separated by physical methods (Table 3).



Iron cannot be separated from its compound iron sulphide using a magnet.

Table 3: Comparison between Elements and Compounds

S. No.	Elements	Compounds
1.	Made up of one kind of atoms.	Made up of two or more kinds of atoms.
2.	Cannot be broken down into simpler substances by physical or chemical methods.	Can be broken down into simpler substances by chemical methods.
3.	Have their own set of properties.	Properties differ from those of their elements.

Chemical Formula

A symbolic representation of one molecule of an element or a compound representing the number of atoms of that element or various elements present in it is called formula of a compound.

For example:

- The formula of chlorine molecule is Cl_2. It represents that two atoms of chlorine combine to form a molecule of chlorine.
- The formula of carbon dioxide is CO_2. It represents that one atom of carbon and two atoms of oxygen combine to form a molecule of carbon dioxide.
- O_2 and $2O$ are not the same. O_2 represents one molecule of oxygen but $2O$ represents two atoms of oxygen.

Writing a Chemical Formula of a Compound

For writing a chemical formula, the symbols of elements and their combining capacity or valency should be known.

The combining capacity of an atom of an element is called its valency. It is a whole number (Table 4).

For example:

- The valency of hydrogen, sodium and potassium is 1.
- The valency of magnesium, zinc and oxygen is 2.
- The valency of inert gases is zero.

Note: The valency of all metals is considered positive and the valency of all non-metals is considered negative.

Table 4 : Valencies of Some Elements and Radicals

Metallic Elements (Positive Valencies)			Non-Metallic Elements (Negative Valencies)	
Valency 1	**Valency 2**	**Valency 3**	**Valency 1**	**Valency 2**
K [K^{1+}]	Ca [Ca^{2+}]	Al [Al^{3+}]	Cl [Cl^{1-}]	O [O^{2-}]; S [S^{2-}]
Na [Na^{1+}]	Zn [Zn^{2+}]			
			Radicals	Radicals
			NO_3 [NO_3^{1-}]	SO_4 [SO_4^{2-}]
			OH [OH^{1-}]	CO_3 [CO_3^{2-}]

To write a chemical formula, following steps are followed:

Step 1: Write the symbols of the constituent elements.

Step 2: Write the valency of each element below their symbols.

Step 3: If the valencies are divisible by any common factor, then divide them. When the valencies are not divisible then leave them as they are.

Step 4: Now interchange the valencies and write as subscripts next to the symbols.

Step		Step	
I	Na^{1+}	I	Zn^{2+} Cl^{1-}
II	Na^{1+}_1 ← Cl^{1-}_1	II	Zn^{2+}_1 ← Cl^{1-}_2
III	Na_1 Cl_1	III	Zn_1 Cl_2
	Formula = NaCl [ignore 1]		Formula = $ZnCl_2$

MIXTURES

A mixture is an impure substance which is made up of two or more elements or compounds or both mixed together mechanically in any proportion.

For example:

- When we mix sugar in water, we find that it becomes sweet in taste. Sugar syrup (sugar in water) is an example of a mixture.
- Sodium chloride is added to water, it forms salt solution which is an example of mixture.
- Air is also a mixture of several gases. Although the percentage of various gases in air is approximately known but they are not present in any fixed ratio at all places.

Types of Mixtures

Mixtures are of two types:

1. Homogeneous Mixtures

- Mixtures which have same composition and properties throughout the mixture, *e.g.*, salt and water, sugar and water, alcohol and water etc.
- They all form miscible mixtures.

2. Heterogeneous Mixtures

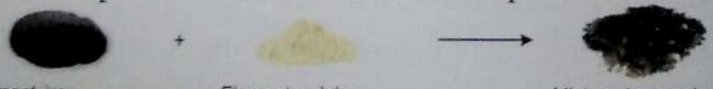
- Mixtures which have different composition and properties throughout the mixture *e.g.*, oil and water, chalk and water, sand and water etc.
- They all form immiscible mixtures.

Characteristics of a Mixture

- Components in a mixture are present in indefinite proportions. They do not combine chemically.

Element 'Sulphur' + *Element* 'Carbon' + *Compound* 'Potassium nitrate' → *Mixture* 'Gun powder'

- The constituents or components, *i.e.*, elements or compounds retain their properties.



Element–iron
Properties–in element
Iron reacts–with hydrochloric acid

+

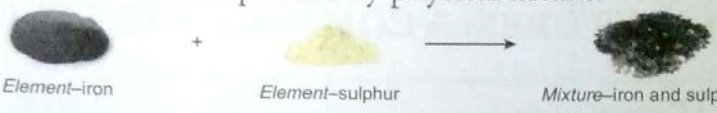
Element–sulphur
Properties–in element
Sulphur dissolves–in solvent acetone

→

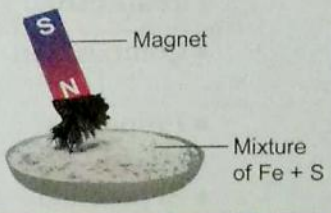
Mixture–iron and sulphur
Properties–in mixture
Iron reacts–with hydrochloric acid
Sulphur dissolves–in acetone

The two properties of each element are retained in mixture of iron and sulphur.

- Components in a mixture can be separated by physical means.



A mixture of the two elements iron and sulphur can be separated by using a magnet, *i.e.*, a physical method, since iron is attracted to the magnet.



Activity

To show the difference between a mixture and compound.

- Take some powdered mixture of iron filings and crystals of sulphur on a piece of paper.
- Observe the mixture under a magnifying glass. You will find yellow particles of sulphur lying separately from the greyish black particles of iron in the mixture.
- Bring a magnet over the powdered mixture on the paper. Iron filings are readily attracted towards the magnet leaving behind the sulphur on the paper (Fig. 7).

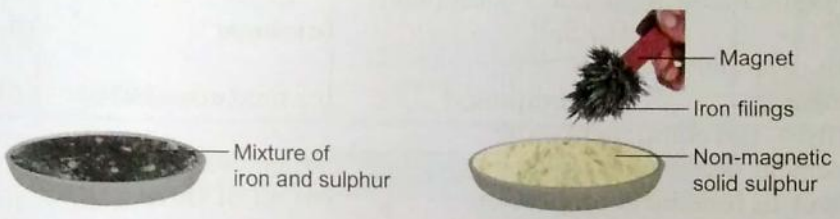


Fig. 7. Mixture of iron and sulphur and its separation

- Take some water in a beaker and transfer the mixture of powdered iron filings and sulphur into it and stir the contents.
- Allow it to stand for some time. Sulphur comes upward and floats on water. Iron filings sink and settle down at the bottom as shown in Fig. 8(A).
- Again take the powdered mixture of sulphur and iron filings in a hard glass test tube and heat it on a Bunsen's burner flame.
- The mixture becomes red hot and begins to glow because both combine chemically to form dark grey compound, *i.e.*, iron sulphide.
- Transfer the grey substance on a piece of paper and observe under a magnifying glass. No particles of them are seen separately.
- Furthermore iron does not attract towards the magnet [Fig. 8(B)].

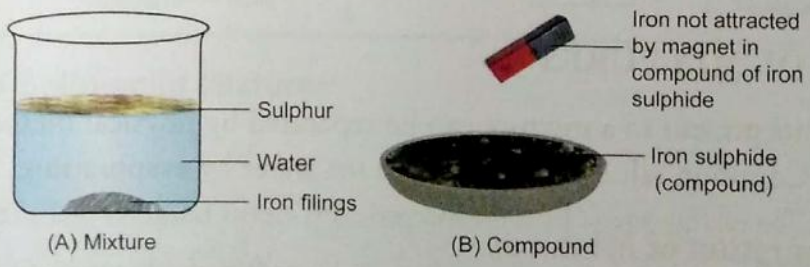


Fig. 8A-B. Mixture and Compound of Iron and Sulphur

- **Conclusion:** Above activity shows that powdered sulphur and iron filings is an example of mixture but upon heating, they form a new substance called iron sulphide. It has entirely different properties from its constituents. So that it is an example of a compound.

COMPOUNDS AND MIXTURES: A COMPARATIVE STUDY

Parameter	Compounds	Mixtures
• Composition	Components are present in a fixed proportion.	Components are present in variable proportions.
• Properties	Components do not retain their original properties.	Components retain their original properties.
• Separation	Components cannot be separated by physical methods.	Components can be separated by physical methods like magnetic separation, evaporation etc.
• Energy change	Energy is usually given out or absorbed in the preparation of compounds.	Energy is neither evolved or absorbed in the preparation of mixtures.

CHECK YOUR PROGRESS!

Tick (✓) the correct option:

13. Which of the following is not a compound?
(a) Ice (b) Salt (c) Sugar (d) Iron

14. Air is an example of:
(a) element (b) compound (c) mixture (d) none of these

15. In mixtures, the components are:
(a) present in definite proportion (b) chemically combined
(c) present in indefinite proportion (d) all of these

16. In compounds, the components:
(a) retain their original properties (b) do not retain their original properties
(c) can be separated by physical methods (d) are always elements

17. The solution of sugar in water is an example of:
(a) compound (b) element
(c) homogeneous mixture (d) heterogeneous mixture

18. The formula of a molecule of oxygen is:
(a) O (b) O_2 (c) O_3 (d) 2O

19. The valency of an element is:
(a) negative (b) positive (c) zero (d) positive or negative

20. The valency of an inert gas is:
(a) 0 (b) 1 (c) 2 (d) 3

SEPARATION OF MIXTURES

The constituents present in a mixture can be separated by physical methods.
For example: Common salt is separated from sea water by evaporation.

Reasons for Separation of Mixtures

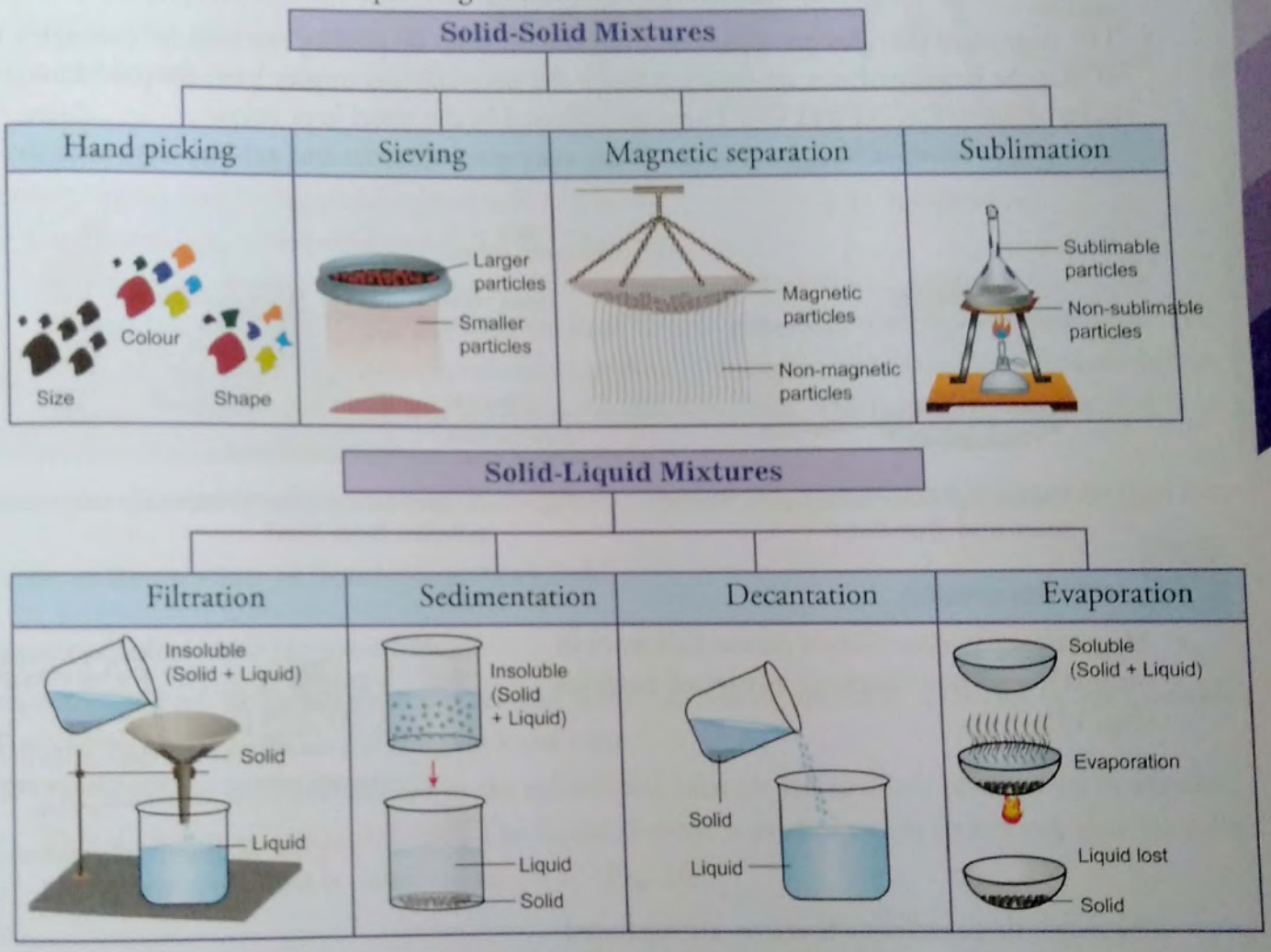
- **To remove unwanted substances from mixture.**
  Example:

Useful Component	Unwanted Component
• Rice	Small stones and husk
• Grain particles or pulses	Small stones

- **To obtain useful components.**
  Example: Petrol, diesel, kerosene, and LPG is obtained from crude petroleum.
- **To obtain pure substance from a mixture** of pure and impure substance.
  For example: Separating dissolved salts from tap water by distillation.

Methods of Separation

Common methods used for separating mixtures are discussed below:



Methods of Separation of Solid-solid Mixtures

1. Hand Picking

- This principle of separation is based upon the size, colour and shape of the solid particles.
- The undesirable component which differs from desirable components in shape, size or colour is hand picked and removed (Fig. 9).

Example: Hand picking of small stones from grain particles like pulses, rice etc.

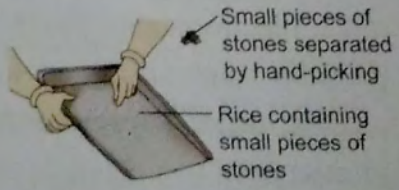


Fig. 9. Hand picking

2. Sieving

- The method of sieving is based on the difference in size of solid particles (Fig. 10).

Fig. 10. Sieving

- The large sized particles are separated from smaller ones by passing the mixture through a sieve so that the larger particles are retained above the sieve and the smaller particles pass through the holes of sieve (Figs. 11 and 12). These are collected in the vessel kept below.

Examples: Separation of bran from wheat flour, separation of stones and pebbles from sand etc.

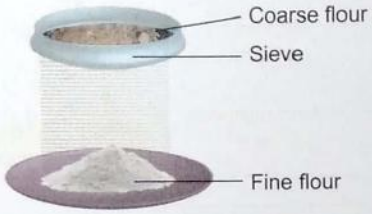


Fig. 11. Sieving of flour to separate 'wheat bran' and 'fine flour'

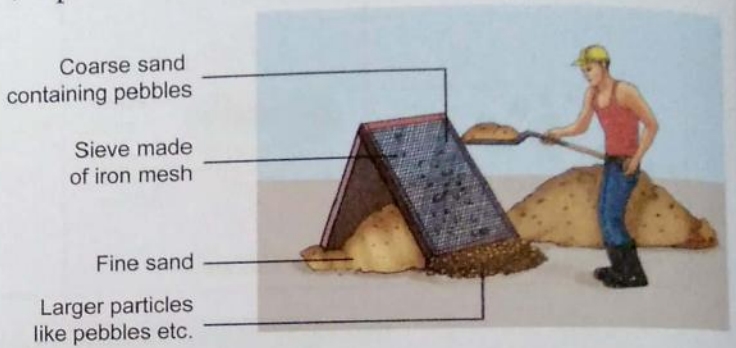


Fig. 12. A sieve being used to separate stones and pebbles from sand

3. Magnetic Separation

- Magnetic separation is based on the difference in magnetic and non-magnetic nature of particles (Fig. 13).

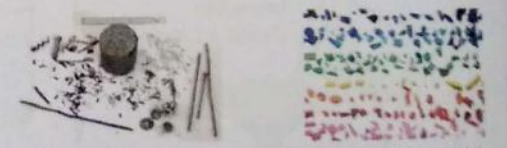


Fig. 13. Magnetic separation

- The magnetic particles such as iron are separated from non-magnetic particles such as wood, plastic etc., by using the magnetic nature of iron (Fig. 14). The iron metal gets attracted to magnet and non-magnetic substances are left behind.

Examples: Electromagnet fitted on cranes pick up iron particles from unwanted waste materials like plastic, glass, paper, separation of iron from iron-sulphur mixture.

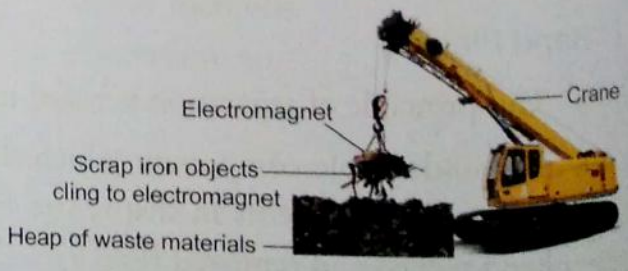


Fig. 14. Separation of iron from waste aterials

4. Sublimation

- The process in which a solid directly changes into the gaseous state without changing into liquid state on heating is called sublimation (Fig. 15). The examples of such substances are iodine, ammonium chloride, naphthalene, camphor etc.
- Sublimation method is based on the difference in sublimable and non-sublimable nature of solids.

  Those solid substances which directly change into vapour on heating without passing through liquid state are called sublimable solids. The vapours on cooling give back the pure solid.

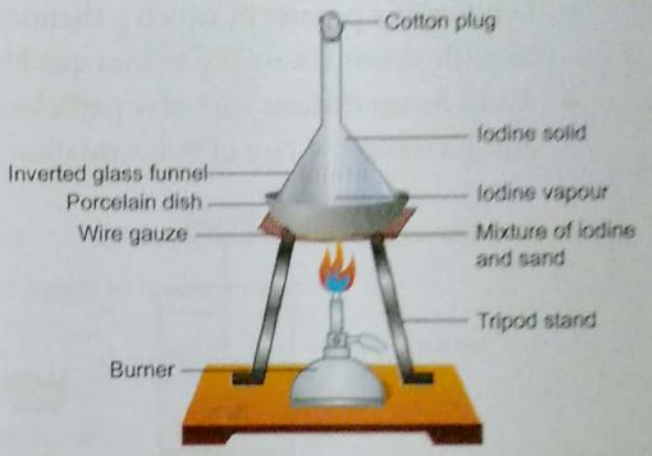


Fig. 15. Sublimation

- The sublimable solid on heating with non-sublimable substance undergoes sublimation. The vapours of sublimable substance condense in its pure form on the inner side of the funnel whereas the non-sublimable solid remains behind the evaporating dish. The function of cotton plug is to prevent the sublimable solid from escaping out.

Examples: Separation of ammonium chloride from common salt, separation of iodine from sand etc.

Methods of Separation of Solid-liquid Mixtures

1. Sedimentation and Decantation

- This method is based upon the settling down of heavier insoluble particles in an insoluble solid-liquid mixture on standing for some time.
- The insoluble solid component in the solid-liquid mixture settles down on standing in a beaker. This is known as 'sedimentation'. The liquid above it is poured out in such a way that the solid remains behind. This is called 'decantation' (Fig. 16).

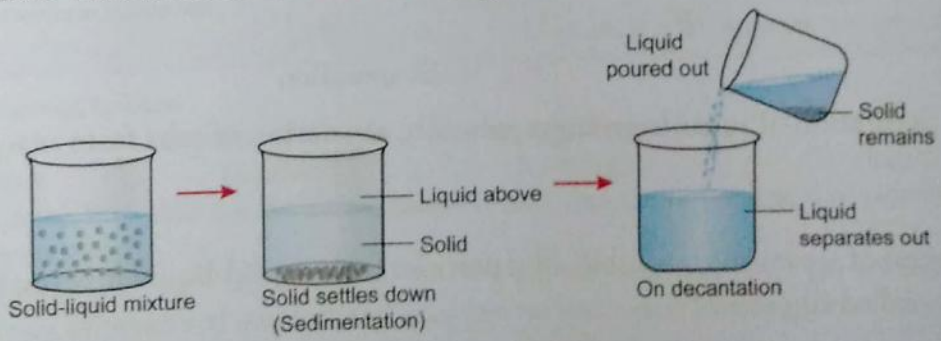


Fig. 16. Sedimentation and decantation

Examples: Separation of sand and water from sand-water mixture, separation of impurities in drinking water using alum, separation of tea leaves from tea by decantation.

2. Loading

- Loading is a process in which a chemical substance like alum is added to the solid-liquid mixtu to settle down the solid particles quickly (Fig. 17).
- Alum forms clusters with clay particles and make them heavy. It helps to them settle down faste and increases the rate of sedimentation.

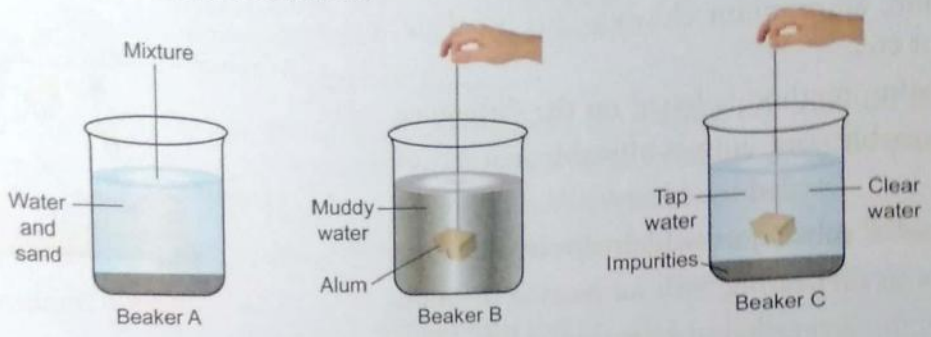


Fig. 17. Loading

Example: Separation of clay or mud from muddy water.

3. Evaporation

- The process during which a liquid changes into its vapour on heating below the boiling point i called evaporation (Fig. 18).
- This method is based on changing the liquid component into its vapour by heating a homogeneou solid-liquid mixture.
- The soluble solid like salt from salt solution can be separated by heating so that the liquid component, water is lost to the atmosphere and the salt remains behind.

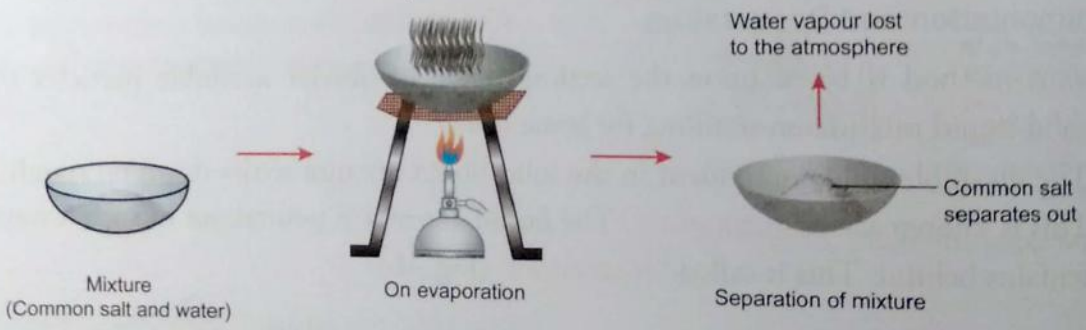


Fig. 18. Evaporation

Examples: Separation of sugar from sugar solution, separation of salts from sea-water.

4. Filtration

- The process of separating insoluble solid particles from a solid-liquid mixture by passing it through a filter is called filtration.
- Filtration technique is based on the separation of insoluble solid substances from a solid-liquid mixture using filter paper.

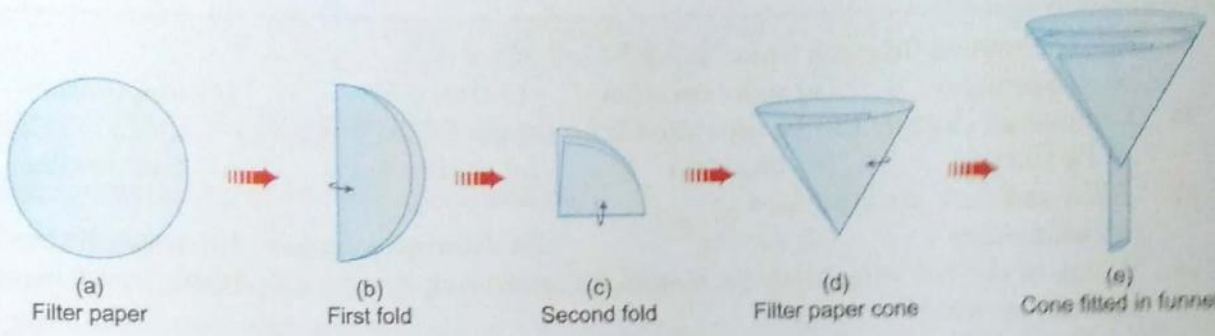


Fig. 19a-e. Folding of filter paper to make a cone

- A filter paper made into a cone is placed in a funnel or strainer (Fig. 19a-e). On pouring the mixture of insoluble solid and liquid into the funnel, the solid particles remain on the filter paper while liquid collects below. This clean liquid is called filtrate and the insoluble solid particles that remain on the filter paper is called residue (Fig. 20).

Examples: Separation of mud from muddy water, sand from sand and water, tea leaves from tea etc.

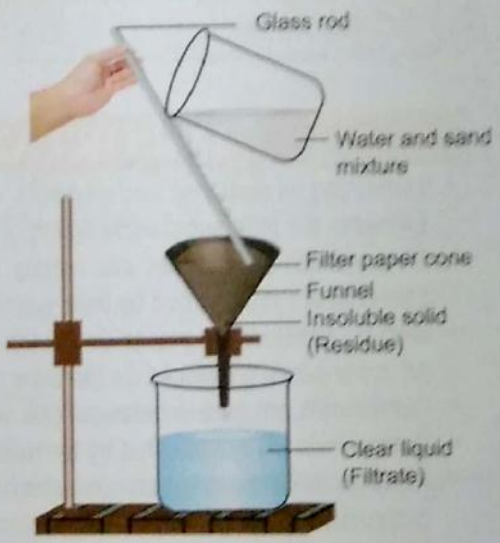


Fig. 20. Cleaning of water by filtration

PREFERENCE OF A PARTICULAR TECHNIQUE OVER ANOTHER

Out of all the above mentioned techniques, filtration is much better and sensitive approach for separation of a mixture of solid and liquid because it can be used to separate even smaller solid particles present in the form of impurities which may not completely settle down with sedimentation. At the same time, during decantation, there is a chance of the particles mixing back in the liquid. Filtration technique can overcome this. Thus, filtration is better than sedimentation and decantation.

CHECK YOUR PROGRESS!

Tick (✓) the correct option:

21. The property which forms the basis of sieving is difference in:
(a) colour (b) size (c) weight (d) shape

22. The process in which a solid gets converted into vapour on heating and converts back into solid is called as:
(a) evaporation (b) filtration (c) sublimation (d) decantation

23. A mixture of powdered sulphur and iron can be separated by the process of:
(a) magnetic separation (b) filtration
(c) sublimation (d) evaporation

24. Separation of tea from tea leaves can be done by:
(a) sublimation (b) filtration (c) evaporation (d) sieving

25. Salt is obtained from sea water by:
(a) sublimation (b) sedimentation (c) filtration (d) evaporation

26. Ammonium chloride can be separated from common salt by:
(a) distillation (b) filtration (c) sublimation (d) evaporation

27. Grain and husk are separated by:
(a) winnowing (b) sieving (c) hand picking (d) magnetic separation

28. Which of the following methods is used for separating heavier and lighter components of a mixture by wind?
(a) Hand-picking (b) Sieving (c) Winnowing (d) Filtration

29. The clear liquid obtained after filtration is called:
(a) residue (b) filtrate (c) sediment (d) supernant liquid

IMPORTANT POINTS TO REMEMBER

- Matter can be classified into elements, compounds and mixtures on the basis of chemical constitution.
- Elements are pure substances which cannot be split up into two or more simpler substances.
- Elements can be classified into metals, non-metals, metalloids and noble gases.
- Elements are represented by their symbols and they have been placed in periodic table.
- Metallic elements are placed on the left and non-metallic elements are placed on the right of the periodic table.
- All noble gases are placed on the extreme right of the periodic table.
- Compounds are pure substances that are made up of two or more elements combined in fixed ratio by mass.
- Compounds are represented by formulae.
- Mixtures are impure substances which are made up of two or more elements or compounds mechanically mixed in any proportion. Mixtures may be either homogeneous or heterogeneous.
- Mixtures can be separated by physical methods.
- Hand picking, sieving, sedimentation and decantation loading, filtration, sublimation, evaporation and magnetic separation are different methods used for separating the mixtures.
- Winnowing is used by farmers to remove husk from grains.
- Sieving is a process in which a mixture is passed through porous medium.
- Magnetic separation is used for separating the magnetic component from non-magnetic substance.
- Sedimentation and decantation is used for a heterogeneous mixture of solid and liquid where the solid component is insoluble and heavier than the liquid component.
- The process in which an external agent is added to bring about the sedimentation is known as loading.
- Filtration is used to separate lighter and insoluble solid particles from a liquid through a filter.
- Evaporation is used to separate the components of a homogeneous solid-liquid mixture by heating below the boiling point.
- Sublimation is used to separate sublimable substance like ammonium chloride from non-sublimable substance like sand, common salt etc.

WORKSHEET

TYPE I: OBJECTIVE TYPE QUESTIONS

A. Write 'True' or 'False' for the following statements.

1. An atom is divisible into nucleus and electrons.
2. Metalloids have the properties of both metals and non-metals.
3. Noble gases are reactive in nature.
4. Phosphorus is a diatomic molecule.
5. The properties of a compound differ from their constituent elements.
6. The latin name of sodium is *kalium*.
7. Magnesium is present in the haemoglobin of blood.
8. Elements are made up of dissimilar type of atoms.
9. A mixture of powdered salt and iodine can be separated by the process of sublimation.
10. The method of evaporation is used to obtain a solid substance that dissolves in a liquid.
11. Elements and compounds are considered as pure substances.
12. Non-metals are bad conductors of heat and electricity.
13. A molecule of a compound is represented by a symbol.
14. All the elements in the same group have similar chemical properties.
15. Components of compounds can be separated by physical methods.
16. Filtration technique is based on the separation of insoluble solid substances from solid-liquid mixture.
17. Decantation technique is better method of separation of mixtures than filtration.

B. Choose a word from the list to complete each sentence.

definite	indefinite	physical	pure	ozone
periods	groups	increasing	left	right
metalloids	noble gases	non-metals	filtration	sublimation
homogeneous				

1. The constituents of a mixture are present in ..... proportion.
2. The components of a mixture can be separated by ..... methods.
3. Mixtures contain two or more ..... substances.
4. Compounds have a ..... set of properties.
5. An example of triatomic molecule is ..... .
6. Elements in the periodic table are placed in vertical columns called ..... and in horizontal rows called ..... .
7. Elements in the periodic table are placed in the ..... order of their atomic numbers.
8. Metals are placed on the extreme ..... of the periodic table and noble gases are placed on the extreme ..... of the periodic table.
9. ..... show the properties of both metals and non-metals.
10. ..... are inert in nature.
11. Sand and water are best separated by ..... method.

12. Ammonium chloride from the mixture of ammonium chloride and sodium chloride can be separated by ..... method.
13. ..... are poor conductors of electricity.
14. Alcohol and water form ..... mixture.

C. Choose the correct option.

1. Mixture of sand and water is separated by the process of:
   (a) filtration (b) sedimentation and decantation
   (c) sublimation (d) both (a) and (b)
2. When a mixture is formed:
   (a) a physical change takes place (b) a chemical change takes place
   (c) no change takes place (d) both (a) and (b)
3. Salt is obtained from sea water by the process of:
   (a) filtration (b) evaporation (c) magnetic separation (d) sublimation
4. Oxygen molecule is:
   (a) monoatomic (b) diatomic (c) triatomic (d) none of these
5. Impurities settled at the bottom when muddy water is kept overnight in bucket. The clear was then poured off from the tap. This process of separation is called as:
   (a) decantation (b) sieving (c) filtration (d) hand picking
6. Iron from the mixture of iron and sulphur is separated by:
   (a) filtration (b) sieving (c) magnetic separation (d) sublimation
7. Aluminium is an example of:
   (a) element (b) compound (c) metalloid (d) mixture
8. Which of the following is an example of heterogeneous mixture?
   (a) Brass (b) Air (c) Sugar solution (d) Oil and water

D. Match the Statements in Column I with those in Column II.

S. No.	Column I		Column II
1.	Element	(a)	Sand-water
2.	Sublimation	(b)	Wheat flour-bran
3.	Filtration	(c)	Sea water
4.	Compound	(d)	Copper
5.	Sieving	(e)	Iron-sulphur
6.	Evaporation	(f)	Ammonium chloride-sodium chloride
7.	Magnetic separation	(g)	Air
8.	Homogeneous mixture	(h)	Carbon dioxide

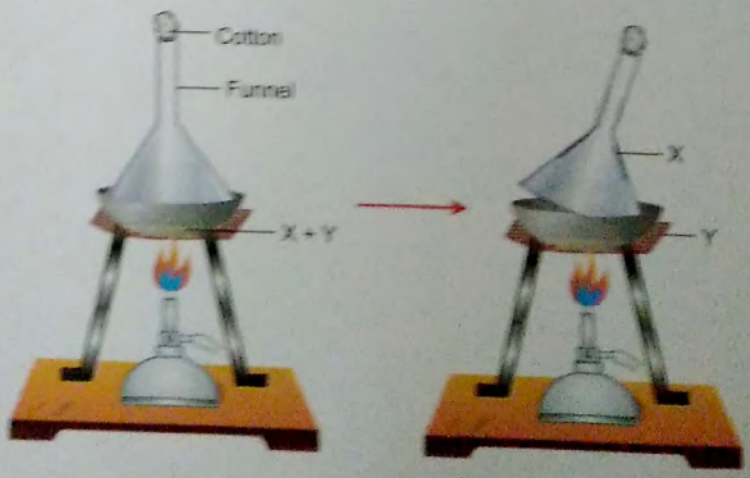
E. Give one word for the following:

1. A pure substance made up of only one kind of atoms.
2. Elements showing the properties of both metals and non-metals.
3. Elements which are chemically unreactive.

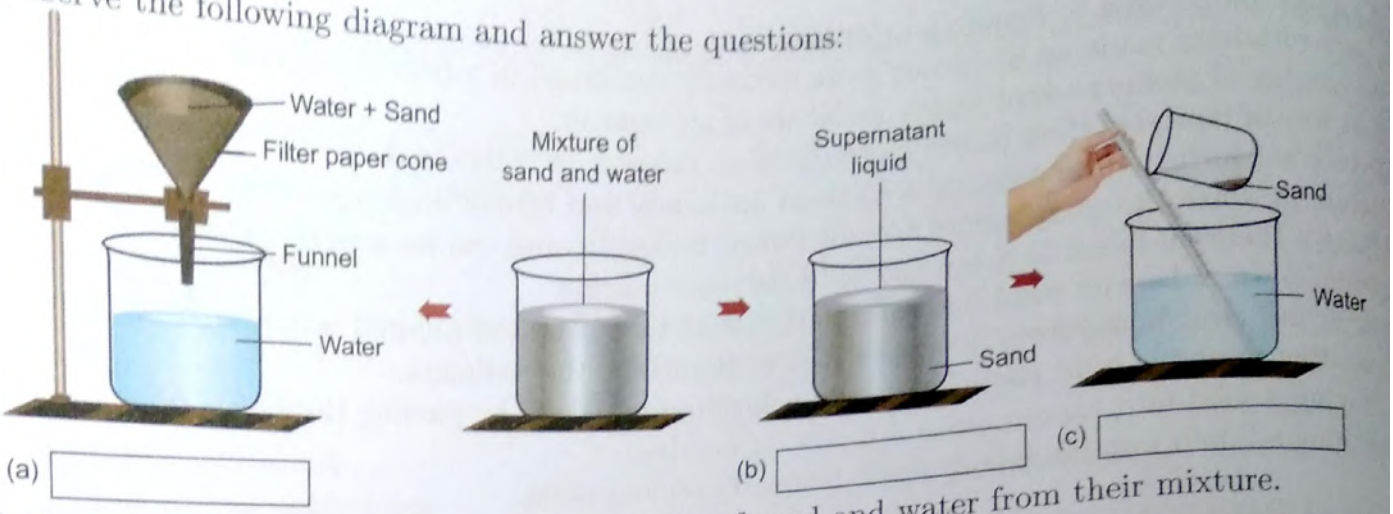
4. The abbreviation used to denote an element.
5. A pure substance made up of two or more elements combined in a fixed proportion.
6. The number of atoms present in the molecule of an element.
7. Short way of representation of the molecule of an element or compound.
8. Mixture in which the components are mixed uniformly and cannot seen separately.
9. Mixture in which the components are not mixed uniformly and can be seen separately.
10. Adding a chemical to settle down the solid particles quickly.
11. Settling down of heavier insoluble solid particles at the bottom of a liquid.
12. Pouring out clear liquid from a vessel without disturbing the sediment.
13. Separating insoluble solid particles from a solid-liquid mixture by passing through a filter.
14. Changing a solid into vapour state directly on heating.
15. Changing a liquid into its vapour state below its boiling point.

TYPE II: SUBJECTIVE TYPE QUESTIONS

1. Write the correct symbol of the following elements and classify them into metals, non-metals, metalloids and noble gases:
   Calcium, Sodium, Oxygen, Sulphur, Neon, Boron, Magnesium, Chlorine.
2. What is an atom? Show the various parts of an atom by a labelled diagram.
3. On the basis of the properties, classify the elements into metals, non-metals, metalloids and noble gases:
   (i) The element having lustre, malleable and ductile: ..... .
   (ii) Element which is non-malleable, non-ductile and poor conductor of heat and electricity: ..... .
   (iii) Element which is unreactive and inert: ..... .
   (iv) The element having the properties of metals and non-metals: ..... .
4. What do you mean by the term 'compound'? State its any two characteristic properties. How does a compound differ from a mixture?
5. Write the molecular formula for the following:
   (i) Nitrogen (ii) Iodine (iii) Zinc chloride (iv) Calcium chloride (v) Magnesium sulphate (vi) Potassium hydroxide.
6. What is sieving? Where is it used?
7. Is it possible to separate sugar mixed with wheat flour? How will you do it?
8. How would you obtain clear water from a sample of muddy water?
9. Give reasons for the following:
   (i) Elements have been placed in periodic table.
   (ii) A mixture does not have definite set of properties.
   (iii) Filtration is a better method of separation of sand and water than sedimentation and decantation.
   (iv) Magnets are used for separation of iron from iron-sulphur mixture.
   (v) A piece of alum is generally added to impure drinking water.
10. **Diagram based questions.**
    A. The following diagram represents a method of separation of a mixture containing 'X' and 'Y'. Answer the following questions:
    (i) Which substance among 'X' and 'Y' is sublimable? Give one example of a sublimable substance.
    (ii) Which substance among 'X' and 'Y' is non-sublimable? Give one example of a non-sublimable substance.
    (iii) What is the function of the cotton at the end of the funnel?



B. Observe the following diagram and answer the questions:



(i) Name the processes involved in the separation of sand and water from their mixture.
(ii) Which of the process is more beneficial?
(iii) Mention the principles involved in the above processes of separation.
(iv) Give some examples of mixtures in which the above processes are employed to separate them