SHAKTHII ACADEMY

TNPSC MATERIAL

SCIENCE - CHEMISTRY

SAMACHEER KALVI

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SHAKTHII ACADEMY

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CHANGES AROUND US 3

Kalpana Chawla

Kalpana Chawla was the first Indian born American woman who travelled to space in the space shuttle Columbia. This is an excerpt from the interview given by her in the year 1997 when she returned from space.

Interviewer : How did you feel when you flew in the spacecraft? What were the changes you felt in your body?

Kalpana Chawla :- At first, I felt all parts of my body losing weight. When this transformation overpowered me, I could not feel any part of my body. As the spaceshuttle hurled at high speed, a kind of fear went down my spine. Before I could say, “Look at India” I was crossing it. The Gangetic Plains appeared to be a thin line, Africa looked like a desert and the river Nile appeared to be a thin vein on it. In about an hour and a half I revolved around the earth. I observed with wonder as the day and night changed very fast. I went round the whole world within one and a half hour. The moon, moving away from me, waned and waxed and then appeared and disappeared. I felt shocked and overjoyed at the same time. All these things happened in a very short span of time.

How do you feel when you read her statements? Isn’t it wonderful? The slow and natural changes that take place on earth seem to take place at a fast rate when we travel in space.

Shall we look at the changes that happen around us? That is, the seasonal changes, occurence of day and night due to the rotation of the earth, curdling of milk, ripening of fruit, cooking of food, rusting of iron etc.

In this lesson, let us learn about the different types of changes that occur.

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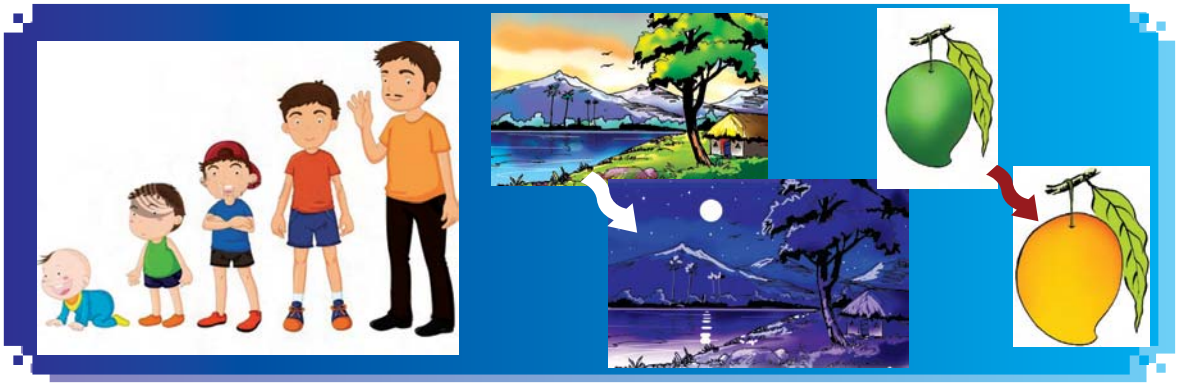
Look at the pictures given below and discuss in groups about the changes taking place.



Fill in the blanks with the given hints.

1. The_____and _____of the child have increased.
2. The_____changes during day and night .
3. The _____and the_____change when a mango ripens.

(Hints: temperature, weight, taste, height, colour)

Hence changes in colour, temperature, place, shape and size of the substances are considered as changes.

Slow and Fast Changes

Activity 1

Discuss in small groups about the time duration for the changes to take place.

Changes	Duration (few hours/ days/ weeks/months/ years)
Growth of a child	_____
Rusting of iron	_____
Germination of a seed	_____
Cooking of food	_____
Curdling of milk	_____

My Inference: All changes take place in _____ (the same/different) time duration.

Changes that take place in a few hours, days, months or years are called slow changes.

Burning a piece of paper, firing crackers, glowing of an electric bulb take place in a few seconds or minutes. don't they?

The changes that take place in a short duration of time are called fast changes.

Slow Change

Activity 2

List some examples for fast change and slow change

Fast change _____ _____ _____

Slow change _____ _____ _____

Let us know

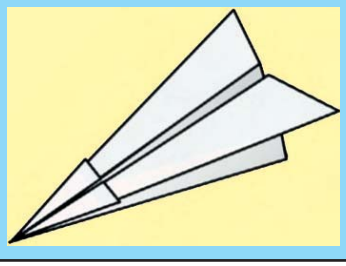
Trees which got buried under the earth nearly 30 crore years ago had undergone many changes and turned into coal.

Reversible and Irreversible Changes

Activity 3

Take a piece of paper and make a model of rocket as shown in the picture. Shall we unfold it after playing? Can you get back the same piece of paper? What do you infer?

_____



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Activity 4

Take a balloon and inflate it by blowing air. After sometime release the air from it. Does the balloon get back its original shape?

What do you infer? _____

Inflate the same balloon and tie it using a thread. Pierce it with a pin. Can you inflate the balloon again?

What do you infer? _____

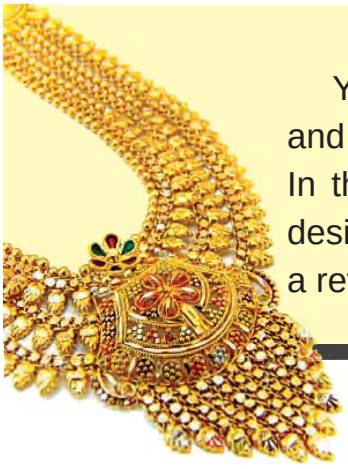
_____

Can we get back the green vegetables from the cooked ones? The batter from Idly or dosa? Raw rice from cooked rice?

Is it possible to get back the original substances in the above changes ? _____. (Yes/No)

In some changes, the substance can be brought back to its original state. Such changes are called reversible change.

The change in which the substance cannot be converted back into its original form is called irreversible change.



Let us know

You would have seen some hard metals like gold, silver, and iron being used to make ornaments and instruments. In this process, metals are heated, melted and cast into desired shapes. On cooling they become hard. This is also a reversible change.

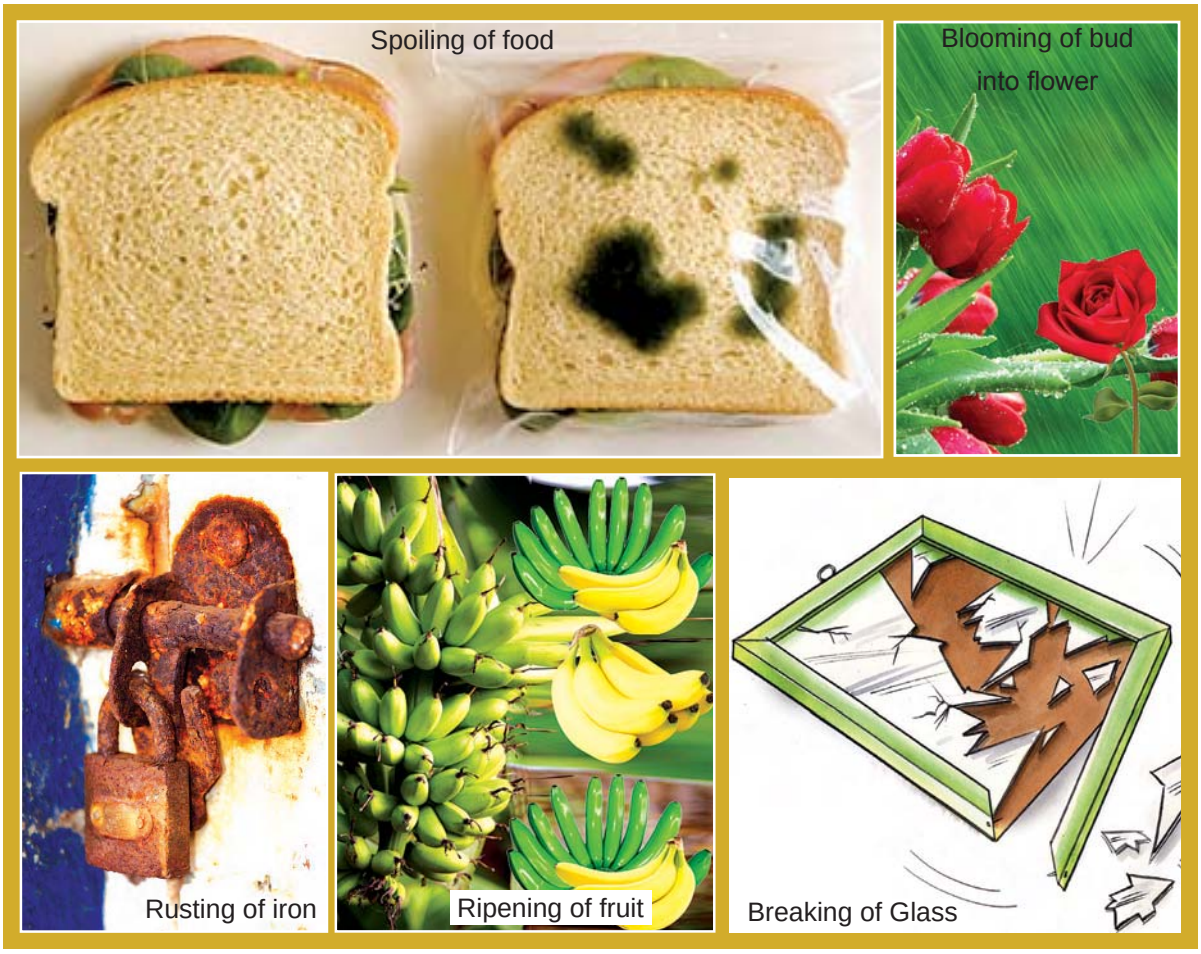
I have seen workers laying road using a black substance(Tar). Is melting of tar a reversible change? or an irreversible change?

Shall we classify the following changes?

Reversible change		Irreversible change
Melting of ice	1. Curdling of milk	_____
_____	2. Melting of ice	_____
_____	3. Burning of wood	_____
_____	4. Batter into Idly	_____
_____	5. Evaporation of water	_____
	6. Greying of hair	

Desirable and Undesirable Changes:

Are all changes that take place around us useful? Look at the pictures and write whether the changes are useful to us or not.



Changes like raining, ripening of fruits, blooming of flowers, etc. are useful to us. Such useful changes are called desirable changes. Changes like spoiling of food, eruption of volcano, rusting of iron, breaking of glass are not liked by us, as they are harmful and not useful to us. Changes which are not useful to us are called undesirable changes.

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Periodic and Non-Periodic Changes

Look at the calendar (monthly) and complete the tabular column;

Month	New Moon (Date /Day)	Full Moon (Date /Day)

How many days are there between a new moon day and a full moon day?

Do the new moon and full moon occur at regular intervals?

We understand that the new moon and full moon occur at regular intervals. Hence the changes that occur at regular intervals are called periodic changes.

More examples for Periodic Changes

Pendulum of a clock

Phases of Moon

Day and Night

Look at the pictures given below.

Can you predict when will these changes happen?
Will they take place at regular intervals?

We cannot predict how and when the above given changes will occur. So, the changes that do not occur at regular intervals are called non-periodic changes.

Let us learn the differences between the periodic and non-periodic changes.

S.No.	Periodic changes	Non-periodic changes.
1.	Occur at regular intervals.	Do not occur at regular intervals.
2.	Can be predicted e.g. weather.	Cannot be predicted e.g. earthquake.

Exothermic and Endothermic Changes

Do the following activities and record your inference in the table.

Activity 5

1. Take a small amount of detergent powder in your palm and add water to it. How do you feel?
2. Take a small amount of quicklime in a beaker and add water to it. Touch the beaker. How do you feel?

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3. Take a small amount of glucose in a beaker and add water to it. Now touch the beaker. How do you feel?

4. Take a small amount of water in a beaker. Add Ammonium Chloride salt and stir it. Touch the beaker. How do you feel?

Experiment No.	My inference
1.	
2.	
3.	
4.	

From the above **activities we find that in some cases heat is liberated while** in others heat is absorbed. Changes in which heat is liberated are called exothermic changes. E.g .burning of a matchstick, dissolution of detergent or washing soda in water.

Changes in which heat is absorbed are called endothermic changes. E.g. Dissolution of glucose or ammonium chloride in water.

Let us know

An invention from Nature

We can create new things by closely observing the Nature .

Invention of Velcro by George Mestral in the year 1948 is a right example for this.

George Mestral used to go for a walk with his pet dog daily. One day he found that some seeds were hooked on his clothes and on the fur of his dog. He observed these seeds under a microscope and found some hooklike structures on them. Based on this he tried to create a new thing.

This led him to the invention of Velcro. It has tiny hooks which can attach to the objects. Today Velcro is widely used in bags, footwear and clothes.

Extended Activities

Activity 1

Using a thermometer measure the temperature of your classroom from morning till evening and record in the tabular column. Know the changes in temperature.

Day	Temperature		
	Morning	Noon	Evening
Monday			
Tuesday			
Wednesday			
Thursday			
Friday			

Activity 2

1. Mention the months during which we have summer season in our state.

_____

2. During which months do we have winter season?

_____

3. During which months do we have rainy season?

_____

4. Do we get the above seasons during the same months every year?

_____

5. Under what type of change do you classify these seasonal changes?

_____

Activity 3

Select two students from each class of your school and record their age, height, and weight. See the changes in their height, weight with the increase in their age.

Activity 4

Have you seen potmaking? The potter is making the pot by heating wet clay. When can you get back the wet clay from the pot? (before heating / after heating) Discuss in small groups and find the changes that take place in this process.

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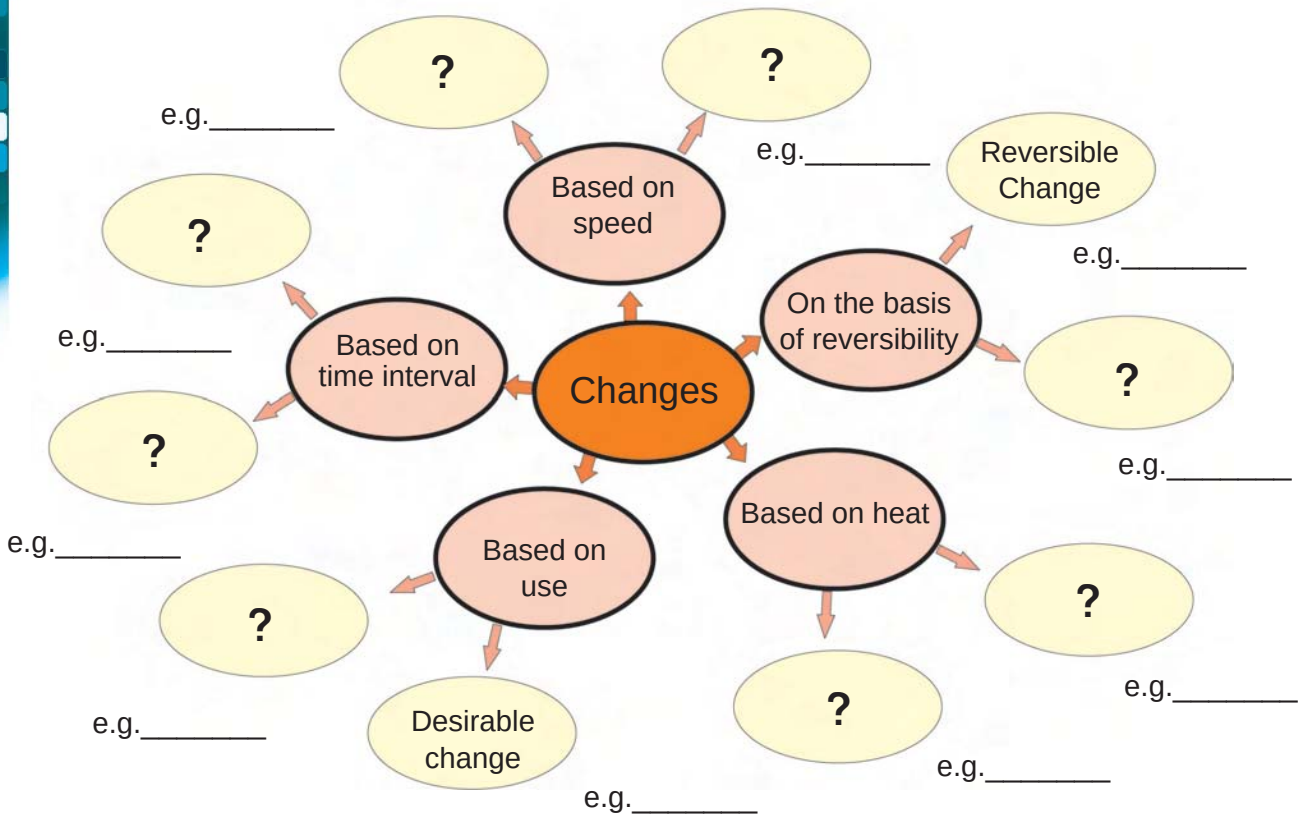
Evaluation

I. Fill in the blanks and question marks:



II.Choose the correct answer

1.Release of the compressed spring is _____

a) an irreversible change b) a reversible change

c) a non-periodic change d) an undesirable change

2. Spoilage of food is_____

a) a reversible change b) a fast change

c) an undesirable change d) a periodic change

3. Dissolution of washing soda in water is_____

a) an exothermic change b) an irreversible change

c) an undesirable change d) an endothermic change

4. Which of the following changes is non-periodic?

a) heartbeat b) earthquake

c) occurrence of day and night d) oscillation of pendulum

III. Identify the changes in the following

a) Tsunami

b) Swinging

c) Occurrence of New Moon and Full Moon

d) Melting of wax

IV. Answer the following

1. Give five examples for desirable and undesirable changes.
2. What type of change is an earthquake? Why?
3. What is meant by slow change?
4. What is an irreversible change? Give example.
5. Differentiate the following
   a. Exothermic and Endothermic change
   b. Periodic and Non-periodic change

V. Reason out the following questions

1. You have broken your favourite toy. Can you mend it ? What type of change does this belong to?
2. Meena and Nisha were about to have their lunch in their school. Nisha was not able to eat her lunch as her food was stale and spoiled. So Meena shared her food with Nisha . In the above situation, what kind of change is spoilage of food?
3. Mention any five changes that take place in your kitchen. Identify the kind of changes each belong to

   e.g. Preparation of chapathi - Slow change, desirable change, irreversible change.

4. The pencil and eraser that you use become smaller in size after a few days. Why? What are the different types of changes that occur?
5. Based on the changes differentiate a paper boat made by folding and a paper boat by cutting.

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Further reference

Websites:

www.simplescience.net

http://www.bbc.co.uk/school/scienceclips/ages/10-11/rev-irrev-changes.htm

http://www.learnnext.com/class6/science/changes-around-us.htm

Separation of Substances 2

Ibrahim loves science and always participates in science competitions. Last week, he won the first prize at the Science Talent Search Competition. Ibrahim found the competition interesting and challenging. Each participant was provided with (i) an empty bucket (ii) a bucket full of water (iii) a bag of sand (iv) gravel and (v) a sieve.

The participants had to fill the empty bucket with water, sand and gravel. They had to use all the materials. The participant who filled the bucket without the water overflowing would be declared the winner.

Some of them first poured water into the empty bucket and then added the gravel. Immediately the water overflowed.

Some put the sand in first and then poured in the water. The bucket became full and the gravel could not be added.

Do you want to know what Ibrahim did?

First he put the gravel in the bucket, then he put the sand gently over it and poured water slowly over it. The bucket became full and did not overflow. He used his knowledge of science to fill the bucket with the given materials.

Then, Ibrahim was asked to separate the mixture. How did Ibrahim separate the mixture? First he poured out the water slowly from the bucket, and spread the wet sand and gravel mixture on a newspaper and dried it. Then he poured the mixture of gravel and sand on the sieve. The sand fell through and the gravel remained on the mesh. Thus he separated all three components.

Discuss and give reasons why the others lost to Ibrahim.

In the above competition Ibrahim used methods of separation like decantation and filtration.

We drink water after it is boiled and filtered. We know that before cooking rice, it is cleaned with water. While preparing tea, we separate tea leaves by filtration. We purify rava and wheat flour by sieving, and rice and pulses by winnowing.

What do we understand from this?

We need to use different methods of separation

- to remove the unwanted substances
- to remove substances which are harmful to our body
- to obtain the substances which are useful to us in a pure state.

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Let us learn about the different methods of separation we use in our daily life.

Methods used to separate mixture of solids:

Solid mixtures can be separated using methods like hand-picking, winnowing, sieving and magnetic separation.

Hand-picking

How do we separate vegetables at home? We separate them into its kinds like tomato, chilly etc. by using our hands. Separation is easier as they differ in size, colour and shape.

The method of separating the substances based on size, colour and shape using hands is called handpicking.

1. By which method does the woman in the given picture separate the substances?
2. Mention some substances which can be separated by this method.

Lighter particles present in a mixture can be separated by winnowing.

_____

_____

_____

Hand picking method can be applied when the quantity is small and of reasonable size.

Winnowing

Farmers allow the mixture of grain and husk to fall from a height. Grains, being heavier fall down and form a heap. Husk, being lighter is carried away by wind and forms a separate heap.

The method of separating lighter particles from heavier particles with the help of wind is called winnowing.

Sieving:

We can separate the impurities like bran, husk, stone, worms, stalk and tiny insects from flour by sieving. It allows the fine particles to pass through the pores while the coarser particles remain on the sieve .

Components of a mixture can be separated by the method of sieving only when they differ in their size.

At construction sites, you would have seen the separation of pebbles and stones from sand by sieving using a sieve.

Magnetic separation :

Insert a magnet into a heap of sand and take it out. If iron particles are present in the heap of sand, we can see them clinging to the ends of the magnet.

Magnetic separation is used to separate mixtures containing components which are attracted by magnet.

Can we separate iron substances from water using a magnet?

Activity 1 **I Do**

I need : Beaker, water, bell pins and a magnet

I take a beaker and fill half of it with water.

I drop some pins into it.

I hold a magnet over the surface of water or by the side of the beaker.

My inference:

_____

_____

_____

_____

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Shall we complete the table?

Mixture	Method of separation	Physical state of the components (Solid, Liquid, Gas)
Paddy and chaff		
Ragi and pulses		
Sand and stone		
Rava and Iron particles		

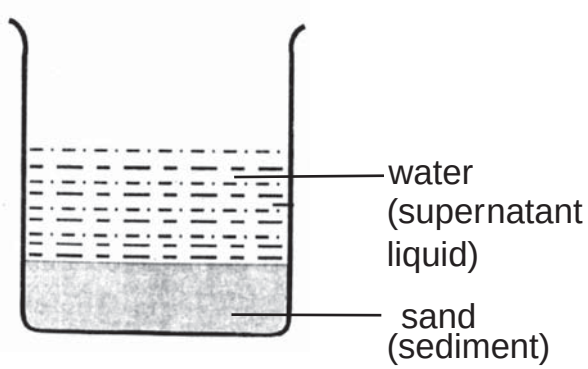
Methods of separation of insoluble solids from liquids

Can we separate a mixture of sand and water by using methods like hand-picking, sieving, winnowing or by magnetic separation? No we can not separate them. why? Since water is in liquid state, the methods used to separate solid mixtures cannot be used here. The method of separation depends on the nature of the substances to be separated.

Hence we can separate insoluble solids from liquids by using the method of decantation, sedimentation and filtration.

Sedimentation

The mixture of insoluble solids and liquid is taken in a beaker and the solid subtances are allowed to settle down as sediments. This is known as sedimentation. The clear liquid above the sediment is called supernatant liquid.

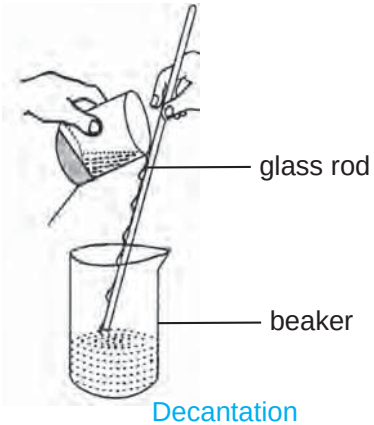


Sedimentation

e.g. a mixture of sand and water

Decantation

Transferring the clear liquid (supernatant liquid) into another container using a glass rod is called decantation.



Decantation

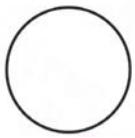
Filtration

Observe the liquid obtained by decantation and see whether it contains suspended impurities. Try to filter the impurities using a clean cotton cloth. As there are tiny pores in the cloth(like the pores in a sieve), the clear water passes through the pores and the suspended impurities

like sand remain on the cloth. In the laboratory we use a filter paper instead of a cloth to purify water. There are tiny pores in the filter paper also.

Let us filter the mixture in the laboratory using a filter paper.

Take a filter paper and fold it like a cone. Fix it inside a glass funnel. Fix the funnel in a stand and place a beaker below it. Pour the impure liquid containing suspended impurities into the funnel. Liquid drains through pores of the filter paper. The clear liquid that is collected in the beaker is known as filtrate. The dust particles which remain on the filter paper are called "residue".



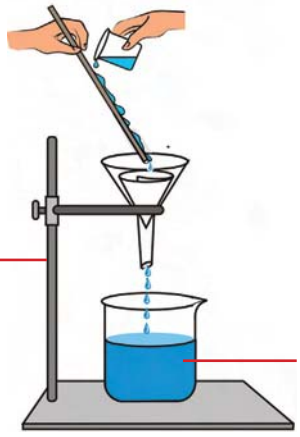
filter paper

first fold

second fold

cone

filter paper cone in the funnel



Methods of separation of solid substances dissolved in liquids

Evaporation and condensation processes are used to separate solid substances dissolved in liquids.

Activity 2 **We Observe**

Take a small amount of salt solution in a beaker and place it over a wire gauze on a tripod stand. Heat the solution well. After the complete evaporation of water, see what is left in the beaker.

Our observation and inference:

_____

_____

Evaporation

Thus we have separated salt from water by evaporation method.

Evaporation is a process in which a liquid changes into its vapour on heating. Evaporation method is used to separate the dissolved solids from the liquids.

Salt pan

Do you know?

One litre of sea water contains about 3.5 grams of salt. Sea water contains not only common salt but also more than 50 other mineral salts. These salts are industrially important.

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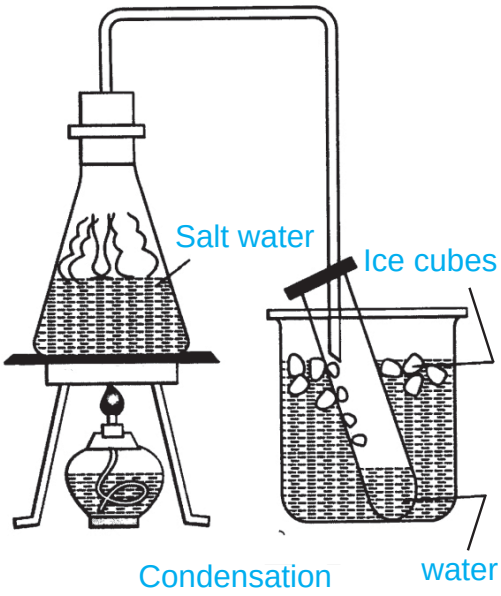
Condensation

Take a mixture of sand and salt in a beaker. Add water to this mixture and stir. Salt gets dissolved. How can we separate the components from this mixture? Filter this solution using a filter paper. The sand can be separated from the salt solution by filtration.

I want to get back both salt and water. What should I do for this?

Set up the apparatus as shown in the picture. Take the salt solution in a conical flask and heat it strongly. The water vapours pass through the delivery tube and get collected in a test tube. The test tube is placed inside a pack of ice cubes. The water vapours get cooled and condense into water. Salt remains as residue in the conical flask, once the whole water gets evaporated. When the vapours of a substance get cooled, they condense into liquid. This process is known as condensation.



Need for applying more than one method of separation

The various substances which we use in our life, reach our hand only after undergoing different methods of separation and purification.

For example, in the preparation of sugar from sugarcane juice, the methods of separation like filtration, evaporation and crystallization are used. More than one method of separation are used to extract metals like iron, gold, aluminium and copper in pure state from their ores.

Shall we complete the table?

Mixture	Method of separation	Physical state of the components (Solid, Liquid, Gas)
sand and water		
rava and water		
salt and water		

Do you know?

Evaporation and Condensation are the basic processes involved in the Water cycle. Formation of rain involves these two processes.

Activity 3 — We Do

We are going to separate iron filings, salt and chalk powder from the given mixture.

We need: bar magnet, beaker, water, filter paper, funnel, tripod stand, glass rod, watch glass, matchbox, wire gauze, bunsen burner.

1. We take the mixture in a watch glass and stir it using a bar magnet.

Our observation	Substance separated

2. We take the remaining portion of the mixture containing salt and chalk powder in a beaker. Then we add water and stir it well using a glass rod. We allow the liquid to remain undisturbed.

Our observation :

_____

_____

3. We fold the filter paper into a cone shape and keep it inside a funnel.
4. We keep the funnel on a tripod stand and place a beaker below it.
5. We transfer the liquid mixture slowly into the funnel using a glass rod.

Our observation	Substance separated

6. We take the beaker containing the salt water and place it over a wire gauze on a tripod stand. We heat the solution strongly using a bunsen burner.

Our observation	Substance separated

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Our inference:

S.No.	Separated substance	Method used for separation

Facts at a glance:

1. Crude oil is a mixture from which nearly eighty six substances like petrol, kerosene and naphtha are obtained.
2. Air is a mixture of gases.

Evaluation

I. Choose the correct answer

1. Suitable method to separate lighter impurities from a mixture
   a) winnowing b) hand-picking
   c) evaporation d) magnetic separation
2. In a mixture, solids of different size can be separated by
   a) magnetic separation b) winnowing
   c) sieving d) evaporation
3. The method used to separate the seeds from the fruit juice is
   a) filtration b) sieving
   c) crystallization d) winnowing
4. Separation of common salt from the sea water is by
   a) sieving b) evaporation
   c) magnetic separation d) winnowing
5. The method used to separate substances differing in colour, size and shape from a solid mixture
   a) magnetic separation b) decantation
   c) hand-picking d) sieving

II. Encircle the odd one and give reason:

1. hand-picking, evaporation, winnowing, sieving
2. filtration, sedimentation ,decantation, condensation

3. evaporation, magnetic separation, condensation, crystallization
4. filter paper, sieve, funnel, glass rod

III. Write the correct method of separation instead of the wrong method given in the following statements.

a) We can separate the different kinds of vegetables by winnowing.

b) Lighter particles present in a mixture can be separated by magnetic separation.

c) The method of converting liquid into vapour by heating is known as condensation.

d) Sieving method is used to separate a magnetic substance from a mixture.

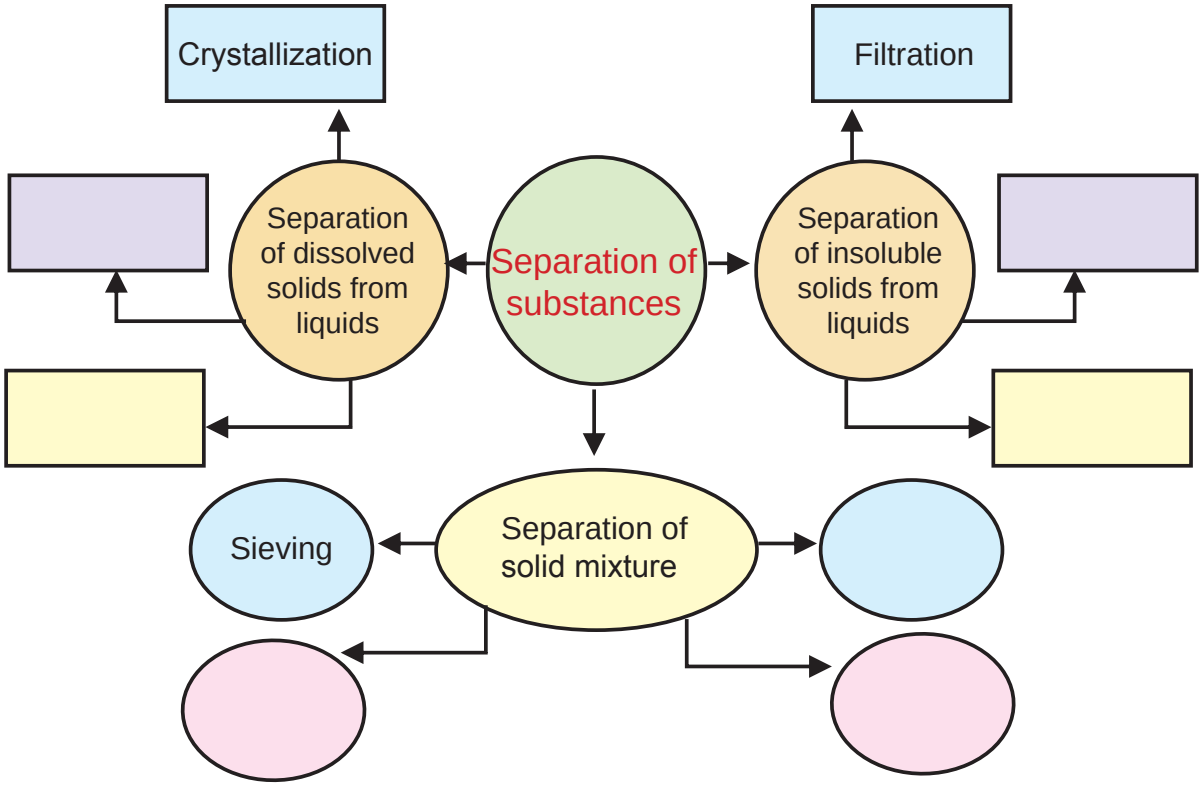
IV. Draw and label the apparatus used for filtration in the laboratory.

V. Explore and answer

1. Amudha's family gets drinking water from the nearby pond which is turbid in nature. Suggest her some methods to convert the water into pure drinking water.
2. We do not apply the same method of separation to separate a mixture of chalk powder and water, a mixture of green peas and ground nuts, and iron objects from garbage. why?
3. Why is separation of substances necessary in our daily life?
4. You are given a sample of salt solution. You are asked to separate the salt from it. Filtration method cannot be applied here. Why? Mention the correct method of separation.
5. Differentiate the following:
   a. filtrate and residue
   b. winnowing and sieving
6. While preparing lemonade, how will you remove the seeds of the fruit from the juice? We add ice cubes to get chilled juice. When will you add sugar to the juice before or after adding ice cubes? Why? When can you dissolve more amount of sugar?
7. A mixture contains saw dust and iron nails. Which method will the carpenter use to separate the iron nails from the saw dust?
8. During winter season we see dewdrops on grass and plants. Can you give reason for this?

9. Can we separate tiny white stones from 100kg of rice by the method of hand picking? Give reason for your answer.

VI. Fill in the boxes with suitable answers:

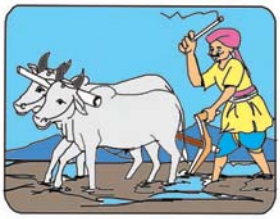


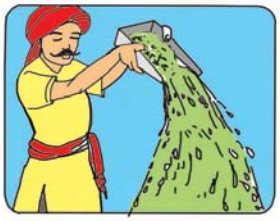
VII. Spot out the different methods of separation in this word puzzle

P	W	X	N	C	B	A	T	I	M	C	F	I	L	T	I	Q	F	O
Q	R	A	C	O	N	D	O	L	I	N	I	A	I	E	X	Y	I	E
L	T	C	R	N	Y	S	N	I	X	Y	L	O	Q	U	I	D	L	V
T	O	L	Z	D	E	C	A	N	T	A	T	I	O	N	A	C	T	A
S	J	S	I	E	V	S	O	L	U	T	H	Y	X	O	U	V	E	P
M	I	X	E	N	W	A	T	E	R	V	A	P	O	U	R	T	R	O
T	L	R	E	S	I	D	U	E	E	X	T	L	M	O	S	Q	P	R
I	S	E	V	A	P	T	I	O	S	I	E	V	I	N	G	O	A	A
C	R	Y	S	T	A	L	L	I	S	A	T	I	O	N	N	G	P	T
L	I	Q	U	I	D	V	A	P	T	N	I	O	I	A	Q	R	E	I
I	L	T	S	O	L	U	T	I	O	N	L	E	O	T	X	Y	R	O
Q	M	A	G	N	E	T	I	C	S	E	P	A	R	A	T	I	O	N

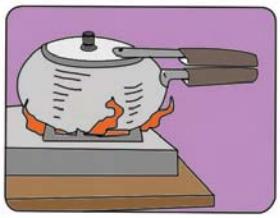
VIII. Observe the pictures given and arrange them in proper order based on the activities given in them. Encircle the methods of separation found in them.


Sowing


Ploughing


Winnowing


Hand-picking


Cooking


Thrashing


Eating


Harvesting

1. _____ 2. _____

3. _____ 4. _____

5. _____ 6. _____

7. _____ 8. _____

Projects:

1. List the various methods of separation used in our day-to-day life. Describe the method and places they are used in. Mention their significance.
2. Discuss in groups how salt is obtained from sea water. Collect relevant pictures and stick them in your scrapbook. Find out the places of salt pans in Tamil Nadu.

Further reference

Web sites:

http://en.wikipedia.org/wiki/separation_process

http://encarta.msn.com/encyclopedia_761574279_2/evaporation.html.

SCIENCE

Chemistry in Daily Life 3

Do you know Tamizharasi ?

What does Tamizharasi do from the time she wakes up till she goes to school? As we all get up in the morning and brush our teeth with toothpaste, she too brushes her teeth.

She washes her dirty clothes using detergents. She takes a bath using a toilet soap. She washes her hair with shampoo.

She also uses a notebook, pencil, pen and eraser to do her home work as we do.

She stands before a mirror to comb her hair, dresses herself, takes water in a plastic water bottle and wears her spectacles and rubber shoes and goes to school by a bicycle. These are the daily activities of Tamizharasi.

Tamizharasi's parents are constructing a house. So they have bought cement, bricks, gravels, and iron rods. She carefully crossed all these materials and reached the tar road.

Most of the things that she uses are chemical substances.

The ink used in our pen and chalk piece used by our teachers are also chemical substances.

Based on the chemical properties of naturally available raw

materials, we produce many things which are very useful in our daily life.

Chemistry plays a major role in manufacturing useful things that we need.

3.1. Cement and its uses

We all would have played making sand houses with our friends. We enjoy ourselves by heaping sand in the form of a mound and on its top build a castle with steps. In real life, can we build a house so easily with sand alone?

Tamizharasi's house and the school she goes to are stone buildings. List out the materials that are needed to construct these buildings.

_____

_____

_____

Cement is an important chemical substance used in the construction of buildings.

SCIENCE

In 1824 Joseph Aspidin, a mason in England synthesised cement. As this cement resembled the limestone found in Portland, he named the cement as Portland cement.

Cement is a mixture of limestone, clay and gypsum in definite proportion. This mixture is heated, cooled and powdered to get the chemical substance called cement. This greyish powdery cement is packed in airtight bags and sold.

What happens when a little water is added to cement?

ACTIVITY 3.1 **WE DO**

Aim: To know about the nature of cement.

Materials we require: paper cups, a small amount of cement, water, a stick or glass rod.

Procedure :

- Let us take a small amount of cement in the paper cup and add required amount of water and stir it well with the help of the glass rod/ stick.
- After a few hours let us observe the change that has occured.

Our observation :

_____

_____

We understand from the above activity that when water is added to cement, it sets to a hard substance within a few hours. This is known as setting of cement.

Uses of cement

Cement is used in different forms like mortar, concrete and reinforced cement concrete.

Mortar

Mortar is obtained in the form of thick paste by mixing cement, sand and water. This paste is used in flooring, constructing and plastering the walls of the houses.

Concrete

Concrete is a mixture of cement, sand, gravel and water. It is used in the construction of buildings, bridges, dams or reservoirs.

Reinforced cement concrete(RCC)

When concrete is filled in and around a steel wire netting or skeleton of iron rods and allowed to set we get reinforced cement concrete. This RCC is very strong and durable. This type of concrete is used in the construction of dams, bridges, pillars and roofs of the buildings. It is also used in making pipes, constructing water tanks, and laying sewage and drainage canals.

3.2. Plastics

We are familiar with the term plastics. Only glass bottles and iron pipes were in use for a very long period. Do we find them in large numbers at present? No, today we use mostly things made of plastics. Tamizharasi's water bottle is also not an exception.

Nowadays plastics are very much used in making pipes, toys, utensils, stationeries, medical instruments etc. Plastic water bottles are commonly used everywhere. Plastic is also a type of chemical substance.

3.3. Types and uses of plastics

Tamizharasi's father bought a plastic hosepipe for construction purpose. But he could not join it with the water tap as the size of the plastic pipe was smaller in diameter than the water tap. What should be done to join the plastic pipe with the water tap?

_____

_____

What happens when we pour boiling water into a plastic (PET - Polyethylene terephthalate) bottle?

_____

_____

In the above incidents, plastic pipe and plastic bottle melt and become soft on heating. On cooling, they become hard. These types of plastics are known as 'Thermo Plastics'. Polythene bags, PET bottles, PVC(Polyvinyl chloride) pipes, buckets, mugs, combs, toys etc. are made of thermo plastics.

Do the plastic handles of cookwares melt on heating? Can we expand them like PVC pipes by heating? No, we cannot. It is because they are thermo setting plastics.

An object made of thermo setting plastics cannot be softened or melted by heating. Example: Bakelite and melamine.

Bakelite is a non conductor of heat and electricity. It is used to make electrical insulators, switches and handles of cookwares. Melamine is a non-inflammable substance. Moreover, it can withstand very high temperature. Therefore, it is used to make floor tiles, cookwares, fireproof clothes etc.

3.4. Plastics and environment

We know that plastics are widely used in our day-to-day life. At the same time they are also a great threat to our planet Earth. The disposed plastics bring about the following effects,

- Plastics do not get degraded.
- They do not allow rainwater to seep through the soil.
- They affect the growth of the plants.
- Water gets stagnant in these disposed plastic pieces. It becomes the breeding place for mosquitoes, which in turn spread contagious diseases.
- They arrest the flow of water.
- When food contaminated with plastic material is consumed, it leads to the death of living organisms.
- When Plastics/Polythene bags are burnt, they emit toxic gases. These gases mix in air and cause respiratory problems.

As plastics pollute land, air and water, we must avoid the usage of plastics. Instead of plastics we can use things made of cloth, jute, coir and areca-plate which are bio-degradable.

3.5.Glass and its uses

When we hear the word glass, it immediately reminds us of plane mirrors and spectacles. Glasses are also used in window panes, automobiles, decorative lamps etc., There is a plane mirror in Tamilazhrasi's house also. She is wearing spectacles.

Some glasses allow the light to pass through them like Tamizharasi's spectacles. But the plane mirror does not allow light to pass through it. A chemical substance coated at the

back of the mirror reflects the light thereby we could see the image.

What is glass made of ?

Glass is made of chemical substances like silica(sand), calcium carbonate(limestone) and sodium carbonate. The above mixture is melted into a viscous liquid by heating it to a very high temperature. This liquid is poured into a suitable mould and cooled to get glass objects of desired shape. When molten glass is cooled rapidly it becomes brittle. When the molten glass is cooled very slowly, it will not allow light to pass through. Therefore glass should not be cooled either very slowly or rapidly. It should be cooled gradually. This method of cooling is called annealing.

Glass finds a wide range of application in the manufacture of window panes, automobile windows, electric bulbs, medical instruments, laboratory apparatus like standard flasks, test tubes, beakers, measuring jars etc.

3.6.Soap –preparation and uses

Every morning Tamizharasi uses toilet soap for bathing; Detergents for washing her clothes. We also use different types of soaps in our daily life to keep ourselves and our clothes clean.

Different types of soaps like washing soap, toilet soap, baby soap, liquid soap, medicinal soap etc. are in use.

All the above mentioned soaps are not prepared from the same raw materials. The ratio of raw materials also differ. The raw materials used for the preparation of the soap are mentioned on the wrapper of the soap.

We should wash our hands before eating. Because of various reasons the germs that stick to our hands, which mix with the food particals. While eating can cause diseases. In order to prevent from infection, we should wash our hands with soap is essential.

How is soap prepared? Can we prepare soap at home? Yes, we can prepare soap at home provided sodiumhydroxide is available.

ACTIVITY 3.2 WE OBSERVE

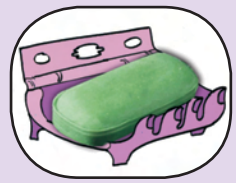
Aim: To prepare soap

Materials we require:

- *water-35 ml*
- *sodiumhydroxide -10 g*
- *coconut oil - 60 g*
- *glass rod*
- *beaker*

Procedure:

Take 35 ml of water in a beaker and dissolve 10g of sodiumhydroxide pellets in it. Allow the liquid to cool. Add 60g of coconut oil to this solution little by little. Stir it gently with the glass rod till it becomes a paste. Pour this paste into an empty match box and dry it to get the soap.



3.7. Fibres

We come to know from history, that ancient man wore the leaves of plants and skin of animals as clothing. But in our present civilized and modern scientific world we have developed fashionable and attractive dresses using different types of fibres. Are all of them alike?

Which kind of clothes do you wear during the following seasons?

1. Monsoon / rainy season: _____
2. Winter season : _____
3. summer season : _____

During hot summer season we like to wear cotton clothes. During winter season we wear woollen clothes to protect ourselves from severe cold. During rainy season, we use umbrellas and rain coats made of polyester. The clothes which we wear are of different kinds. Let us know how we get all these.

ACTIVITY 3 .3 — *I DO*

Aim: *To separate the fibres from the cloth.*

Materials I require: *a piece of cotton cloth.*

Procedure:

- *I take a piece of cotton cloth.*
- *I slowly remove the threads from the edge of the cloth.*
- *I press one end of the thread on the table and scratch it gently with the nail till the fibres are separated.*
- *I will stick the samples as below.*

Cloth

Thread

Fibre

My observation:

_____

_____

In the above activity, the thin strands we get while separating thread are fibres. Fibres are drawn together and twisted to get thread. Clothes are woven using the thread.

3.7.1.Types of fibres and their uses

Fibres are classified into two types based on their source.

- natural fibres
- synthetic fibres

Natural fibres

Fibres which are obtained from plants and animals are known as natural fibres. Jute is obtained from the stem of the jute plant. It is used to make bags, curtains, carpets, etc.

Cotton is obtained from cotton plant. Cotton fibres are twisted to get threads which are used to make cotton cloth. Cotton fibre consists a chemical substance called “cellulose”.

The fibres on the coconut shell are removed and processed to get coir. Coir is used to make ropes, carpets and other household articles. We get silk from the silkworms and wool from the fur of sheep.

Synthetic fibres

The fibres which are synthesized from chemical substances using scientific technology are called synthetic fibres. Polyester, nylon, rayon are some of the examples of synthetic fibres. These fibres are not only used in making clothes but also used in making fishing nets, ropes and parachutes. They are also used widely in various industries.

Can you differentiate the clothes which are made out of natural fibres and made out of synthetic fibres?

ACTIVITY 3.4 *WE DO*

Aim: To differentiate various types of clothing materials.

Materials we require: Cloth bits of cotton, wool, silk, polyester and a magnifying glass.

Procedure:

- *We identify the type(natural/synthetic) of fibre used for making each cloth.We record our findings in the following table.*
- *We touch and feel each cloth bits of cotton, wool, silk and polyester cloth, a magnifying glass to know the nature (soft /rough).*

S. No.	Material	Type of the fibre (Natural / synthetic)	Nature (soft /rough)
1	Cotton		
2	Wool		
3	Silk		
4	Polyester		

SCIENCE




Each group should share their observations with peer groups.

Chemical substances are not only used to prepare the things that we have seen in this lesson but also used in the preparation, preservation, enriching taste and colouring of every substance that we use.

Thus in our daily life chemical substances are used in food, clothing, shelter, transportation, medicine, entertainment and in industries. Since they have become part of our life, it is the duty of each and every one of us to use them carefully and wisely so as to preserve our environment.

Science club debate topic

"Invention of plastics by man is a crime"

Students can be divided into two groups and they can have a debate on this topic.

Importance should be given for scientific information and effects of science. A science teacher or a student can be the judge.

FACT FILE

- *The first Government approved Indian cement factory was started in the year 1914 at Porbandar in Gujarat by India Cement Ltd.,*
- *Broken glass pieces found during the archeological survey at Mesopotamia confirms that Mesopotamians were the first to use glass in the third century.*
- *Nowadays a new kind of plastics namely Bio-plastics are manufactured. This kind of plastics is Bio-degradable in nature.*

EVALUATION

I. Choose the correct answer

1. Identify the one which is not a natural fibre.
   (a) silk (b) wool (c) polyester (d) jute
2. Which kind of clothes do you prefer in summer?
   (a) nylon (b) wool (c) silk (d) cotton
3. The clothes which are made from the fur of the animals
   (a) woollen (b) cotton (c) silk (d) nylon
4. Which of the following is widely used in the manufacture of medical instruments?
   (a) polyester (b) plastics (c) glass (d) cotton
5. The important chemical substance used in the preparation of soap is _____
   (a) sodiumhydroxide (b) sodium amalgam
   (c) sodiumsilicate (d) sodiumbicarbonate

II. Fill in the blanks

1. The basic raw materials used in the manufacture of cement are _____, _____ and _____
2. The expansion of P.V.C.is _____
3. _____ is used to make fireproof clothes.
4. The process of slow and steady cooling of glass is called _____
5. The fibre obtained from the stem of the plant is _____
6. The chemical substance present in the cotton fibre is _____

III. Match the following

1. Glass	-	a. gypsum
2. Switch	-	b. silica
3. Tiles	-	c. synthetic fibre
4. Cement	-	d. bakelite
5. Nylon	-	e. melamine

IV. Think and answer

1. Why do we spray water (i.e. curing) on the building that is being constructed? What will happen to the building if water is not sprayed?
2. We use mortar for flooring and plastering the walls. But we use _____ to construct dams and bridges. Find out the differences between the two?
3. Name the part of the cookwares labelled as 'X' in the given diagram. Name the material used to make it. Why is it used? What type of material is it?

4. You know that switches and waterbottles are made of plastics. Under what category do you classify them based on the kinds of plastics?
5. During winter season how will you feel when you wear two or three clothes one over the other instead of wearing a woollen sweater? Why?
6. Explain in your own words whether the chemical substances that we use in our daily life are useful and do not pollute the environment.
7. Plastics are 'a great threat to the life of the planet Earth'. How?
8. Classify the following :

   jute, rayon, nylon, silk, cotton, polyester, wool - Give reason.

9. Molten glass should not be cooled rapidly or very slowly during its preparation. Why? Instead of that what should be done?

V. Project

1. Visit a nearby construction site. Collect the following information and prepare an assignment.
   i) List of materials used for construction
   ii) The method of preparation of concrete.
   iii) The type of cement mixtures used in flooring and construction of roofs.

2. *Observe your school campus and its surroundings for a week, collect the following information and present them in your class.*

   i) *What are the plastic materials accumulated in your class, school and its surroundings?*

   ii) *How do they get accumulated?*

   iii) *What are the steps that you will take to make your school a 'plasticfree zone'?*

FURTHER REFERENCE

Webliography :

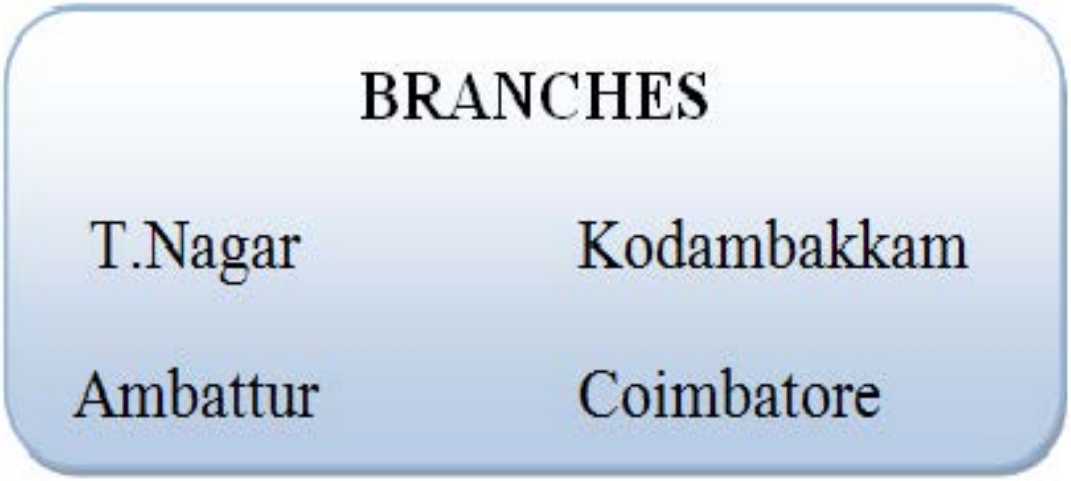
http://www.jute.com/html/indian-jute.htm

http://www.fabrics.net/cotten.asp

SHAKTHII ACADEMY

SCIENCE -CHEMISTRY

STANDARD - SEVEN



We are surrounded by a number of objects. eg : iron, wood, water, air etc. We do not see air but we feel its presence. All these things occupy space and have mass. In the **World of Science, matter is anything that has mass and occupies space.** There are different kinds of matter. Here, we learn about matter based on its physical properties.

ACTIVITY 5.1

Look at your surroundings, observe and write the objects around you.

In your house	1..... 2..... 3.....
In the playground	1..... 2..... 3.....
In your classroom	1..... 2..... 3.....

SCIENCE

5.1. PHYSICAL NATURE OF MATTER

Let us perform an activity to learn about the nature of matter.

ACTIVITY 5.2

Let us take a small piece of chalk and powder it. We can see that the chalk powder consists of small particles. These particles are responsible for the formation of matter (chalk). **Matter is made up of tiny particles** known as atoms and molecules. Molecules are made up of atoms. Molecules and atoms are the building blocks of matter.

MORE TO KNOW

The size of the atoms and molecules of matter is very small, almost beyond our imagination. It is measured in nanometres ($1nm = 10^{-9}m$).

Fig.5.1-Chalk piece

Fig.5.2-Chalk powder

5.2. CHARACTERISTICS OF PARTICLES OF MATTER

ACTIVITY 5.3

- Take some water in a beaker.
- Mark the level of water. Add some sugar to the water and stir well.
- Do you observe any change in the water level?
- What does the solution taste like?
- What happened to the sugar?
- How did it disappear?

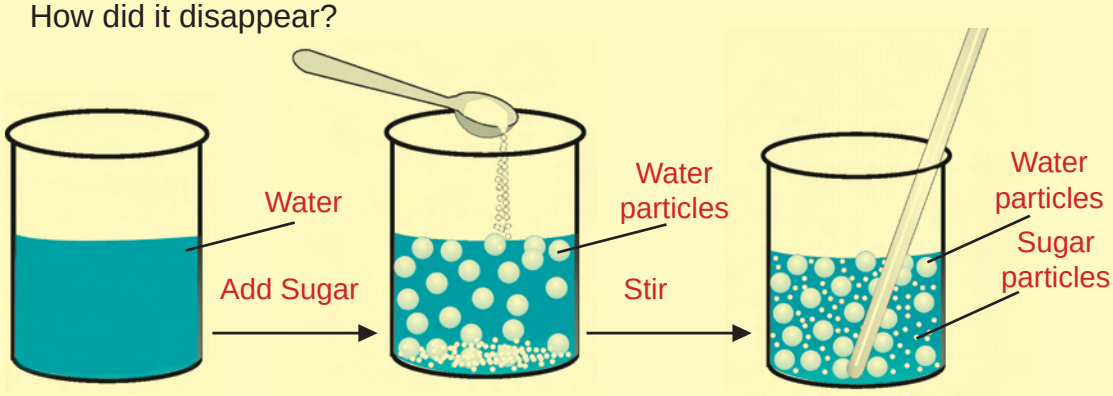


Fig.5.3-Particles of water and sugar are magnified million times.

From the above activity you can notice that there is no change in the water level but the taste is sweet. It indicates that the sugar is completely dissolved in water. When you dissolve sugar in water, the molecules of sugar occupy the space between molecules of water and get uniformly distributed in water. It is understood **that there exists a space between the molecules in matter.**

ACTIVITY 5.4

- Take some water in a beaker.
- Add a drop of blue ink slowly and carefully into the beaker.
- Leave it undisturbed in your classroom.
- Record your observation.

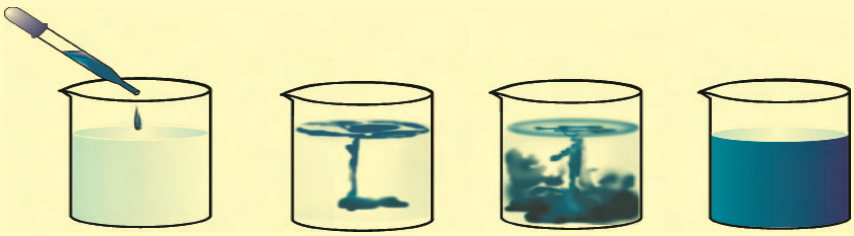


Fig.5.4-Diffusion of ink in water

From the above activity you can understand that **the molecules of matter continuously move and mix with each other.**

SCIENCE

ACTIVITY 5.5

- Open a water tap.
- Try to break the stream of water with your fingers.
- Are you able to break the stream of water?
- What could be the reason behind the stream of water remaining together?

Fig.5.5-Stream of water remains together

The above activity shows that **molecules of matter have force of attraction between them.** This force binds the molecules together. Force of attraction between the molecules (Inter molecular forces) varies from one kind of matter to another. The structure and properties of matter – whether they are hard or soft, coloured or transparent, liquid or gas- depends on the way in which the atoms and molecules are arranged.

5.3. STATES OF MATTER

Matter can exist in three physical states, i.e., solid, liquid and gas.

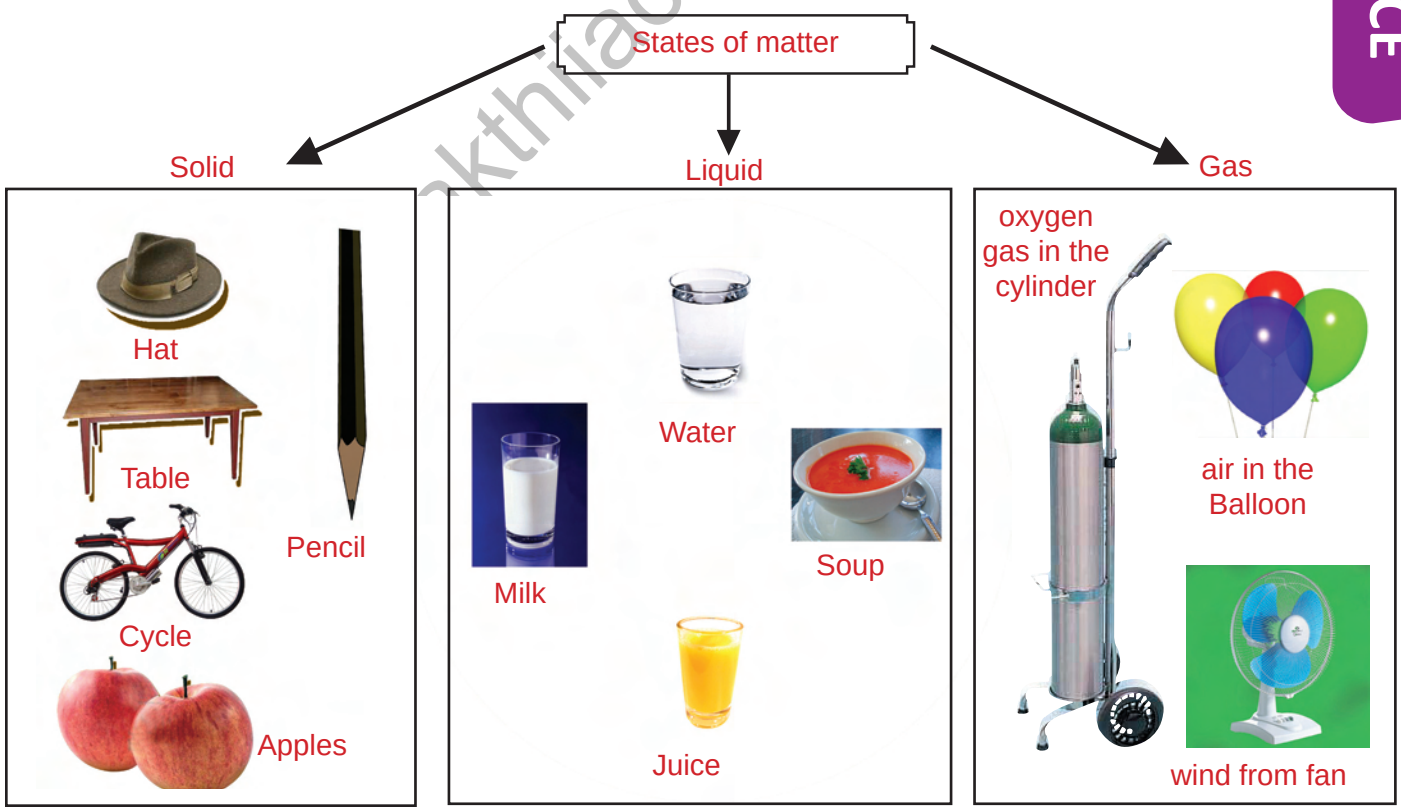


Fig.5.6-States of matter

Solid

Solids are characterized by definite shape, size and volume. In solids, the molecules are very closely arranged because the force of attraction between the molecules is very strong. They are incompressible. The following figures 5.7(a & b) are a few examples to show that matter exists in the solid state. Fig (5.8) shows how molecules are closely arranged in solids.

5.7.(a)

5.7.(b)

Fig. 5.7- Examples of matter in solid state

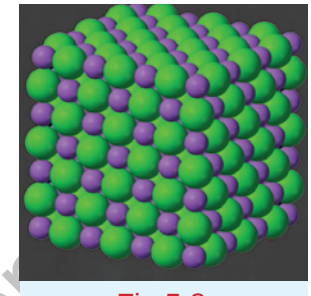


Fig.5.8
Close arrangement of molecules in solid

SCIENCE

TO THINK...

Sponge is also a solid. Yet we are able to compress it. Why? Sponge has minute holes in which air is trapped. When we press it, the air is expelled and we are able to compress it.Solids may break under force. It is difficult to change their shape as they are highly incompressible.

Fig. 5.9. Sponge

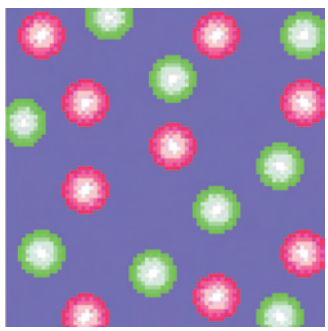


Fig.5.10
Plasma State

MORE TO KNOW

Matter exists in two more states.

Fourth State of Matter -Plasma- super heated gaseous State.

Fifth State of Matter - 'Bose-Einstein condensate' – super cooled Solids.

Liquid

Liquids occupy definite volume but have no definite shape. It takes the shape of the container as shown in fig 5.11. Do you know why? The inter molecular force of attraction between the molecules in a liquid is less when compared to solids and these molecules are loosely packed. This allows the liquid to change its shape easily. They are negligibly compressible. A few examples for matter that exist in liquid state are water, oil, juice etc. From the fig 5.12 you can also see how the molecules are loosely arranged in liquids.

Fig. 5.11. Liquid takes the shape of the container

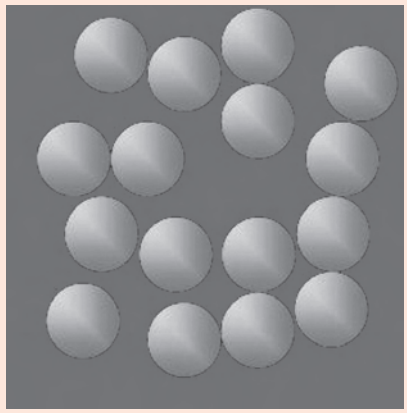


Fig 5.12. Loose arrangement of molecules in liquid

Gas

The atoms or molecules of matter that always occupies the whole of the space in which they are contained is called a **gas**, as shown in Fig 5.13 . It neither occupies a definite volume nor possesses a definite shape. The inter molecular force of attraction between the molecules of a gas is negligibly small, because the molecules are very loosely packed as in Fig 5.14 . The molecules are distributed at random throughout the whole volume of the container. Gases are highly compressible when compared to solids and liquids. Gases will expand to fill the space of the container. The Liquefied Petroleum Gas (LPG) cylinder that we get in our home for cooking and the oxygen supplied to hospitals in cylinders are compressed gases. These days Compressed Natural Gas (CNG) too, is used as fuel in vehicles. In Delhi, CNG gas is used as a fuel in buses.

Fig 5.13.
Gas filled balloon

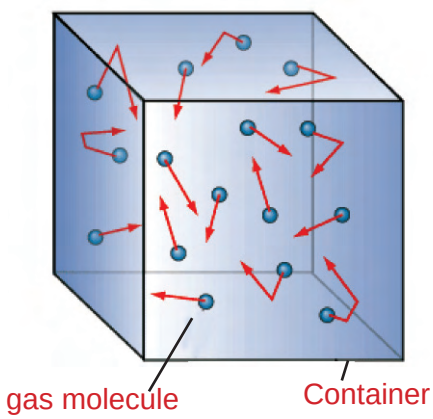


Fig5.14. Very loose arrangement of molecules in gas

SCIENCE

SCIENCE

ACTIVITY 5.6

Take a cork ball and press it. Do you find any change in the size or shape. No,it cannot be compressed. You know well that solids are incompressible.

Let us compare the compressibility of liquids and gases using an activity.

Take two hypodermic syringes and label them 1 and 2.

1. Plaster the nozzle and seal it with a cork.
2. Remove the piston (Plunger) from the syringes.
3. Fill syringe-1 with water.
4. Do not add anything in syringe 2 (still it contains air).
5. Insert the piston back into the syringes. You may apply some Vaseline on the piston before inserting them into the syringes for smooth movement.

Now try to compress by pushing the piston in each syringe. In the case of water (liquid) in syringe1 the piston moves just a little. But in the case of air in syringe2, the piston can be pushed completely.

This shows liquids can be compressed slightly, while gases can be compressed easily.

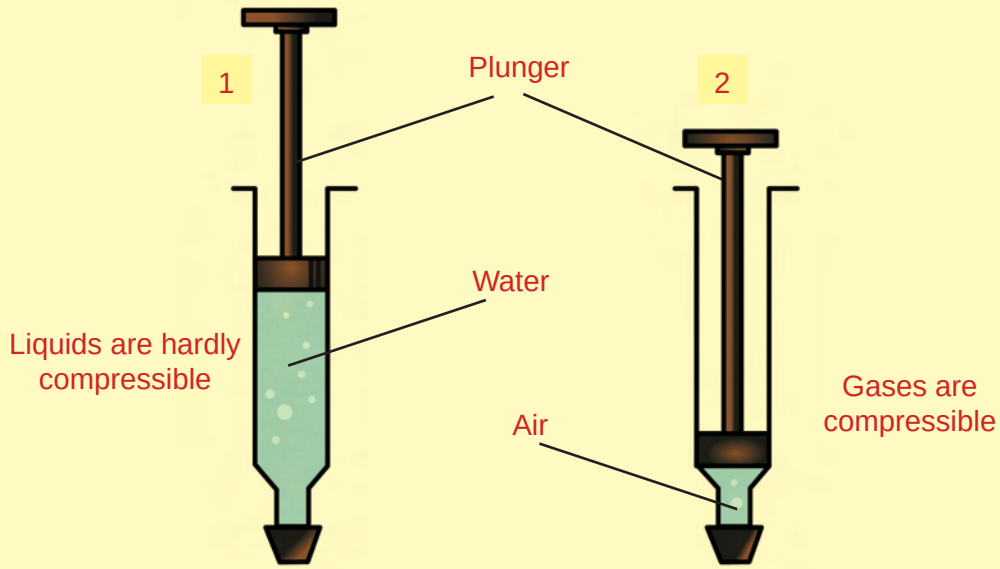


Fig. 5.15. Effect of pressure on liquid and air

MORE TO KNOW

Why does the smell of hot cooked food spread out easily?

Here the particles of the aroma of food mix with the particles of air in the kitchen and spread out from the kitchen very easily. This is due to

(i) The free particles or molecules of gas in aroma and air.

(ii) The high speed of the gaseous particles or molecules.

(iii) The large space between them.

So gases diffuse much faster than solids and liquids.

Properties of Solid, Liquid and Gas :

Table 5.1

S.No	SOLID	LIQUID	GAS
1	Have definite shape and volume	Have definite volume but no definite shape	Have neither definite shape nor definite volume
2	Cannot flow	Can flow from higher level to lower level	Can flow very easily and quickly in all directions
3	Intermolecular space is minimum	Intermolecular space is moderate	Intermolecular space is maximum
4	Intermolecular forces are maximum	Intermolecular forces are less than solid	Intermolecular forces are negligible
5	They are incompressible	They are compressible to an extent	They are easily compressible

5.4 EFFECT OF TEMPERATURE ON SOLID, LIQUID AND GAS

Can you change the state of matter? i.e., from solid to liquid or from liquid to gas.

Let us perform an activity to understand the effect of temperature on matter.

ACTIVITY 5.7

Take some ice cubes in a container, heat the container and observe the changes.

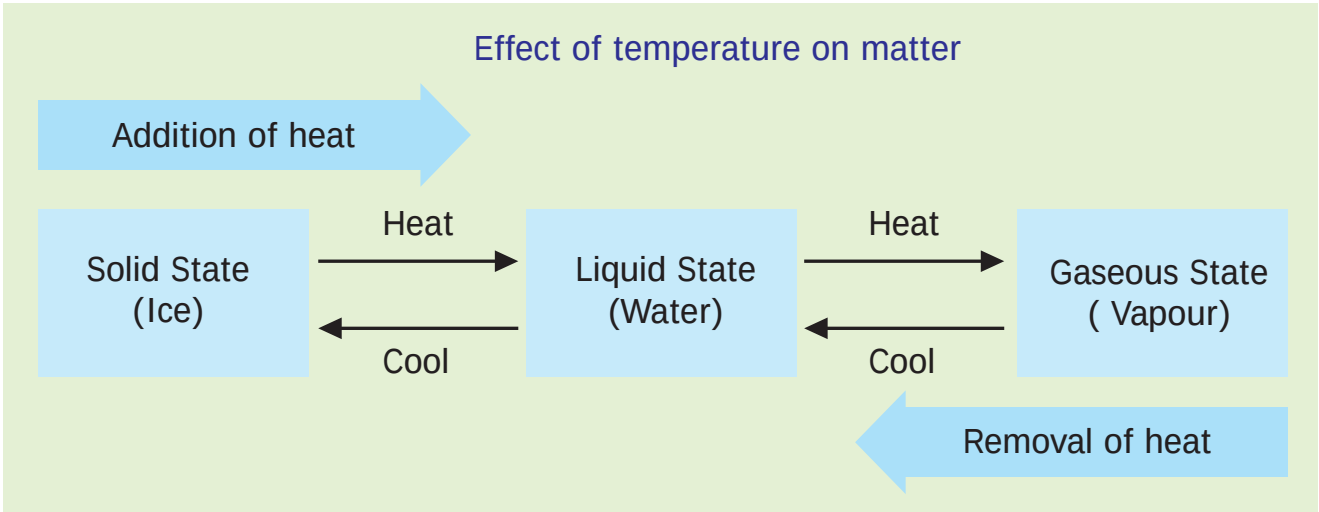
Ice (Solid)

Water (Liquid)

Vapour (Gas)

Fig. 5.16. Effect of temperature on matter.

SCIENCE



SCIENCE

On varying the temperature, you can notice that matter will change from one state to another. For example ice (solid) in the container, on heating, becomes water (liquid) and on further heating, it changes into water vapour(gas).

Water can exist as three states of matter.

- Solid, as ice.
- Liquid, as water
- Gas, as water vapour.

What happens to the particles of matter during the change of states? How does this change of state take place? Don't we need answers to these questions?

On increasing the temperature of solids, the kinetic energy of the particles (molecules/atoms) increases. Due to the increase in kinetic energy, the particles start vibrating with greater speed. The energy supplied by heat overcomes the forces of attraction between the particles. The particles leave their fixed positions and start moving more freely. A stage is reached when the solid melts and is converted into a liquid. The temperature at which a solid melts to become a liquid is called its **melting point. The melting point of ice is 0° C**

When we supply heat energy to water, the particles (molecules or atoms) start moving even faster. At a certain temperature, a point is reached when the particles have enough energy to break free from the forces of attraction between each other. At this temperature the liquid starts changing into gas. The temperature at which a liquid starts boiling is known as its **boiling point.** The boiling point of water is 100° **C**

Particles from the bulk of the liquid gain enough energy to change to the vapour state. So, we infer that one state of matter can be changed into another state by varying the temperature.

THINK AND ANSWER

Does coconut oil solidify during the winter season?

ACTIVITY 5.8

Magesh is interested in classifying the different states of matter shown in the box below. Shall we help Magesh to classify the objects below, depending on its state. Put the appropriate objects in the given table (Table 5.2).


Stone


Smoke from incense sticks


Water


Petrol


Oxygen inside the Cylinder


Iron Rod


Honey


Ice Cubes


Milk


Balloon

Table 5.2

Solid	Liquid	Gas

ACTIVITY 5.9

To check whether all solids change their state at the same temperature.

- Take ice, butter and wax.
- Put the ice into the pan. Heat it until the ice changes into water. Use the thermometer to measure the temperature at which it changes the state
- Continue this process for butter and wax.
- Note down the temperature at which the solid state is converted into liquid state in the following table.

Table 5.3

S.No.	Solids	Temperature (^{0}C)
1.	Ice	
2.	Butter	
3.	Wax	

EVALUATION

1. Materials which are very familiar to Raveena are given below. Help her to classify them into solids, liquids and gas.

   bricks, kerosene, milk, coconut oil, air, book, table, oxygen, carbon dioxide

2. Give reason for the following observation.

   a) We can smell the jasmine flower while we are sitting several metres away.

   b) The level of water remains the same when a pinch of salt is dissolved in it.

3. Gas can be compressed into a smaller volume but a solid cannot be. Could you explain. Why?

4. Match the following:

a)	Liquid on heating	-	liquid
b)	Solid	-	easily compressible
c)	Atoms and molecules	-	becomes vapour
d)	Milk	-	cannot flow
e)	Gas	-	building blocks of matter

5. Choose the correct one from the answers given in bracket:

   a) The only substance which exists in all the three states of matter is _____ (water, stone, glass)

   b) The matter which has a negligible intermolecular space is_____ (solid, liquid, gas)

   c) 1 Nanometer is equal to _____

   (10^{-10}m, 10^{-9}m, 10^{-12}m)

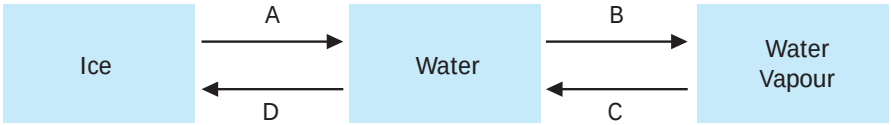
6. Fill in the blanks:

   a) The force of attraction between the particles in gas is _____ (less / more) than that of a solid.

   b) _____ (Solid / Liquid) state has definite volume, but no definite shape.

7. Mohan went to a shop to buy milk. He took his bicycle to go to the shop. He saw that the air in the cycle tube was a very little. He took it to the cycle shop. The cycle mechanic used a compressor pump to inflate the cycle tube. Mohan had a doubt. “How does the compressor works?”. Help Mohan to find the answer.

8. On varying the temperature, you can notice the process that matter will change from one state to another. Name the process A, B, C and D.



9. Solids are incompressible. Sponge is also a solid. We are able to compress it. Could you explain. Why?

PROJECT

Collect 5 or 6 different types of used water bottles. Take a bucket of water. Fill the bottles with water fully. Based on your observation, answer the following questions.

a) Does the volume remain the same?

b) Does the shape of the liquid remain same?

1 Litre 1 Litre 1 Litre 1 Litre 1 Litre

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SCIENCE

Everyday we notice a variety of changes that take place around us. These changes may involve one or more substances. For example, ice melts, water changes into steam, sugar dissolves in water. The milk is turned into curd. A change occurs in all these instances. 'A rubber band that is stretched' since the action causes the change also represents a change. Changes in matter occur under certain conditions. In this chapter, we shall perform some activities and closely examine the nature of these changes. The changes that take place around us are of two types:

1. **Physical changes**
2. **Chemical changes**

3.1. PHYSICAL CHANGES

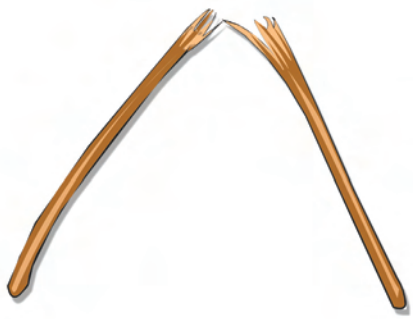

Fig. 3.1. Broken Stick

ACTIVITY 3.1 **I DO**

I need: A small stick.

Let me break the stick into two pieces and find out the change that happened. I break a stick into two pieces. I keep the pieces on a table, in such a way that the pieces acquire the shape of the original stick. Obviously, I cannot join the pieces back to regain the original stick. It is because the stick has undergone a change in the size (physical appearance), but no change has taken place in the chemical composition. Hence I conclude, it is a physical change that has happened.

ACTIVITY 3.2 **I DO**

I need: A piece of paper, scissor.

Now, let me cut a paper into small pieces and see what change undergoes.

I cut a piece of paper into four square pieces.

Further , I cut each square piece into four square pieces.

Then I lay the pieces on the table in order to get back the original shape.

The original paper has undergone a change only in size (physical apperarance), and not in chemical composition, It is a physical change that has occured.

Do you know that the melting of ice stick is an example of a physical change?

Fig. 3.2. Melting of ice stick

Fig. 3.3. Separation of Iron fillings from sand using magnet

ACTIVITY 3.3 I DO

I need: Magnet, tray, sand , iron fillings.

Does sand react with iron fillings to form a new chemical substance? Let us find out what happens by doing an activity. I take some sand and iron fillings in a tray and mix them well. I notice that no new substance is formed. I move a magnet over the mixture. The fillings are easily attracted by the magnet, while the sand remains on the tray. Since, no new substance has been formed, it is a physical change that has taken place.

We will find that no change has taken place in chemical composition and no new product has formed. Only a **physical change** has taken place. A physical change does not involve the formation of any new substance and it is readily reversible.

ACTIVITY 3.4 WEOBSERVE

CRYSTALLIZATION

AIM: To show that crystallization is a physical change.

We need: China dish ,Funnel, Conical Flask, Tripod stand, Wire gauze, Burette stand and Funnel holder, Sulphuric acid, Copper sulphate,Filter paper and bunsen burner.

Procedure :

- Take a little amount of water in a china dish.
- Add sufficient amount of copper sulphate crystals to get a saturated solution. Add a few drops of acid (Sulphuric acid- H_2 So_4) to this solution.
- Heat the solution till the crystals are completely dissolved. Allow the solution to cool and then filter it.
- Continue to cool the filtered solution for some more time, without disturbing it. After some time, crystals are formed in the solution.

Fig. 3.4. Crystallization

SCIENCE

From this activity we observe that the copper sulphate crystals that were dissolved in water have become crystals again. Therefore dissolution of copper sulphate is a physical change. We also observe that the newly formed crystals have definite geometrical shape and size. Thus crystals of pure substance can be obtained from their solution. This process of crystal formation is known as crystallization.

ACTIVITY 3.5 **WE OBSERVE**

SUBLIMATION

Aim: To show that sublimation is a physical change.

We need: Camphor, China dish, Funnel, Tripod stand, Wire guaze, Bunsen burner.

Procedure:

- Take a small amount of camphor in a china dish.
- Invert a funnel over the dish.
- Close the stem of the funnel with a cotton plug. On heating it gently, camphor is converted into vapour. The vapour of camphor gets condensed on the walls of the funnel.

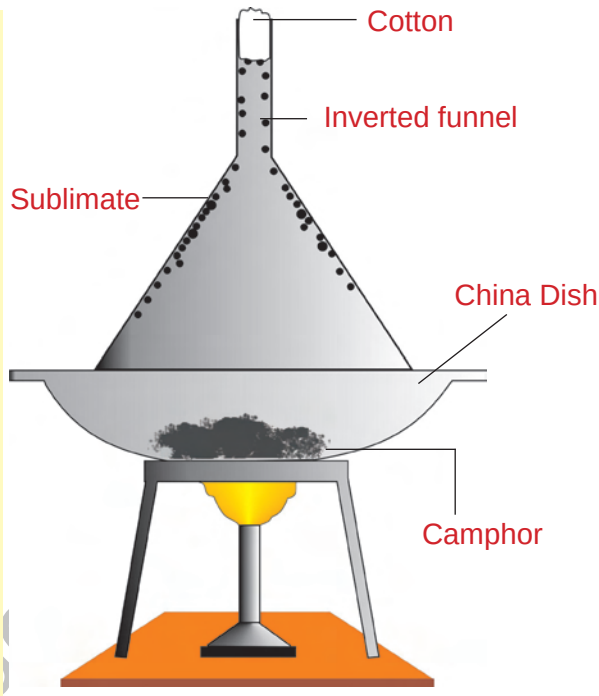

Fig. 3.5. Sublimation

From this activity we observe that the camphor, at first, vapourised, but it was deposited back as camphor on the sides of the funnel. Also the chemical composition of camphor has not changed and the reaction was reversible. Therefore heating of camphor is a physical change.

The process of converting a solid directly into its gaseous state is known as **sublimation**.

TO THINK...

When an electric current is passed through the filament of a bulb, the filament starts glowing and there is a change in the appearance of the filament. When the current is cut OFF, the glow of bulb stops and its original appearance is restored. Do you think burning of electric bulb is a physical change?

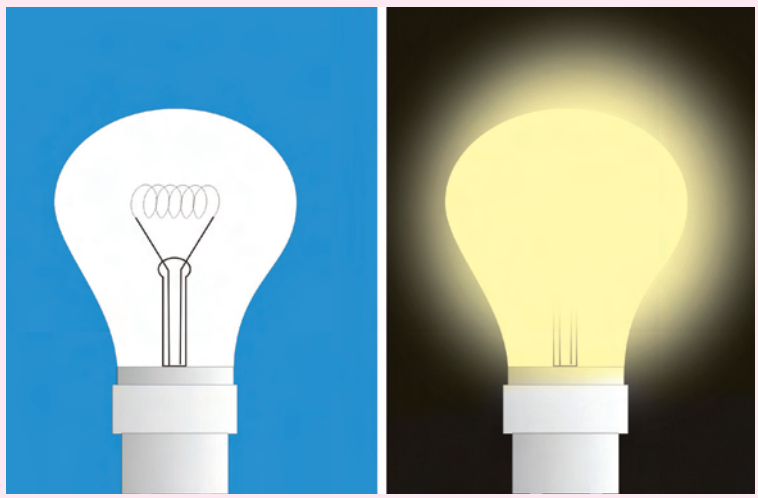
Bulb before switching ON — Glowing Bulb

Fig. 3.6.

ACTIVITY 3.6 WE OBSERVE

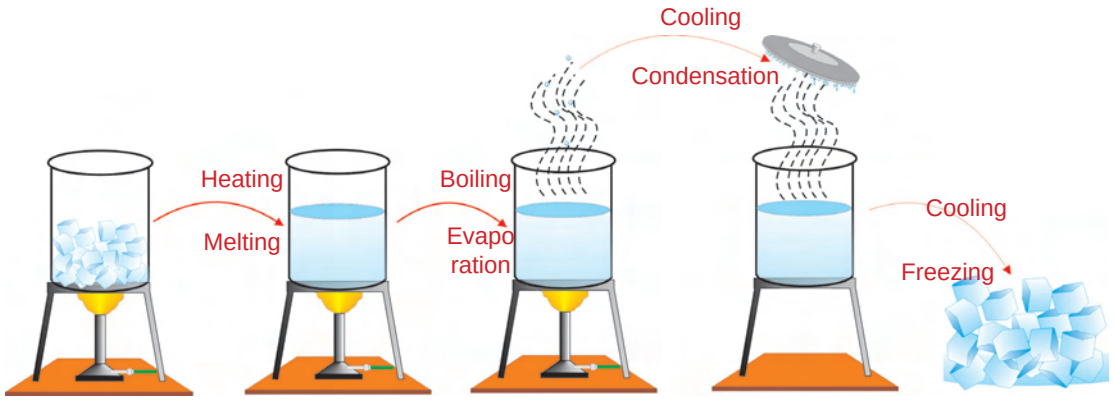

Fig. 3.7. Changes in the state of water due to heating and cooling

Aim:

To show that the change of state is a physical change.

We need

Beaker, Ice cubes, Bunsen burner,Tripod stand, Plate,

Procedure :

- Take some ice cubes in a beaker and place it on a tripod stand and heat it with the help of a burner. What do you observe? Ice melts to form water.
- Can we change this water into the ice again? Suggest a method for it.
- Take some water in a beaker and boil it. What do you observe?
- You can observe water evaporates into water vapour.
- Cover the beaker with an inverted plate.
- Do you notice some water droplets condense on the inner surface of the plate and fall into the beaker?
- Can we change this water into ice again?

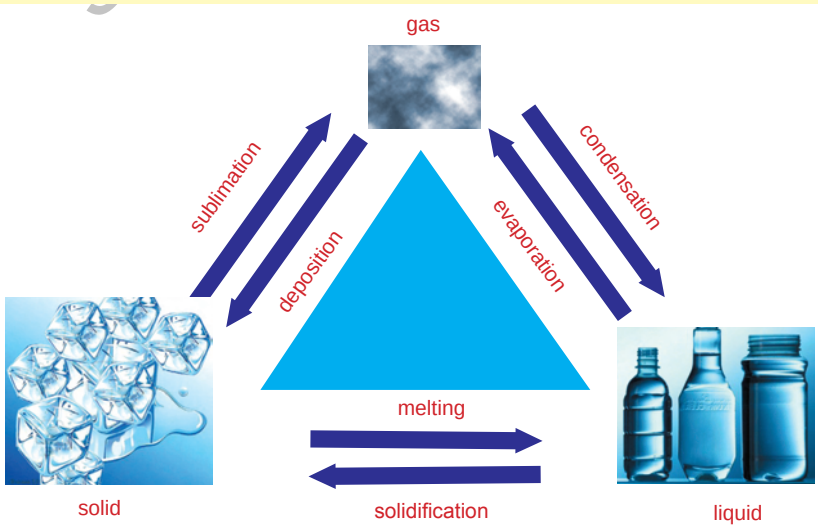

Fig. 3.8. Change of States

From this activity, we see that

- On heating, the water has changed from a solid (ice) into liquid (water) and from a liquid into gas (vapour) and then gas was changed to a liquid. The water (liquid) can be changed into a solid (ice) when it is frozen.
- In all the changes there is no change in the chemical composition of water. This is a physical change. When solids change to liquids on heating. This process is called melting.

Liquids change to gas on heating. This process is called evaporation.

The vapour, when allowed to cool,condenses into its liquid state. This process is called condensation.

Water, when cooled to zero degrees changes into ice. This process is called freezing.

In all the above activities, the changes take place only in the physical properties of a substance, such as shape, size, colour and temperature. A physical change occurs when the substance changes its physical state but does not change its chemical composition. A change in which a substance undergoes changes only in its physical properties is called a **physical change**. A physical change is generally reversible and no new substance is formed.

3.2. CHEMICAL CHANGES:

You are quite familiar with the rusting of iron. If you leave an iron object such as bolt or iron rod in the open air or in the rain, a reddish brown layer is deposited on its surface. **The layer thus formed is called rust and the process is called rusting**.

In the presence of moisture, iron reacts with oxygen present in air, to form hydrated 'iron oxide', known as **rust**. Oxygen and water are two essential ingredients for rusting of iron.

Fig.3.9(a)-rusted nut

Fig.3.9(b) Rusted vehicle

ACTIVITY 3.7 WE OBSERVE

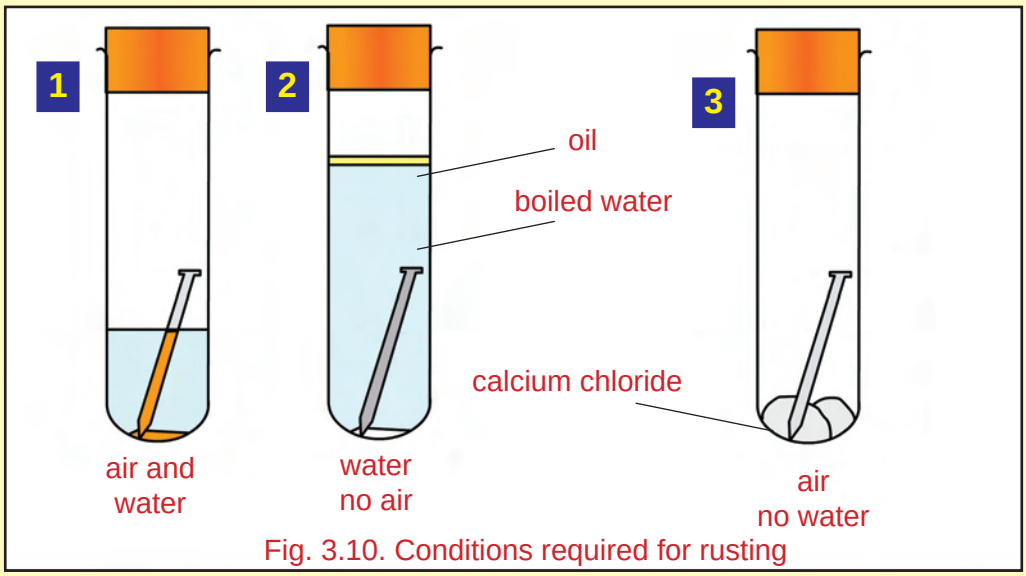

Fig. 3.10. Conditions required for rusting

Aim: To show both oxygen and water are essential for rusting.

We need: test tube, Iron nail, oil, calcium chloride, cork

Procedure :

- Take three test tubes and label them 1, 2 & 3.
- Place a clean iron nail in each of them.
- In test tube-1, pour a small amount of tap water.
- In test tube-2, add boiled and distilled water and add some vegetable oil to keep off the air.
- In test tube-3, add a small amount of calcium chloride (a dehydrating agent).
- Keep them undisturbed for three to four days and observe the nails in each of the test tubes.

We notice that the nails in test tube-2 and-3 have not rusted, while the nail in test tube-1 has rusted. From this activity you can infer that oxygen and water are essential for rusting.

Rust is a brittle substance that flakes off easily from the surface. Rust is different from the iron on which it gets deposited. It means a new substance has formed.

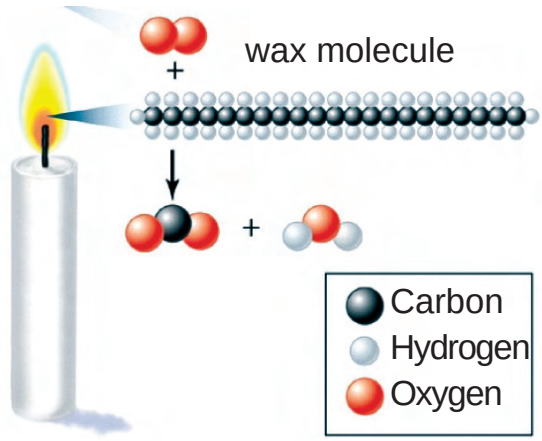

Fig. 3.11. Burning of candle

MORE TO KNOW

Burning of a candle is an example of a chemical change. Wax molecule is converted into carbondioxide and water molecules.

SCIENCE

ACTIVITY 3.8 WE OBSERVE

Aim:

To show burning of magnesium ribbon is a chemical change.

We need :

Magnesium ribbon, bunsen burner, holder.

Procedure :

Take a fine strip of magnesium ribbon. Bring the tip of the strip near a candle flame. It burns with a brilliant white light and finally leaves behind a residue of powdered ash.

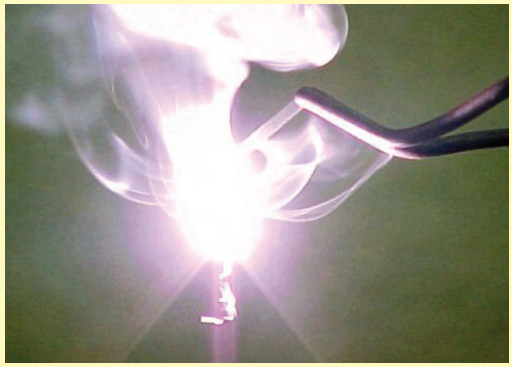

Fig. 3.12.
Burning of magnesium ribbon

Does the ash look like the magnesium ribbon?

No, we cannot get it back. Can we get back the magnesium ribbon from the ash?
No, we cannot get the magnesium ribbon from the ash.

In this experiment a new compound has formed whose chemical composition is different from magnesium. This is a chemical change.

SCIENCE

MORE TO KNOW

Phenolic compounds are responsible for the bright colours, aroma and flavour of many fruits and vegetables. They reduce the risk of heart disease and certain types of cancer.

MORE TO KNOW

Vegetables and fruits turn brown on cutting, due to the reaction between the phenolic compound in fruits and the oxygen in air. Phenolic compound and oxygen react to form a brown pigment known as **melanin**.

TOTHINK...

During Diwali, we are very happy to light fire crackers with our family members. The combination of colour and sound creates an exciting light show and we have a spectacular display. Do you ever think of what happens to the crackers after they are burnt completely? Similarly burning of paper or wood produces heat and light and finally you get a small amount of ash, (i.e.) a new substance is formed. In all these cases, we cannot get back the original substances. Say which change has taken place here.

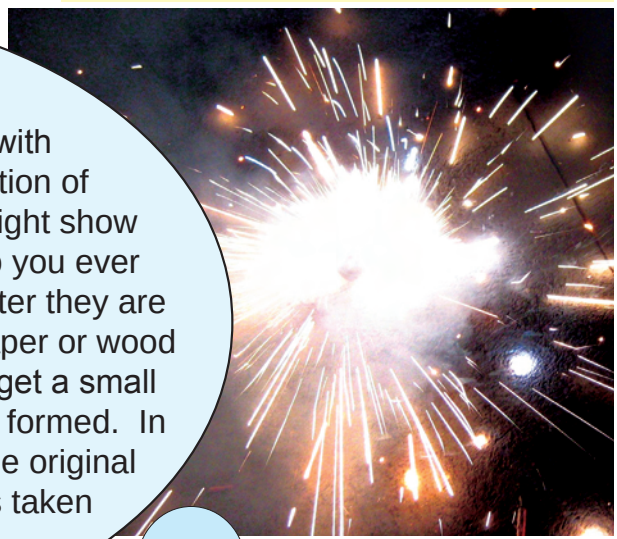

Fig. 3.13. bursting of crackers

ACTIVITY 3.9 WE OBSERVE

Aim: To show that the reaction of baking soda with lemon juice is a chemical change.

We need: lemon juice , baking soda, test tube, test tube holder.

Procedure:

Take a teaspoonful of lemon juice (citric acid) in a test tube. Add a pinch of baking soda to it.

We would hear a hissing sound and see gas bubbles coming out.

The gas that is formed is carbon-di-oxide.

Lemon juice (citric acid) + Baking soda ⟶ Carbon dioxide + Salt + Water

The sound produced is due to the evolution of gas (carbon di oxide) in this reaction. It is a chemical change.

ACTIVITY 3.10 WE DO

Curdling of Milk:

Aim: To show curdling is a chemical change.

We need: Milk, buttermilk (or) curd.

procedure :

- Boil the milk and cool to luke-warm temperature
- Add a teaspoon of starter butter milk or curd into it. Keep it aside for a few hours.

Has any change occurred?

The milk changes into curd. Since both milk and curd have different properties. It is a **chemical change**.

Find out what happens if excess starter buttermilk or curd is added? What happens if the starter buttermilk or curd is added to milk at a very high temperature?

Will the curd set faster when it placed outside or inside the refrigerator?

When a large quantity of starter buttermilk / curd is used,

what happens to the taste of the curd? Find out the reason for your answer.

milk

curd

Fig. 3.15. curdling

In all the above activities, you can see that one or more new substances are formed. The properties of the new substances are not the same as that of the original ones. These processes are also irreversible. This type of change is called a **chemical change**.

A change in which one or more new substances are formed, is called a chemical change. A complete and permanent change in the properties of the substance is produced. A chemical change is also referred to as a **chemical reaction**.

SCIENCE

MORE TO KNOW

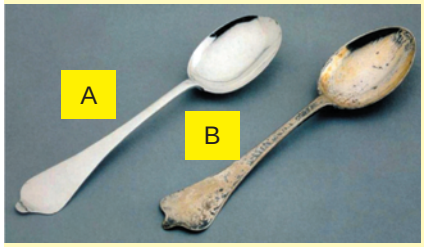

Fig. 3.14. Tarnishing silver Spoon

If you have any object made of silver you know that the bright, shiny surface of silver gradually darkens and becomes dull. This discolouration is known as tarnishing. Look at the picture with two silver spoons 'A' and 'B'. 'A' shines well but 'B' does not. What happens? Why does this discolouration occur? This happens because silver undergoes a reaction with sulphur contained in the air. You can use chemistry to reverse the tarnishing reaction, and make the silver shine again.

Chemical changes are very important in our day- to- day life. A medicine is a product of chemical reaction. Useful materials like plastic, detergents, dyes and paints etc. are also produced by chemical reactions.

In addition to the new products formed, the following may also accompany a chemical change.

- Heat or light may be given off or absorbed
- Sound may be produced
- Colour change may take place
- A change in smell may take place.

SCIENCE

AMAZING FACT!

Iron Pillar

In New Delhi, near Qutub Minar, stands an iron pillar which is more than 7 meters tall and weighs more than 6000 kg. It was built 1600 years ago. Strangely, even after such a long period of time, it has not rusted. Scientists from all over the world have examined its quality of rust resistance. It shows the advancement India had made in metallurgy technology as far back as 1600 years ago.


Fig. 3.16. Iron Pillar in Delhi

Fig. 3.17. A ship in Chennai Port

MORE TO KNOW

You know that ships are made of iron. A part of the ship always remains under water. Since the sea water contains a great amount of salt, the ship suffers a lot of damage from rusting inspite of being painted. These rusted parts need to be replaced every now and then. Imagine the loss of money incurred this way!

3.2.1. DIFFERENCES BETWEEN PHYSICAL CHANGE AND CHEMICAL CHANGE

Table 3.1

S.No	Physical change	Chemical change
		
1	The physical changes are reversible.	The chemical changes are irreversible.
2	New subtances are not formed.	New substances are formed.
3	The molecular composition of the substance remains the same.	The molecular composition of the substance also changes.
4	No energy change is involved.	Energy change is involved.
5	Temporary change.	Permanent change.

Fig.3.18-Painted Window

MORE TO KNOW

Prevention of rusting can be done by

1. Applying oil, paint or grease.
2. Galvanisation (deposition of zinc over iron).
3. Chrome plating (deposition of chromium over iron).
4. Tinning (coating of tin over iron).

SCIENCE

3.3. ACIDS, BASES AND SALTS

On Sunday, Keerthivasan's mother boiled an egg for his lunch. Since it was very hot, she took a bottle of water from the fridge, poured some into a bowl and put the egg in it to cool. She went to the market and forgot all about the egg. When she came back and took the egg out of water, she was surprised to find that the hard shell of the egg had disappeared. She wondered what happened. She smelt the liquid and realized her mistake. She had poured vinegar into the bowl, instead of water. Can you say what would have happened? Perhaps you can do it at home with the help of your mother.

In our daily life, we use substances such as lemon, tamarind, tomato, common salt, sugar and vinegar. Do they all have the same taste? If you have not tasted any of these substances, taste it now and enter the result in table 3.2

CAUTION !

1. Do not taste anything, unless you are asked to.
2. Do not touch anything, unless you are asked to.

Table 3.2

Substance	Taste (sweet/sour/bitter/any other)
Curd	
Orange juice	
Grapes	
Lemon Juice	
Tamarind	
Sugar	
Unripe Mango	
Gooseberry (Nelli)	
Baking soda	
Vinegar	
Common salt	
Tomato	

You find that some of these substances taste sour, some taste bitter, and some taste sweet.

3.3.1 ACIDS,BASES AND SALTS USED IN OUR DAILY LIFE

During summer, when your grandmother prepares pickles (lime, mango, etc.), she adds vinegar to them. Did you ever ask her why she does that? If not, ask her now and find out the reason.

Curd, lemon juice, orange juice and vinegar taste sour. These substances taste sour because they contain acids. The chemical nature of such substances is acidic. The word 'acid' comes from the Latin word 'acidus' which means sour. We come across many acids in our daily life.

In general, acids are chemical substances which contain replaceable hydrogen atoms. Acids can be classified into two categories namely organic acids and mineral acids or inorganic acids.

Organic acids

Acids which are obtained from animal and plant materials are called organic acids. Many such acids are found in nature. Lemon and orange contain citric acid. Hence they are called citrus fruits. Milk that has turned to curd tastes sour, contains an acid called Lactic acid. The acids found in food stuffs are weak. Soft drinks contain some carbonic acid which gives a tingling taste. Apple contains malic acid. Some common organic acids are shown in the Fig.3.19.

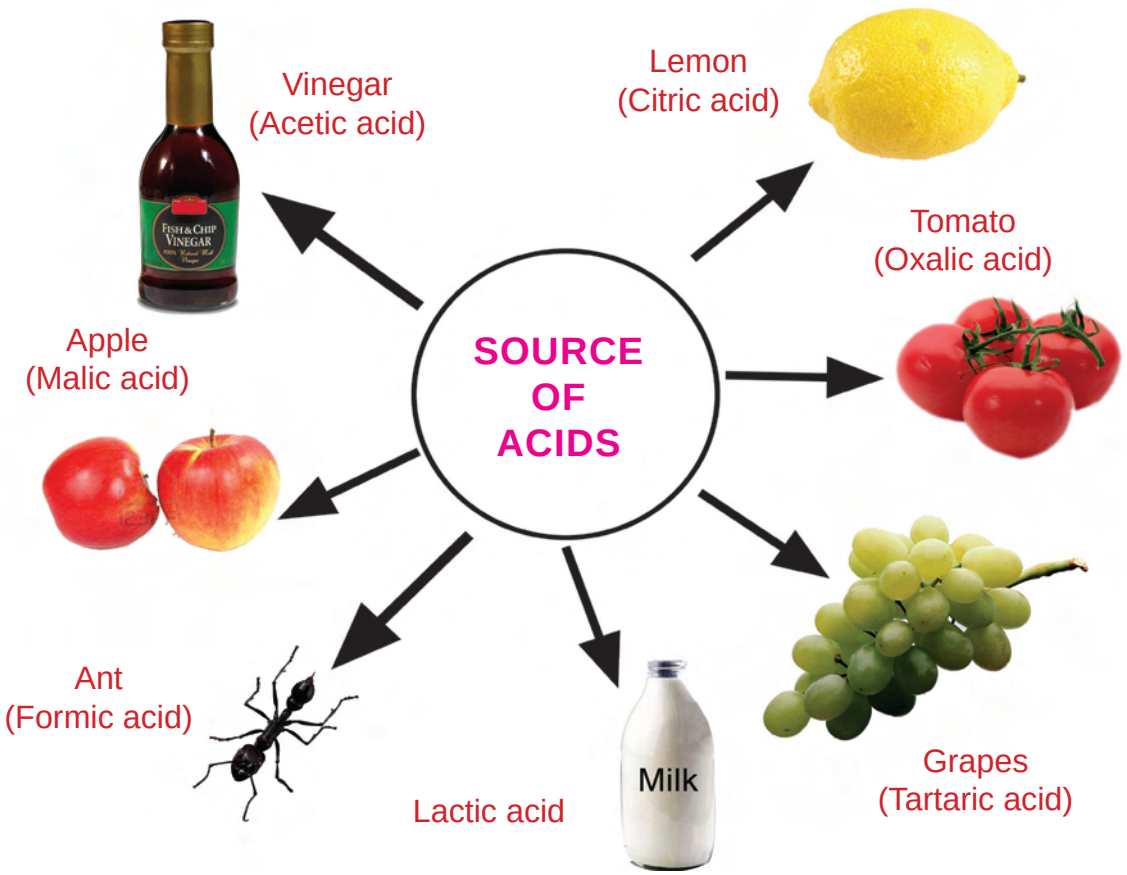

Fig. 3.19. Acids and their sources

SCIENCE

Mineral acids

Acids that are obtained from minerals are called mineral acids or inorganic acids. For example, Hydrochloric acid, Nitric acid, Sulphuric acid (Fig.3.20) which are commonly available in the laboratory. They must be handled with a lot of care. They are corrosive. It means that they can eat away metal, skin and clothes. But they will not corrode glass and ceramic. Hence they are stored in glass bottles.

An acid is a substance which contains replaceable hydrogen ions.

Fig. 3.20. Mineral Acids in Laboratory

Find out...

Observe how copper and brass vessels are washed in your house. Why is tamarind used for washing them?

Bases and alkalies in our daily life

Substances such as baking soda does not taste sour. It is bitter in taste. It shows that it has no acid in it. If you rub its solution with your fingers, it is soapy. Substances like these which are bitter in taste and are soapy on touching are known as bases. The nature of such substances is said to be basic. Bases are oxides or hydroxides of metal. They are chemically opposite to acids. Some bases like caustic soda [Sodium hydroxide] and caustic potash [Potassium hydroxide] are very corrosive.

Bases give hydroxyl ions when treated with water. Bases which are soluble in water are called Alkalis. The hydroxides of Sodium and Potassium are examples of alkalies. They are water soluble bases. **All alkalies are bases, but not all bases are alkalies**. The word alkali is derived from the Arabic word 'alquili' which means plant ashes. Ashes of plants are composed of mainly sodium and potassium carbonates.

Some common bases used in our daily life are given in Table 3.3.

CAUTION !

Never taste or touch any unknown chemicals.

Table 3.3

No	Name	Other Name
1	Quick lime	Calcium oxide
2	Potassium hydroxide	Caustic potash
3	Calcium hydroxide	Slaked lime
4	Sodium hydroxide	Caustic soda
5	Magnesium hydroxide	Milk of magnesia

Table 3.4

Name of Base	Found in
Calcium hydroxide	Lime Water
Ammonium hydroxide	Window cleaner
Sodium hydroxide/ Potassium hydroxide	Soap
Magnesium hydroxide	Antacid

Test for identifying acids and bases

We should never touch or taste a substance to find out whether it is an acid or base because, both acids and bases are harmful and burn the skin. A safe way to find out is to use an indicator. Indicators are a group of compounds that change colour when added to solutions containing either acidic or basic substances. The common indicators used in the laboratory are litmus, methyl orange and phenolphthalein. Apart from these, there are some natural indicators like turmeric, red cabbage juice and beetroot juice.

Table 3.5

Indicator	Colour in Acid	Colour in base
Litmus	Red	Blue
Phenolphthalein	Colourless	Pink
Turmeric powder	Yellow	Brick red
Beetroot juice	Pink	Pale yellow
Red cabbage juice	Pink/Red	Green

SCIENCE

3.3.2. NATURAL INDICATORS

Litmus: A natural dye

The most commonly used natural indicator is litmus. It is extracted from lichens (Fig. 3.21) and it has a purple colour when put in distilled water. When added to an acidic solution, it turns red and when added to a basic solution, it turns blue. It is available in the form of solution, or in the form of strips of paper known as litmus paper. Generally, it is available as red and blue litmus paper.

Fig. 3.21. Lichens

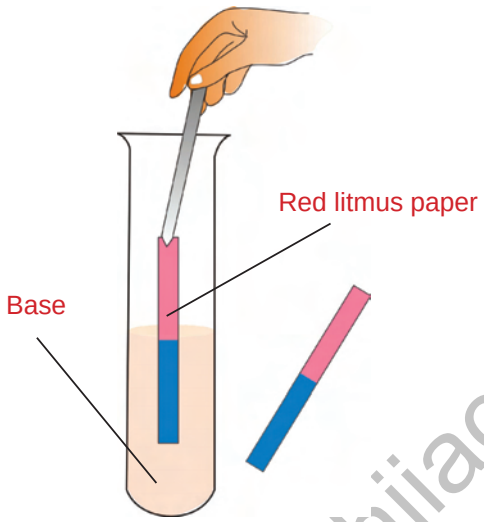

Fig. 3.22. Red litmus paper dipped in Base solution changes to blue

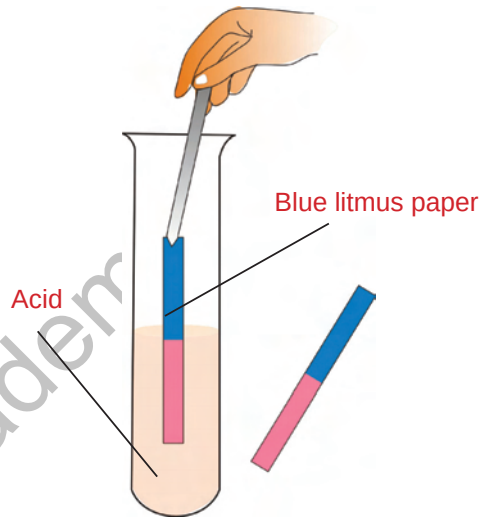

Fig. 3.23. Blue litmus paper dipped in Acid solution changes to red

ACTIVITY 3.11 **WE OBSERVE**

Aim: To find out the nature of solution using litmus paper.

We need: Test solutions, Litmus paper, Test tube, Test tube stand.

Procedure :Add some water to orange juice in a test tube. Put a drop of the above solution on a strip of the red litmus paper with the help of a dropper. Is there any change in colour? Repeat the same exercise with the blue litmus paper.

Note down the change in colour. Perform the same activity with the following substances, and tabulate the results. If the solution does not change its colour to either red or blue on litmus paper, they are known as neutral solutions. These solutions are neither acidic nor basic.e.g. Distilled water.

Fig. 3.24. Students performing experiment

Table 3.6

S.No	Test solution	Effect on red litmus paper	Effect on blue litmus paper	Inference
1	Tap Water			
2	Detergent solution			
3	Shampoo			
4	Common salt			
5	Sugar solution			
6	Lime water			
7	Washing Soda solution			
8	Vinegar			
9	Milk of Magnesia			
10	Aerated drink			

Turmeric as a natural indicator

ACTIVITY 3.12 **I DO**

Making my own Greeting Card

- I prepare my own greeting card using turmeric powder.
- I take a table spoon full of turmeric powder.
- I add a little water and make a paste.
- I spread the turmeric paste on a plain paper and dry it.
- I draw designs in the turmeric paper using soap solution.
- My greeting card is ready to use.
- I cut the turmeric yellow paper into thin strips.
- I use it for testing the test solution in the following table.

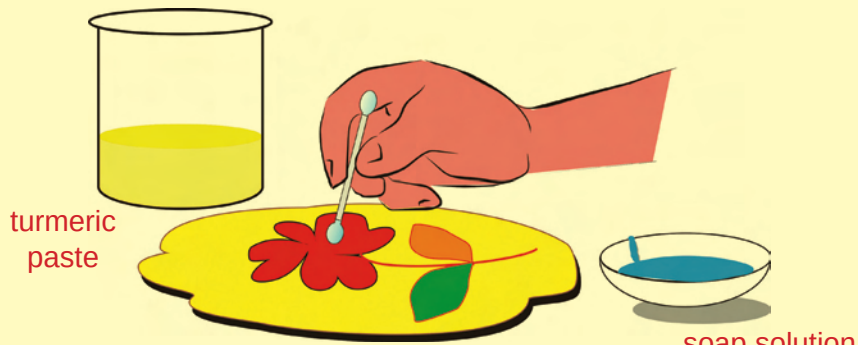

Fig. 3.25. Preparing Greeting card

SCIENCE

Table 3.7

S.No	Test Solution	Effect on strips of turmeric paper	Remarks
1	Lemon juice		
2	Orange juice		
3	Vinegar		
4	Milk of Magnesia		
5	Baking soda solution		
6	Lime Water solution		
7	Sugar solution		
8	Common salt solution		

Coffee is brown and bitter in taste. Is it an acid or a base?

Don't give the answer without doing a test.

ACTIVITY 3.13 WE DO

Prepare our own indicator

Aim : To prepare our own indicator.

We need : Red cabbage, Beet root, some bright coloured flowers such as hibiscus

Procedure :

- We take cabbage, beetroot and some brightly coloured flower such as hibiscus.
- We grind each one of the above items separately using mortar.
- We mix each one to a suitable solvent with the help of our teacher.
- We filter and collect the filtrate in a separate bottle.
- Our indicator is ready to use.

Fig. 3.26. Materials to prepare indicator

MORE TO KNOW

Cells in the human body contain acids.

DNA (deoxy ribonucleic acid) in cells controls the features of our body such as appearance, colour and height.

Proteins are bodybuilders and they contain amino acids.

Fats contain fatty acids.

Properties of Acids

1. They have a sour taste.
2. Strong acids are corrosive in nature.
3. Hydrogen is the common element present in all acids. However, all compounds containing hydrogen are not acids. For instance, ammonia, methane and glucose are not acids.
4. They react with metals and produce hydrogen.

   Metal + Acid ⟶ Salt + Hydrogen gas
5. Acids turn blue litmus to red.
6. The indicator phenolphthalein is colourless in acids
7. The indicator methyl orange is red in acids.
8. They are good conductors of electricity.

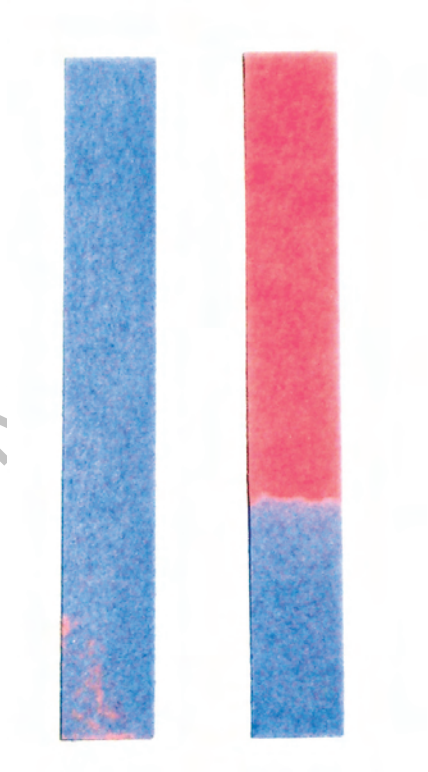

Fig.3.27-Litmus paper

SCIENCE

MORE TO KNOW

Pink or blue? Hydrangea macrophylla, an ornamental plant, can blossom in different colours depending upon the nature of the soil. In acidic soil, thec olour of flower is blue, in basic soil is pink, and in neutral soil, it is white.

Fig. 3.28. Hydrangea macrophylla

Uses of Acids

Inorganic acids are used in:

1. Chemical laboratories as reagents.
2. Industries for manufacturing dyes, drugs, paints, perfumes, fertilizers and explosives.
3. The extraction of glue from bones and metals from its ore.
4. Preparation of gases like Carbondioxide, Hydrogen sulphide, Hydrogen, Sulphur dioxide etc.,
5. Refining petroleum.

Organic Acids like carboxylic acids are used:

- as food preservatives.
- as a source of Vitamin C.
- for preparation of baking soda.
- to add flavour to foodstuffs and drinks.

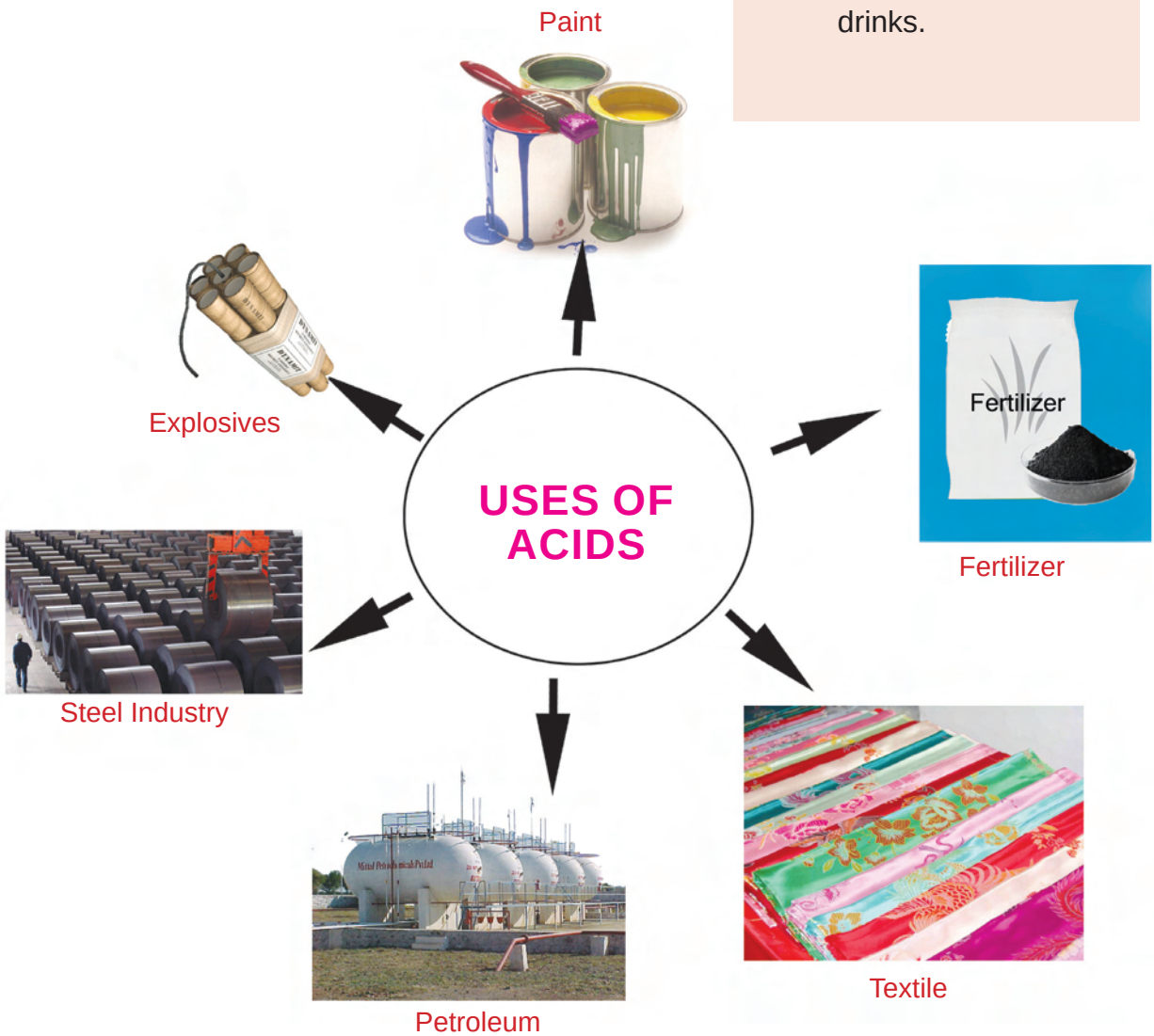

Fig. 3.29. Uses of Acids

Properties of Bases

1. Bases are bitter in taste.
2. Strong bases are highly corrosive in nature.
3. Generally they are good conductors of electricity.
4. Basic solutions are soapy to touch.
5. Bases turn red litmus paper to blue.
6. Bases are compounds that contain hydroxyl group.

Uses of Bases

1. as a reagent in chemical laboratories.
2. in industries for manufacture of soap, textile, plastic.
3. for the refining of petroleum.
4. for manufacturing paper, pulp and medicine.
5. to remove grease and stains from clothes.

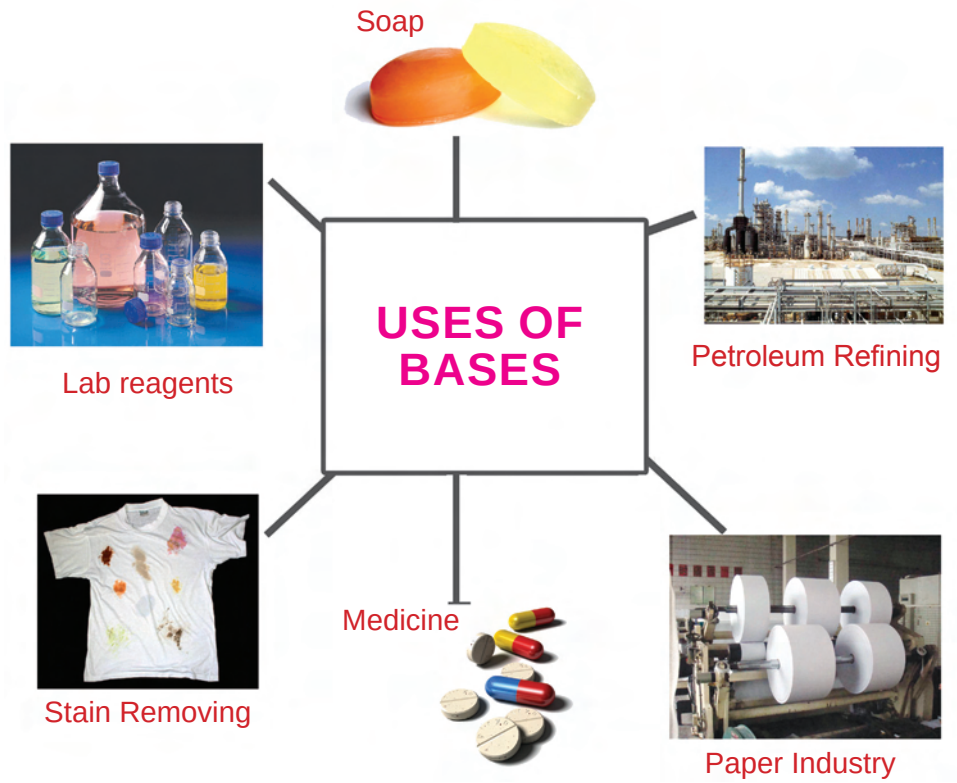

Fig. 3.30. Uses of Bases

ACTIVITY 3.14 **WE DO**

Debate on Acid rain.

- We divide ourselves into small groups.
- Each group discusses and debates about the acid rain formation and its impact on the environment.
- We ask the group leaders to present the views of their groups.
- Our teacher concludes and summarizes it.

SCIENCE

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Neutralisation

You have learnt that acids turn blue litmus to red and bases turn red litmus to blue; hence they have different chemical properties. What do you think that would happen when an acid is mixed with a base? Let us perform the following activity:

ACTIVITY 3.15 WE OBSERVE

Aim: To show acid is neutralized by base

We need: Hydrochloric acid, sodium hydroxide, phenolphthalein, beaker, glass rod, test tube, test tube stand.

Procedure :

- Take a test tube and add 5ml of (caustic soda) sodium hydroxide into it.
- Add 2-3 drops of phenolphthalein in it and you can see that the solution turns pink.
- Now add dilute hydrochloric acid slowly in drops and see what happens.
- The colour will disappear.
- This shows that the base is completely neutralised by the acid.

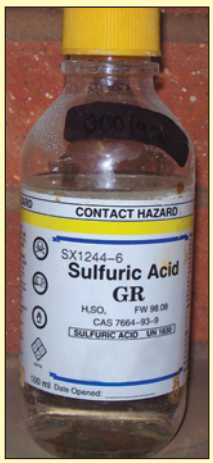
When an acidic solution is mixed with a basic solution, both solutions neutralise the effect of each other. When an acid solution and a base solution are mixed in suitable amounts, both the acidic nature of the acid and basic nature of the base are destroyed. The resulting solution is neither acidic nor basic. Touch the test tube immediately after neutralisation. What do you observe? In the process of neutralisation, heat is always evolved or liberated. The evolved heat raises the temperature of the mixture.

In neutralisation reaction, a new substance is formed. It is known as salt. Salt may be acidic, basic or neutral in nature.

Neutralisation can be defined as the reaction between an acid and a base. In this process, salt and water are produced with the evolution of heat.

Acid + Base ⟶ Salt + Water & heat is evolved.

MORE TO KNOW



Sulphuric acid (H_2SO_4) is called as the king of chemicals, because of its industrial importance. The amount of sulphuric acid that a country uses indicates the economy of a country. The strongest acid in the world is the Fluorosulphuric acid ($HFSO_3$)

MORE TO KNOW

We know that even our stomach produces an acid. Once we start eating, acid is secreted in the stomach to start the digestion process. It is often not the food that we eat that causes acidity problems in the stomach, but an overproduction of this acid that is secreted. In fact, some food can help to reduce the acidity in the stomach by neutralising (reducing) some of the acidity. Milk is one of the most beneficial food items that helps in reducing the acidity in the stomach.

Salt

A salt is a substance formed by the neutralisation of an acid by a base.

Sodium hydroxide + Hydrochloric acid ⟶ Sodium chloride + Water + Heat
(Base) (Acid) (Salt)

Table 3.8

Name of acid	Salt formed	Names of salts
HCl	Chloride	Sodium chloride, Copper chloride, Ferric chloride
HNO_3	Nitrate	Sodium nitrate, Copper nitrate, Ferric nitrate

Uses of Salt (Table 3.9)

Name of Salt	Use
For the human body Calcium phosphate, Calcium lactate, Ferrous sulphate, Sodium chloride etc.	For the proper functioning of the human body.
For domestic purposes	
1. Sodium chloride	Used as a preservative. To add taste to our food
2. Sodium bicarbonate	In baking and in effervescent drinks.
3. Hydrated potassium, aluminium sulphate	In the purification of water.
For Industrial Purposes	
1. Sodium carbonate	For the manufacture of washing powder.
2. Copper sulphate	As an insecticide.
3. Potassium nitrate	In the manufacture of gun powder.

SCIENCE

3.3.3. NEUTRALIZATION IN EVERYDAY LIFE

Indigestion:

Our stomach contains hydrochloric acid. It helps us to digest food. More acid in the stomach will cause stomach upset or indigestion. Sometimes indigestion becomes painful. We take an antacid such as milk of magnesia to neutralise the excess acid.

Ant bite:

When an ant bites, it injects acidic liquid (Formic acid) into the skin. The effect of the acid can be neutralized by rubbing with moist baking soda or calamine solution (Zinc Carbonate).

Factory Wastes:

The wastes of many factories contain acids. If they are allowed to flow into the water bodies, the acids will kill the fish and other organisms. The factory wastes are therefore neutralised by adding basic substances.

Soil treatment:

Excess use of chemical fertilizers, makes the soil acidic. When the soil is acidic, plants do not grow well. So it is treated with bases. If the soil is basic, organic matter releases acids, which neutralises the basic nature of soil.

Fill the table yourself:

Table 3.10

Acids	Bases
1. They have sour taste.	
2.	They turn red litmus to blue.
3. It contains hydrogen.	
4.	Generally good conductors of electricity.

EVALUATION

1. The physical change is generally reversible. The chemical change is irreversible. Classify the following changes as physical change or chemical change.

   a) Frying of egg b)Burning of petrol c) broken glass

   d) formation of curd from milk e) compression of spring

   f) photosynthesis g) digestion of food

2. Kumar had put some the naphthalene balls in his wardrobe to keep the insects away. After a few days, he found that they had become very small. Give reason for the change. Name the phenomenon behind it.

3. Malarvizhi's father bought an apple. He cut it into small pieces and gave them to her. The pieces changed to brown after some time. Seeing the brown colour, she asked her father how it happened. What could be the answer from her father?

4. Sting operations!

   Bee stings can be very painful. If a bee stings your friend, how would you help him?

   a) What substance will you rub on his hand?

   b) What chemical does that substance contain?

5. Answer the following:

   a) Indigestion tablets contain a base. Why?

   b) Explain why rusting of iron objects is faster in coastal areas.

6. Anaerobic bacteria digest animal waste and produce biogas (Change A). The biogas is then burnt as fuel (change B). The following statements pertain to these changes. Choose the correct one.

   i) A- is a chemical change.

   ii) B - is a chemical change.

   iii) Both A and B are chemical changes.

7. Burning of wood and cutting the wood into small pieces are two different types of changes. Give reason.

8. Match the following:

a)	Vinegar	quick lime
b)	Milk	acetic acid
c)	Tamarind	milk of magnesia
d)	Calcium oxide	tartaric acid
e)	Magnesium Hydroxide	lactic acid

9. Fill in the blanks:

   a) Acids have _____ (bitter / sour) taste.

   b) Burning of a candle is an example of _____ (Physical / chemical) change.

   c) Some commonly used natural indicators to identify acid and base are _____ and _____.

10. Take a fresh iron nail and rusted iron nail. Beat them up with a hammer and check for yourself which of the two is stronger? Why?

PROJECTS

1. Let us make a list of items that you find in your home, and classify them as acid, base or salt. You could organize your list as given below:
   a) Bathroom items (soaps, detergents, disinfectants, etc.)
   b) Cosmetics (lotions, shampoos, etc.)
   c) Food items (pickle, lemon, ajinamoto, soda water.)
   d) Miscellaneous (car batteries, refrigerators, window cleaners, insect repellants, etc.)
2. Prepare a natural Indicator. Bring the different water samples (minimum 5 samples) in your area and test the sample using the indicator. Find out whether it is acidic, basic or neutral. Record your observations and tick (✓) the appropriate column in the table below. Discuss the results.

Water samples	Acid	Base	Neutral
Sample - 1			
Sample – 2			
Sample – 3			
Sample – 4			
Sample – 5			

After classifying the different samples, write down which of the samples you will use for (a) Drinking (b) Washing (c) Irrigation (d) Bathing.

SCIENCE

FURTHER REFERENCE

Books

1) Introductory Chemistry - M Katyal, Oxford University press, New Delhi
2) Advanced Organic Chemistry – Bahl and Arun Bahl Johnson

Websites

http://chemistry.about.com/library/btacid.quiz.htm
http://www. chem4kids.com/files/read-acidbase.html
http://www funsci.com/fun3-en/acids/acids htm

In the Stone Age, people never knew the use of fire. They ate raw food. Accidently they discovered that by rubbing two stones together, they could produce fire. Later they used fire for cooking, getting light and for safeguarding their lives from animals. Fire is obtained by the rapid oxidation of a substances in the chemical process of combustion, releasing heat, light and various other products.

Fig 3.1 (a)

Fig 3.1 (b)

3.1. COMBUSTION AND ITS TYPES

Combustion is the burning of substances in air or oxygen to release heat and light. The substance that undergoes combustion is called **fuel**.

ACTIVITY 3.1 **WE DO**

Aim : To know about the various substances that are used as fuel.

We use various kinds of fuel for various purposes at home, in industries and for running automobiles. Let us name a few fuels.

1.

2.

3.

There are many substances that can burn. They can be classified depending on their state state as solid, liquid and gas. Cowung, coal and firewood are solid fuels. Kerosene and petrol are liquid fuels. LPG, coal gas, natural gas and bio-gas are gaseous fuels. You have learnt that magnesium burns to form magnesium oxide and produces heat and light. You can perform a similar activity with a piece of charcoal. What do you observe? You will find that coal burns in air producing carbon dioxide, heat and light. This process is an example of combustion. The substances that undergoes combustion are called **combustible substances**.

ACTIVITY 3.2 WE OBSERVE

Aim: To differentiate combustible and non-combustible substances

We need: straw, wood, iron, nail, kerosene, a piece of stone, charcoal, match sticks, glass, burner, tongs

Procedure:

- Light the burner
- Using tongs, hold a piece of straw over the flame.
- What happens to the straw? Record the observation in the table given below
- Repeat the above procedure with other substances and record your observation in the table.
- If combustion takes place, mark the substance as combustible, otherwise, mark it as non-combustible.

Table 3.1

Tick the appropriate column

Substance	Combustible	Non-Combustible
Straw		
Wood		
Iron nail		
Kerosene		
Stone piece		
Charcoal		
Matchsticks		
Glass		

From the above activity, we infer that substances like paper, straw, wood, matchsticks, etc. are combustible substances. Substances like stone, glass, iron nails, etc. do not burn on being exposed to flame. Such substances are called **non-combustible** substances.

Let us investigate the conditions under which combustion takes place.

Fig.3.2 combustible & non-combustible things

ACTIVITY 3.3 WE OBSERVE

Aim: To show air is necessary for combustion

We need: chimney, candle, match box, wooden blocks, glass plate

Procedure:

(Caution:Be careful while handling the candle)

- Fix a lighted candle on a table.

Case 1

- Place a glass chimney over the candle and rest it on a few wooden blocks in such a way that air can enter the chimney.
- Observe what happens to the flame.

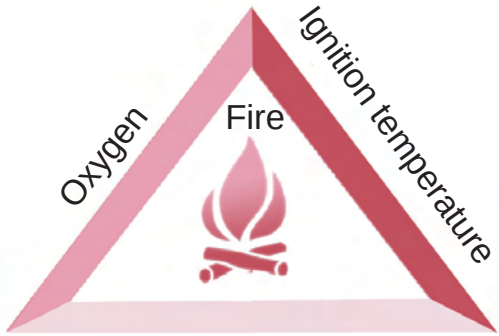
Case 2

- Now, remove the wooden blocks and let the chimney rest on the table.
- Again observe the flame.

Case 3

- Finally, place a glass plate over the chimney.
- Watch the flame again.
- What happens in the three cases?
- Does the flame flicker off?
- Does it flicker and give smoke?
- Does it burn unaffected?
- Can you infer anything about the role played by air in the process of burning?

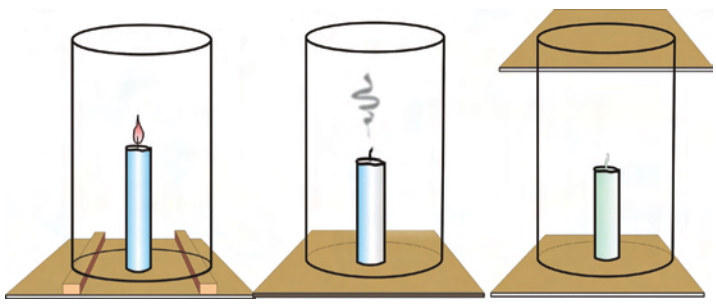
Condition necessary for combustion



TO THINK

You might have heard that when the clothes of a person catch fire, the person is covered with a blanket to extinguish the fire. Can you guess why?

The candle burns freely in case 1 when air can enter the chimney from the bottom. In case 2, when air does not enter the chimney from the bottom, the flame flickers and produces smoke. In case 3 the flame finally goes off, because the air is not available. Therefore you can easily understand that air is necessary for combustion.



Case 1 Case 2 Case 3

Fig 3.3
Air is essential for burning

SCIENCE

Ignition temperature

When a sparkler is lighted with a burning candle, it does not burn immediately. It takes some time and only when it attains a particular temperature, it starts burning.

A fuel has to be heated to a certain minimum temperature before it can catch fire. This temperature is different for different fuels. Some substances catch fire immediately, while some take a longer time. The lowest temperature at which a fuel catches fire is called its **ignition temperature**.

ACTIVITY 3.4 WE OBSERVE

Aim: To understand the importance of ignition temperature.

We need: paper cup, water, burner

Procedure:

1. Place a paper cup containing water on a flame.
2. The water will become hot, but the cup will not burn.
3. This is because the water takes away the heat from the cup and does not allow it to reach its ignition temperature.

Fig 3.4. Heating water in a paper cup

Now, we can easily understand why fire is extinguished by water, and a log of wood takes a longer time to start burning than wood shavings, when heated in a flame.

When water is poured over a burning substance, it absorbs heat from the substance. As a result the temperature of the substance falls below the ignition temperature, and it stops burning.

A log of wood has a huge mass. So, when we heat it with a flame, the heat received by the log is dissipated through its bulk mass. And the log takes a long time to attain its ignition temperature. On the other hand, wood shavings, having a smaller mass, attain the ignition temperature more readily. So, a large piece of wood takes a longer time to start burning than wood shavings.

Types of combustion

Combustion can be of different types. It can be spontaneous, rapid, slow and incomplete.

Spontaneous combustion

Some combustion reactions take place without the application of heat energy. When white phosphorus is exposed to air at room temperature, it catches fire immediately; even without being lit by a match stick. This type of combustion reaction that occurs without the help of any external heat source is called **spontaneous combustion**.

Rapid combustion

Bring a burning match stick or gas lighter near a gas stove in the kitchen with the help of your parents. Turn on the knob of the stove. What do you observe ? The gas burns rapidly. Such combustion is known as **rapid combustion**. Bursting of fire crackers, burning of camphor, magnesium ribbon in air, gas in a burner and kerosene in a stove are good examples of rapid combustion.

Fig 3.5. Burning of Magnesium ribbon

Slow combustion

Combustion that takes place at a very slow rate is called **slow combustion**. During this type of combustion low heat and light are produced. Food oxidized in our body to release energy is an example of slow combustion.

Carbohydrates + Oxygen ⟶ Carbon dioxide + water + heat energy

Incomplete combustion

Combustion takes place in the presence of oxygen. If the supply of oxygen is insufficient, then combustion will be incomplete. This is called **incomplete combustion**. Carbon forms carbon monoxide when it undergoes incomplete combustion.

Carbon + Oxygen ⟶ carbon monoxide

SCIENCE

MORE TO KNOW

Rusting of iron is another good example of slow combustion. During rusting, iron is oxidised and energy is released, but the process is very slow. So we cannot see how it happens.

Fig 3.6. Rusting of iron

3.2. FIRE CONTROL

Heat energy in the form of fire plays an important role in our daily life. Unfortunately, fire has an enormous destructive quality, if it is not controlled properly. We read in the newspaper about the destruction by fire leading to loss of life and property. Thus, it is important to know not only the methods of controlling fire, but also the different means of putting out the fire when they get out of control.

Fig 3.7-Fire Control

Fire can be controlled and extinguished by

1. removing any combustible substances near the region of fire;

2. cutting off the supply of air by using sand or blanket;

3. bringing down the ignition temperature by using water;

Usually sand and water are thrown on burning substances to extinguish fire. Sand reduces the supply of air and cools it. **Water should not be used for oil fire**. Oil being lighter, floats, spreads and causes severe damage. So, oil fire should be extinguished by using substances like foamite. Fire that is caused by electrical appliances or installations, can be put out by using solid carbon dioxide or carbon tetrachloride. Water should not be used as there is a risk of getting an electric shock.

Fire Extinguishers

All of us are familiar with fire extinguishers, the red painted steel containers kept in factories, hospitals, schools, theatres, business places, etc. In the event of a fire breaking out, fire extinguishers can be used to put out the fire.

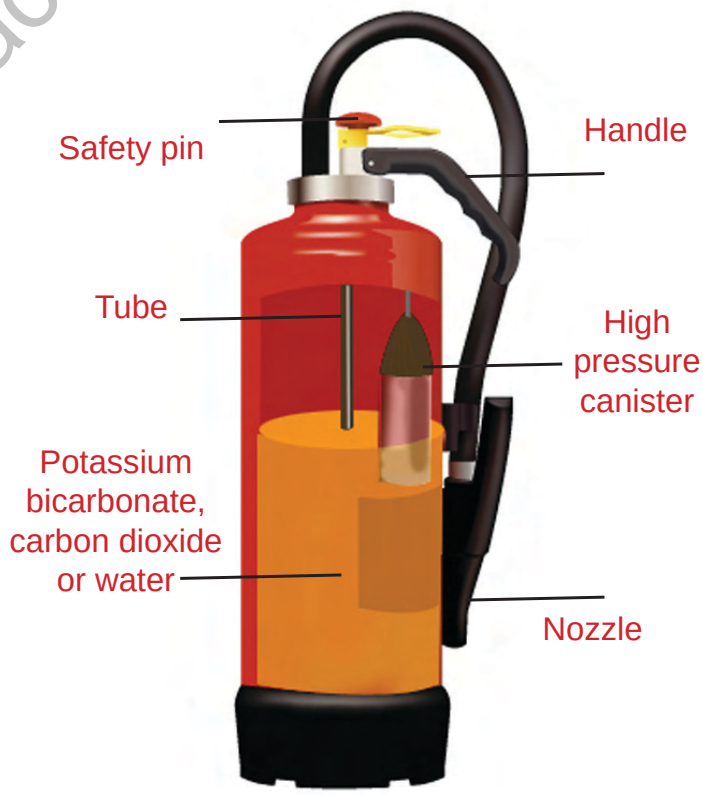


Fig 3.8. Fire Extinguishers

3.3. FLAME AND ITS STRUCTURE

Observe an LPG flame. Did you observe the colour of the flame? What is the colour of a candle flame? Recall your experience of burning a magnesium ribbon. If you have not done the experiment so far, try burning the substances given in the table below.

Is flame formed on burning the following substances? Record your observations.

Table 3.2 (Tick the appropriate column)

Sl.no	Substance	Forms flame	Does not form flame
1	candle		
2	magnesium		
3	camphor		
4	kerosene		
5	charcoal		

Parts of a candle flame

Zone of non-combustion: This is the dark zone that lies around the wick. It contains unburnt gas particles. No combustion takes place here as no oxygen is available.

Zone of partial combustion: In this zone, the hydrocarbons present in the oil gas from wax decompose into free carbon and hydrogen. The unburnt carbon particles impart a pale yellow colour to the flame. This is the luminous part of the flame.

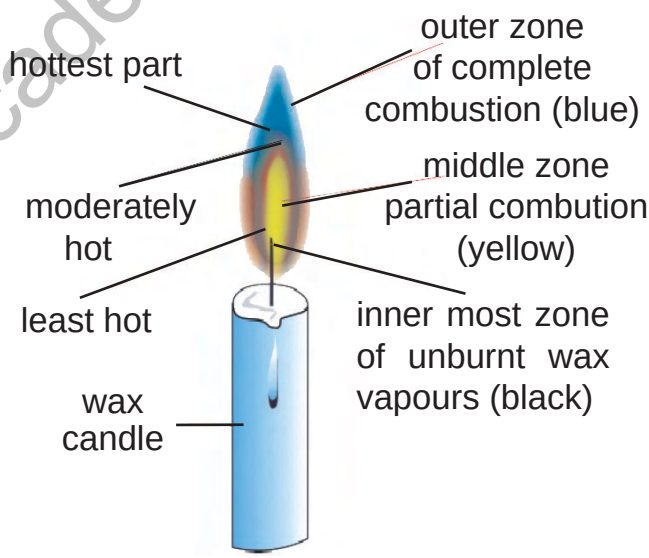


Fig 3.9. Structure of candle flame

Zone of complete combustion (blue) : This is the non-luminous thin zone of the flame. It is the outermost hottest region in the flame that is invisible. Here, carbon and hydrogen are completely oxidized to carbondioxide and water vapour.

Hydrocarbon + Oxygen ⟶ Carbondioxide (blue flame) + Water (vapour)

SCIENCE

MORE TO KNOW

Incase of emergency we should call...

108 - Free Ambulance Service

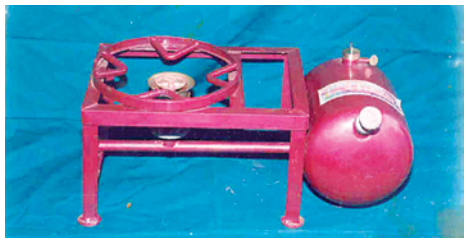
101 - Fire Service

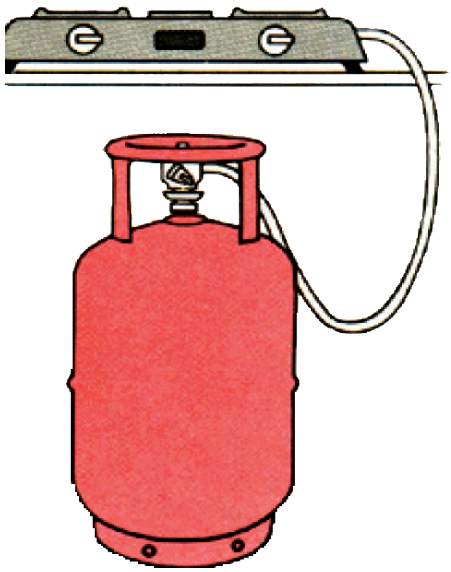
3.4. EFFICIENCY OF FUELS

Any substance that can be burnt or otherwise consumed to produce heat energy is called a fuel. Wood, natural gas, petrol, kerosene, diesel, coal, and LPG are commonly used as fuels.

We use fuels to run all forms of modern transportation like automobiles, trains, buses, ships, and aeroplanes. Fuels are the important source of energy for many industries. Thermal power stations depend heavily on fuels for generating electricity. We also use fuels for domestic purposes, e.g. cooking.

Fig 3.10. using different types of fuel





Characteristics of a good fuel:

We know that a large number of substances burn to produce heat energy. But not all of these substances can be used as fuel. The characteristics of a good fuel are as follows:

1. It should be cheap and readily available.
2. It should be easy to store, transport and handle.
3. It should not produce toxic fumes or smoke or other harmful products on combustion.
4. The amount of soot or ash left behind should be minimum.
5. It should have a high calorific value.
6. It should have a low ignition temperature.

Calorific Value

The main constituents of fuels are hydrocarbons. During combustion, these hydrocarbons get oxidized to form carbon dioxide and water. Heat is evolved in this process (exothermic process).

Hydrocarbon + Oxygen $\longrightarrow$ Carbon dioxide + Water + Heat energy

Fuel

The nature of the fuel can be determined by the amount of heat energy evolved. The higher the heat energy evolved, the better is the fuel.

The amount of heat energy liberated when 1 kg of the fuel is burnt completely in oxygen is called the **calorific value** of the fuel. The calorific values of some common fuels are given in Table 3.3.

Table 3.3

Calorific value of some fuels

Fuel	Calorific value (Kcal/Kg)
Wood	4000
Coal	7000
Coke	8000
Kerosene	10,300
Petrol	11,500
Natural gas	8000-12,000
Water gas	3000-6000
Hydrogen	34,000
Methane	13,340
LPG	11,900

Types of Fuels

There are three types of fuels. They are solid, liquid, and gaseous fuels.

Solid Fuels

Coal, wood, charcoal, coke, and paraffin wax are some commonly used solid fuels. The drawbacks of solid fuels are as follows:

1. They have a high ignition temperature.
2. They produce a large amount of residue (soot, ash) after combustion.
3. Their calorific value is low.

Liquid Fuels

Petrol, kerosene, and diesel are some commonly used liquid fuels which are obtained from petroleum (an oily mixture of hydrocarbons in its crude form). Ethyl alcohol is also a liquid fuel. Locomotives, buses, and lorries use diesel as fuel.

Gaseous Fuels

Gases such as methane, carbon monoxide and hydrogen are combustible. Natural gas, producer gas, coal gas, water gas, LPG (Liquefied Petroleum Gas), and biogas (gobar gas) are other examples of gaseous fuels.Gaseous fuels are preferred over solid and liquid fuels because of the following advantages:

- They have a low ignition temperature.
- They burn completely (complete combustion) and leave no residue (soot, ash, smoke).
- They are easy and safe to handle, transport, and store.
- They have a high calorific value.
- They are cheap.

Natural gas

Natural gas is obtained from petroleum wells. It contains a mixture of hydrocarbons (methane and ethane). It is one of the cheapest available gaseous fuels.

Producer gas, coal gas and water gas

Producer gas, coal gas, and water gas are important gaseous fuels used in industries. All these are obtained from coal or coke.

LPG (Liquefied Petroleum Gas)

It is the most widely used gaseous fuel for cooking. LPG is a mixture of propane (15%) and butane (85%) liquefied under pressure. It has a high calorific value. A small amount of ethyl mercaptan, an inert gas with a characteristic odour, is added to LPG to detect any leakage.

Biogas (Gobar gas)

Gobar gas contains a mixture of methane and ethane and is a very cheap form of gaseous fuel.Gobar gas is becoming increasingly popular in villages, where cattle can be maintained in large numbers. It is also comparatively less expensive.

Fig.3.11-Biogas (Gobar gas) plant

3.5. FUELS AND ENVIRONMENT

The increasing fuel consumption has harmful effects on the environment.

1. Carbon fuels like wood, coal and petroleum release unburnt carbon particles. These fine particles are dangerous pollutants causing respiratory diseases like asthma.

2. Incomplete combustion of these fuels gives carbon monoxide gas. It is a very poisonous gas. It is dangerous to burn coal in a closed room, because the carbon monoxide gas produced can kill persons sleeping in that room.

3. Combustion of most fuels releases carbon dioxide in the environment. Increased concentration of carbon dioxide in the air causes global warming.

4. Burning of coal and diesel releases sulphur dioxide. It is an extremely suffocating and corrosive gas. Moreover, petrol engines give off

Acid rain formation

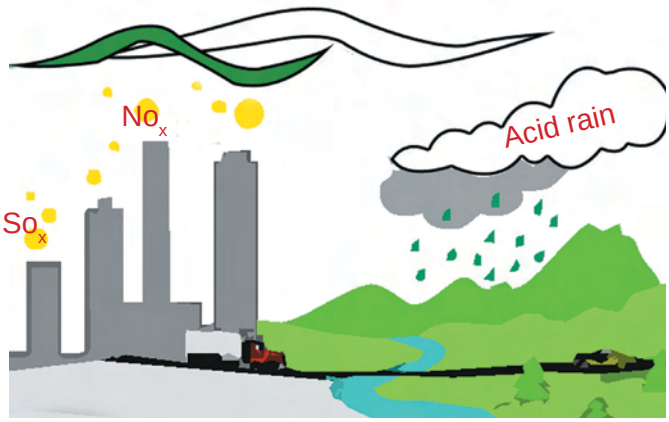


Fig 3.12. Acid Rain Formation

gaseous oxides of nitrogen. Oxides of sulphur and nitrogen dissolve in rain water and form acids. Such rain is called **Acid Rain**. It is very harmful for crops, buildings and soil.

The use of diesel and petrol as fuels in automobiles is being replaced by CNG (Compressed Natural Gas), because CNG produces harmful products in very small quantities. CNG is a cleaner fuel.

GLOBAL WARM(N)ING

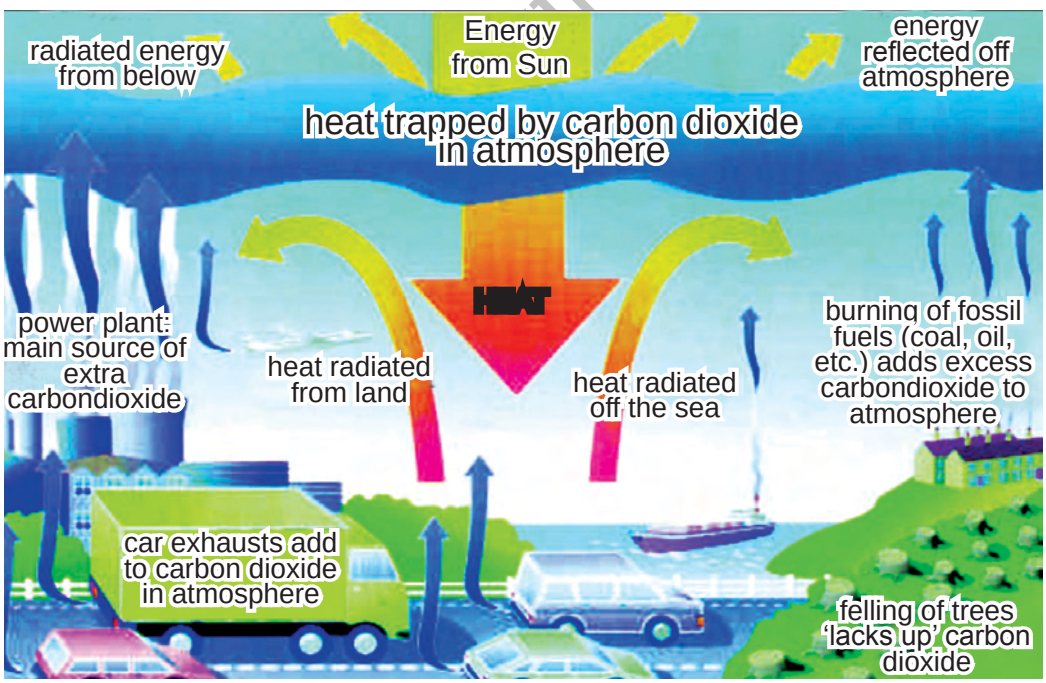


Fig 3.13. Global warming

It is the rise in temperature of the atmosphere of the earth. This results, in the melting of polar glaciers, which leads to a rise in the sea level, causing floods in the coastal areas. Low lying coastal areas may even be permanently submerged.

SCIENCE

EVALUATION

I.Choose the correct answer

a. During combustion light is evolved along with

i. heat ii. flame iii. air iv. none of these

b. Substances that catch fire easily are

i. inflammable ii. non-combustible iii. heavy iv. light

c. L.P.G is a mixture of

i. methane and propane ii. propane and butane
iii. butane and methane iv none of these

d. Rusting of iron is an example of _____combustion

i. slow ii. rapid iii. spontaneous iv. incomplete

e. _____is a good supporter of combustion.

i. oxygen ii. carbon di oxide iii. nitrogen iv. hydrogen

f. Petrol is a

i. solid fuel ii. highly inflammable substance
iii. non combustible substance iv. less inflammable substance

II. Fill in the blanks:

a) The lowest temperature at which fuel catches fire is called _____

(body temperature / ignition temperature)

b) _____ is used to extinguish oil fire. (Water / Foamite)

c) The amount of heat energy liberated by completely burning 1 kg of fuel is called_____

(calorific value / flame value)

III. Write True for the correct statement and False for the wrong statement. Also correct the wrong statement(s)

a. In a rapid combustion, substances catch fire without application of heat.

b. All types of fire can be extinguished by water.

c. Non –luminous zone is the hottest part of a flame.

d. A good fuel should have a low calorific value.

IV. Match the following:

1) Oxides of Sulphur and Nitrogen	-	Luminous flame
2) Biogas	-	Non- Luminous flame
3) Ethyl alcohol	-	Acid rain
4) Yellow colour flame	-	Gaseous fuel
5) Blue colour flame	-	Liquid fuel

V. Sharmila has the following substances. Help her to classify them into combustible and non-combustible.

dry leaves, petrol, rubber tube, chalk, paper

VI. Oil fire should be controlled by using foamite. Water should not be used to control oil fire. Could you explain why this is so?

VII. Give reasons.

a. Water is not used to control fire involving electrical equipments.

b. Gaseous fuels are considered superior to solid fuels.

c. Large piece of wood takes a longer time to start burning than wood shavings.

d.Kerosene burns more readily than wood.

VIII. Magesh and Keerthivasan were doing an experiment in which water was to be heated in a beaker. Magesh placed the beaker close to the wick in the yellow region of the flame. Keerthivasan placed the beaker on the outer most blue region of the flame. Which beaker would get heated faster?

IX. How would you put out the fire in each of the following cases? Justify the method chosen.

1) a pan of hot oil catches fire

2) a cotton pillow catches fire

3) a wooden door is on fire

4) an electric fire

X. Classify the following into solid, liquid, and gaseous fuels.

petrol, coal, wood, oil, natural gas, LPG, coke, water gas, charcoal, kerosene

Solid fuel	Liquid fuel	Gaseous fuel

XI.Compare the characteristics of the following fuels and choose the best fuel on the basis of the responses to the following questions.

i) Coal ii) Kerosene iii) LPG

- How much heat energy does it give out ?(Use table 3.3)
- Does it cause pollution ?
- Is it easily available ?
- Is it easy and safe to store and transport ?
- How much does it cost ?

XII. Debate on the following topics

a. Are biofuels a better alternative to fossil fuels ?

b. Carbon dioxide is necessary for photosynthesis but it causes global warming.

PROJECT

1) Survey 5 houses in your area. Find the number of households using LPG, kerosene, electricity, wood, biogas and cattle dung as fuel. Then tick (✓)the appropriate column in the table below.

Name of the resident : Door No. :

Characteristics of the fuels used		Types of fuels					
		LPG	Kerosene	Electricity	Wood	Biogas	Cattle dung
Smoke produced	High						
	Moderate						
	Low						
Residue formed	High						
	Moderate						
	Low						
Time taken to cook food	Long						
	Moderate						
	Less						
Cost of the fuel	Costly						
	Moderate						
	Less						

Based on your observations and data provided by the households.

which of these fuels would you choose for use in your house ? Why?

FURTHER REFERENCE

Books

1. Chemistry-Facts, Patterns and Principles - Kneen, Rogers and Simpson (ELBS), The Language Book Society
2. Framework of Science – Paddy Gennom, Oxford University Press, New Delhi

Webliography

http://www.einstrumentsgroup.com

http://www.en.wikipedia.org/wiki/combsustion

http://www.chem.csustan.edu./consumer/fuels

Places of scientific importance for visit:

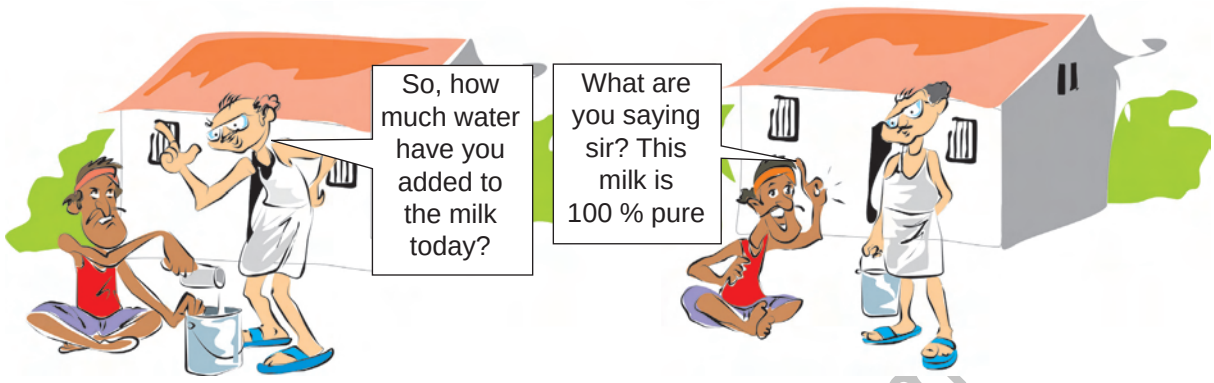
1. Murugappa Chettiyar Research Centre, Tharamani, Chennai
2. A Fire and Rescue Station

SHAKTHII ACADEMY

SCIENCE - CHEMISTRY

STANDARD - EIGHT

5. ELEMENTS AND COMPOUNDS AROUND US



5.1. TYPES OF PURE SUBSTANCE

Read the above conversation. How often do we use words such as 'pure milk' and 'pure water'? Have you ever wondered what 'pure' really means?

For an ordinary person, "a pure substance" means that it is free from adulteration. In that sense, the air we breathe and the milk we drink are not pure. However, there are a few cases where the matter that we encounter in ordinary experience is pure' that is, they consists of only a single substance. Distilled water, sugar, baking soda etc. are pure substances like the copper used in electric wiring.

How to recognise a pure substance?

MORE TO KNOW

Air we breathe is not a pure substance but a mixture of gases

Milk is a mixture that contains liquid fat, protein and water.

One can recognise a pure substance by its properties such as density, melting point, refractive index, electrical conductivity and viscosity. Then, how can we define a pure substance?

A pure substance has fixed composition and fixed properties which cannot be easily separated by physical methods.

For example, pure water boils at 100°C at one atmospheric pressure and ice freezes at 0°C. These are the properties of all samples of pure water, regardless of their origin. Pure water contains only two hydrogen atoms and an oxygen atom which cannot be separated by physical methods.

In science, a pure substance is either an element (e.g., iron) or a compound (e.g., Sodium chloride).

ACTIVITY 5.1

List any 5 substances you consider pure:

1. _____
2. _____
3. _____
4. _____
5. _____

ACTIVITY 5.2

You have to unscramble the following words given in bracket:

1. Water conveying pipes are made of _____ (ONIR)
2. Electric wire contains _____ (PPERCO)
3. Ornaments are made of _____ (LDGO)
4. The air we breathe consist of _____ (YGENOX)
5. Coal contains _____ (RBONCA)

5.2. WHAT IS AN ELEMENT?

The unscrambled words such as iron, copper, gold, oxygen and carbon that we come across in our daily life are said to be elements.

Look at the pictures. What do you notice? Did you notice this. In fig.1, a boy is alone and in fig 2 two boys seem to be similar in all aspects (like twins)? Hence for analogy, we can say that both are elements.

Fig: 1

Fig: 2

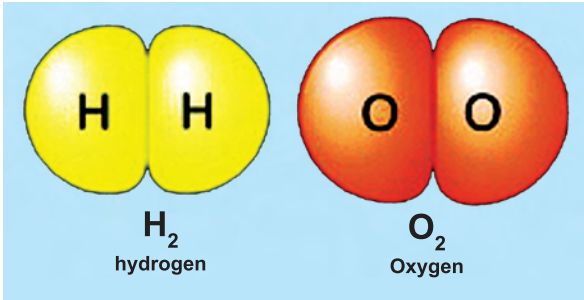
Let us see the different views of an element put forth by scientists

- An element is a pure substance that cannot be split into anything simple by physical or chemical methods. (BOYLE)
- An element is the basic form of matter that cannot be broken into a simpler substance. (LAVOISIER)
- An element is made of same kind of atoms. (Modern atomic theory)

MORE TO KNOW

An atom is the smallest particle of an element.

A molecule is made up of the same kind of atoms or different kinds of atoms



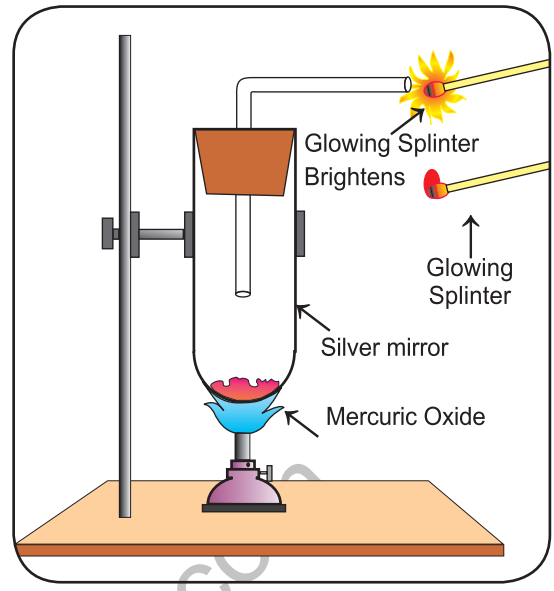
Examples of elements are hydrogen, nitrogen, oxygen, carbon, aluminium, gold, silver etc. A lump of sulphur contains sulphur atoms only. Nitrogen contains atoms of nitrogen only. Copper wires contain only copper atoms.

Thus,all elements are made up of one kind of atom only. However, atoms of different elements are not identical. For example, if we compare atoms of copper and silver, we find that they differ from each other in size and internal structure.

ACTIVITY 5.3

Take a little amount of mercuric oxide in a test tube. Heat it first gently, and then strongly in a bunsen flame. Observe the test tube. You will notice a silver mirror gradually appearing on upper part of the test tube and later, globules of mercury will be seen. Insert a glowing splinter into the test tube. The flame of splinter brightens showing the presence of oxygen. What does this tell you?

A complex substance like mercuric oxide is broken down into simpler substances, mercury and oxygen. It is not possible to split these substances any further by any other chemical method. Thus, mercury and oxygen are elements.



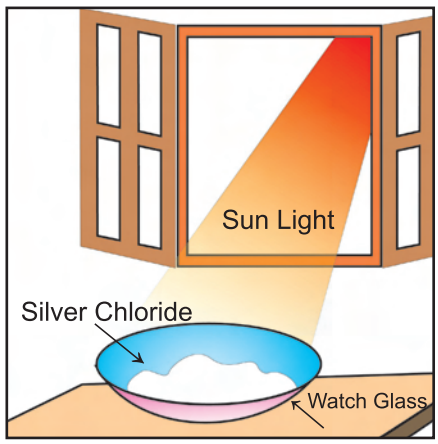
Mercuric oxide → Mercury + Oxygen
(element) (element)

ACTIVITY 5.4

Take a small amount of crystals of silver chloride which are white in colour on a watch glass. Place the watch glass under sunlight for some time. What do you notice?

The crystal will slowly acquire grey colour. On analysis, it is found that sunlight has decomposed silver chloride into silver and chlorine(element)

Silver chloride (white) $\xrightarrow{\text{Sunlight}}$ Silver (grey) + Chlorine Greenish Yellow (element) (element)



you can repeat the same activity with silver bromide.

$$\text{Silver bromide (light yellow)} \xrightarrow{\text{Sunlight}} \text{silver (grey)} + \text{bromine (Reddish brown)}$$

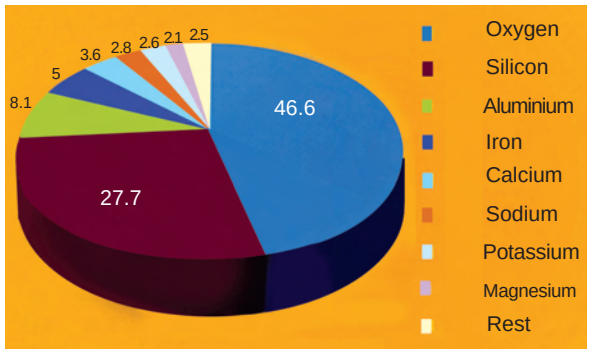
(element)(element)

5.2.1. Do you know how many elements exist in nature?

There are **118** elements known at present, out of which **92** elements occur in nature and the remaining **26** have been prepared in laboratory by artificial methods. However, only 112 elements have been authenticated by IUPAC (International Union of Pure and Applied Chemistry), and are allotted symbols.

Let us see the relative abundance of various elements in earth's crust, either in free state or in the combined state.

In earth's crust, oxygen is the most abundant element followed by silicon. Together, these make up three quarters of the earth's crust.



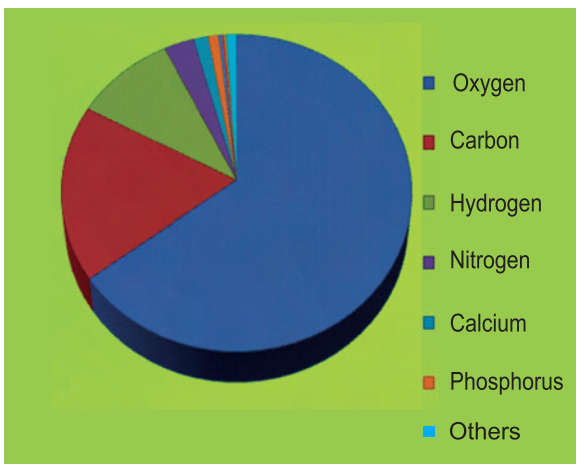
Pie Diagram - Elements present in the earth's crust

ACTIVITY 5.5

Can you find the most abundant element from the above pie diagram?

5.2.2. Have you ever thought about the elements found in our body?

About 99% of the mass of human body is made up of six elements (oxygen, carbon, hydrogen, nitrogen, calcium and phosphorus) and the rest 1% by other elements.



Pie Diagram - Elements present in the human body

SCIENCE

All the living things, both plants and animals, are made from a few elements only. They are,

Oxygen (65%), Carbon (18%), Hydrogen (10%), Nitrogen (3%), Calcium (2%) along with some other elements.

Hydrogen and helium are the main elements in the universe and stars.

5.2.3. Classification of elements based on their physical state

Let us classify the known elements on the basis of their state of subdivision as solids, liquids and gases.

Liquids: Mercury, bromine, (at room temperature) cesium and gallium can exist in liquids around 30° C.

Gases: Hydrogen, nitrogen, oxygen, chlorine, fluorine, helium, neon, argon, krypton, radon and xenon.

Solids: Remaining elements are solids. e.g. Carbon, silicon, copper, gold etc.

5.2.4. Classification of elements based on properties

Now we classify the known elements on the basis of their properties as ***metals, non-metals*** *and* ***metalloids.***

Metals: Of the 92 natural elements 70 elements are metals. Metals are hard lustrous (shining in appearance), malleable(can be beaten into very thin sheet) ductile(drawn into wire), good conductors of heat and electricity, and sonorous (producing sound)

e.g. Copper, gold, silver, iron etc,.

Non-metals: Only about 16-17 elements are soft, non lustrous, non-malleable, non-ductile, bad conductors of heat and electricity, and non-sonorous.

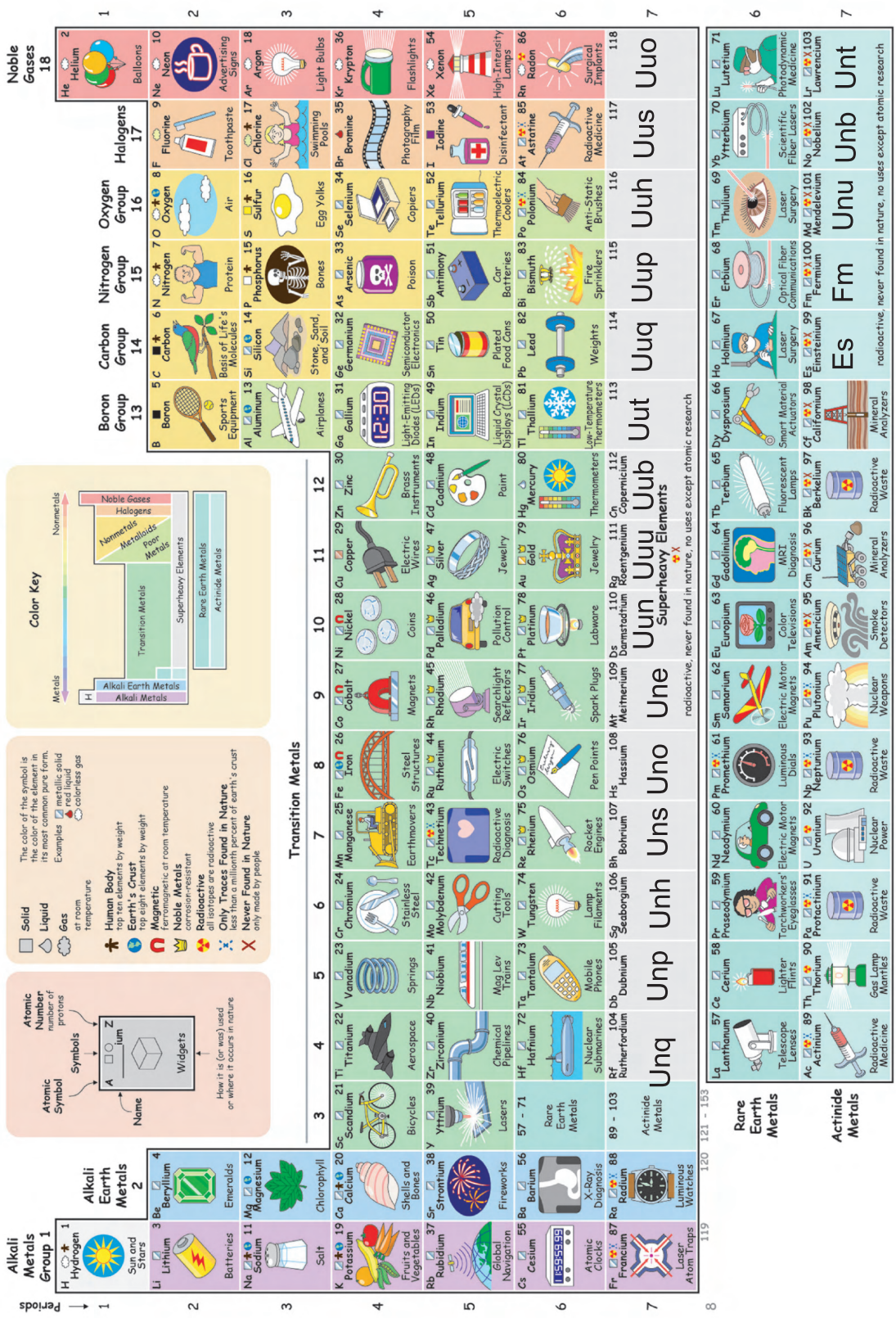
e.g. Hydrogen, oxygen, sulphur, carbon etc,.

Metalloids: Very few semi-metals are known as metalloids which shows properties of metals as well as non metals.

e.g. Boron, silicon, germanium etc.

MORE TO KNOW

- 20 % of the Earth's oxygen produced by the Amazon forest.
- An ounce of gold can be stretched into a wire of 80 kms (50 miles) long.
- The amount of carbon in the human body is enough to fill 9000 'lead' pencils.
- The noble gas xenon lasers can cut through materials that even diamond tipped blades will not cut.
- An average adult body contains 250g of salt .
- The metal with the highest melting point is tungsten. (3410° C)


How elements are used in day- to- day life - Periodic table
Color Key
Metals
Nonmetals
Alkali Earth Metals
Alkali Metals
Transition Metals
Noble Gases
Halogens
Nonmetals
Metalloids
Poor Metals
Superheavy Elements
Rare Earth Metals
Actinide Metals
Atomic Symbol
Atomic Number
number of protons
Symbols
Name
Widgets
How it is (or was) used or where it occurs in nature
Solid
Liquid
Gas
at room temperature
The color of the symbol is the color of the element in its most common pure form.
Examples: metallic solid, red liquid, colorless gas
Human Body
top ten elements by weight
Earth's Crust
top eight elements by weight
Magnetic
ferromagnetic at room temperature
Noble Metals
corrosion-resistant
Radioactive
all isotopes are radioactive
Only Traces Found in Nature
less than a millionth percent of earth's crust
Never Found in Nature
only made by people
Periods
Alkali Metals Group 1
Alkali Earth Metals 2
Transition Metals
Boron Group 13
Carbon Group 14
Nitrogen Group 15
Oxygen Group 16
Halogens 17
Noble Gases 18
Superheavy Elements
radioactive, never found in nature, no uses except atomic research
radioactive, never found in nature, no uses except atomic research
Rare Earth Metals
Actinide Metals

ACTIVITY 5.6

Learn about uses of gases with the help of the periodic table:

Fill the blanks:

1. The gas that can be used to fill party balloons is _____.
2. The gas that is used to make flash light is _____ .
3. The gas widely used in advertisement signs is _____.
4. The gas present in tungsten bulb is _____.
5. The gas present in the universe is _____.
6. The gas used in high intensity lamp is _____.
7. The gas which is used in tooth pastes to keep the teeth strong is _____.
8. The gas which helps to keep swimming pool clean is _____.
9. The radioactive gas used to cure cancer is _____
10. About 21% of earth's atmosphere consists of_____.

5.3. WHY SYMBOLS?

Every chemical change can be conveniently represented in the form of chemical equation. This is because describing a chemical change with the names of substances becomes difficult. So, we need symbol for an element.

What is symbol?

You are familiar with the use of shortened forms of names of people, countries etc. we refer to United Kingdom as U.K., United States of America as U.S.A. and so on. It is more convenient to use the shortened forms instead of writing down long names. Similarly, in chemistry, symbols are used to represent names of elements.

A symbol is a shortened form of the name of an element.

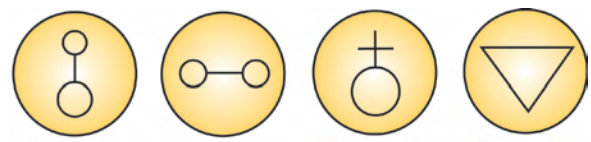
Let us learn the brief history of symbols of elements.

Greek symbols

Some earliest symbols in form of geometrical shapes were those used by the ancient Greeks to represent the four elements earth, air, fire and water.

Alchemist symbols

In the days of alchemists,the different materials that they used were represented by pictorial symbols.

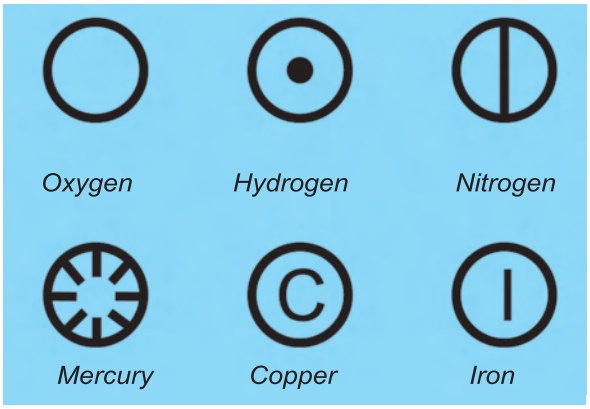


Nickel *Arsenic* *Antimony* *Water*

The work of trying to change less valuable metal into gold was called **alchemy,** and the men who did this work were **alchemists.**

Dalton's symbol

In 1808, **John Dalton**, English scientist tried to name the various elements based on these pictorial symbols.



The uses of the above symbols are difficult to draw and inconvenient to use. Hence, Dalton, symbols are not used; it is only of historical importance.

Berzelius symbols

In 1813, **Jon Jakob Berzelius,** Swedish chemist devised a system using letters of alphabet. He argued that letters should be used because they could be written more easily than other signs. The modified version of Berzelius system follows under the heading

'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

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

2. If the name of the element has the same initial letter as another element, then symbol uses the first and second letters of their English name.

Element	Symbol
Aluminium	Al
Barium	Ba
Beryllium	Be
Bismuth	Bi
Bromine	Br
Cobalt	Co
Gallium	Ga
Helium	He
Lithium	Li
Neon	Ne
Silicon	Si

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

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

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

4. Some symbols are based on the old names or Latin name of the element. There are eleven elements.

MORE TO KNOW

Names of some elements are derived from important country/scientist/colour/ mythological character/planet. Examples

Name	Symbol	Name derived from
Americium	Am	America (Country)
Europium	Eu	Europe(Country)
Nobelium	No	Alfred Nobel(scientist)
Iodine	I	Violet (colour, greek)
Mercury	Hg	God mercury (mythologic character)
Plutonium	Pu	Pluto (planet)
Neptunium	Np	Neptune (planet)
Uranium	U	Uranus (planet)

How to write a symbol?

While writing a symbol for an element, one has to follow the method given below.

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.

Significance of the symbol of an element

Symbol of an element signifies

- Name of the element
- One atom of the element

For example,

- The symbol N stands for the element of nitrogen
- One atom of nitrogen

GROUP ACTIVITY 5.7

Here is an interesting game which helps you to remember the symbols and their names. Make cards as instructed and then form a small group with your class mates to play.

INSTRUCTIONS:

Prepare 15 cards with the name of elements written on them and 15 cards with their corresponding symbols. Here is a list of names of elements (you have a freedom to choose the name of the elements)

Hydrogen	Calcium	Arsenic	Sodium	Mercury
Oxygen	Argon	Chlorine	Gold	Magnesium
Copper	Helium	Chromium	Iron	Manganese

How to play?

1. Shuffle the 30 cards and place the cards face down on the table .
2. Start the game. Each player will get a chance of taking 2 cards at a time to see. If a player does not get the correct pair, then he/she should keep the cards at the original position. If the name and symbol of the cards match correctly, then he/she can show to all the players and can keep the correct pairs of cards with him/her. If correct pairs are shown, players will get another chance until the player makes wrong match. Game will continue till all the cards are taken up. The winner is the one having maximum number of cards.

SCIENCE

ACTIVITY 5.8

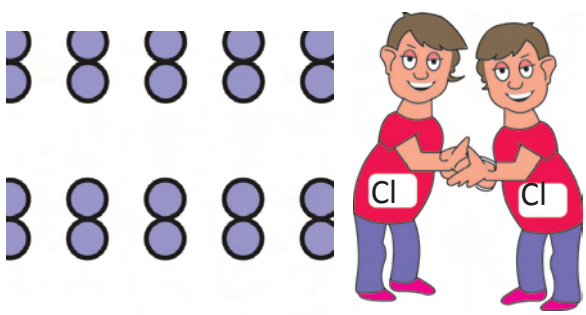
Analyse the number of elements, if any present in your name.

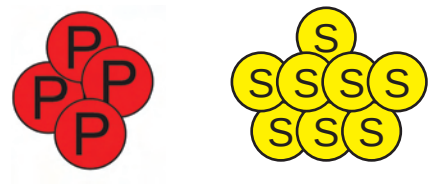
Here are few examples

1. Name : Gautam
   Written as : GaUtAm
   Elements : Ga-Gallium
   U-Uranium
   Am-Americium
2. Name : ARUN
   Written as : ArUN
   Elements : Ar-Argon
   U-Uranium
   N-Nitrogen

5.4. MOLECULE OF AN ELEMENT

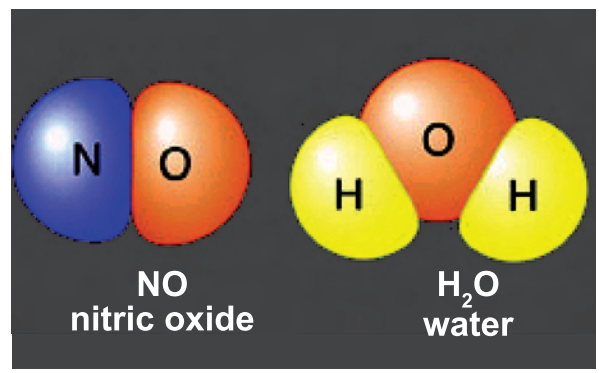
The molecule of an element contains two or more similar atoms. For example, a molecule of chlorine contains two atoms of chlorine; it is therefore written as Cl_2 (Chlorine). Similarly, a molecule of nitrogen contains two atoms of nitrogen; it is therefore written as N_2 (Nitrogen). Molecules like chlorine and nitrogen which consist of two atoms of the same kind, are called diatomic molecules. A molecule of ozone consists of three atoms of oxygen and is represented as O_3. Similarly, some molecules, like phosphorus (P_4) and sulphur (S_8), consists of more than two similar atoms.

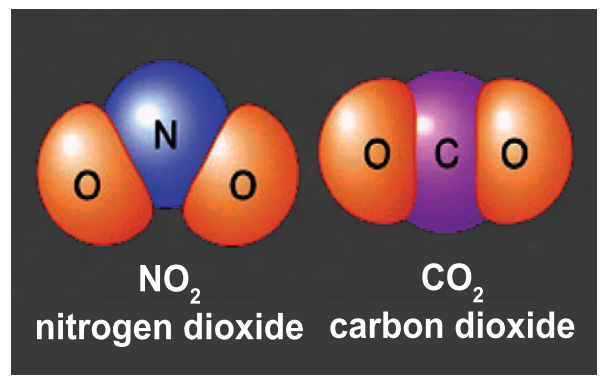




5.5. WHAT IS A COMPOUND?

Do you know that common salt, water, sugar, sand etc., which we use daily are said to be compounds? Similarly, our body is composed of hundreds of compounds. We have learnt that there is limited number of elements (<120), but number of compounds is unlimited.





From the picture, can you define a compound?

When two or more elements combine in a fixed ratio by mass, they form compound.

For example, water is a compound made of two hydrogen atoms and one oxygen atom in the ratio 2 :1 by volume or 1 : 8 by mass.

A compound is a pure substance composed of two or more elements combined together chemically in a fixed ratio by mass.

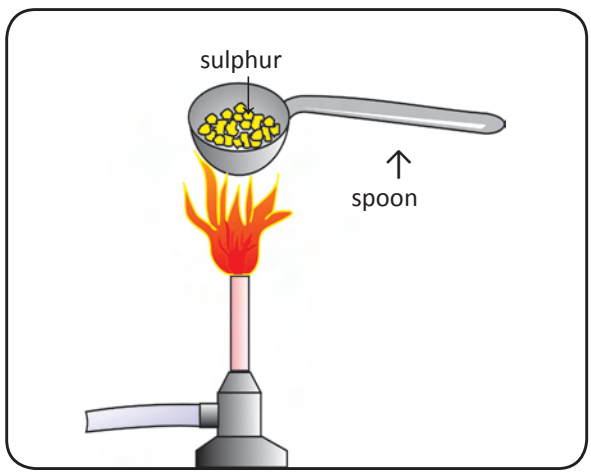
Element + Element →Compound

$N_2 + 3H_2 \rightarrow 2NH_3$

$2H_2 + O_2 \rightarrow 2H_2O$

ACTIVITY 5.9

Take a little sulphur in a spoon. Heat it. It burns with a blue flame which slowly disappears. You can smell a pungent odour. what is it due to?

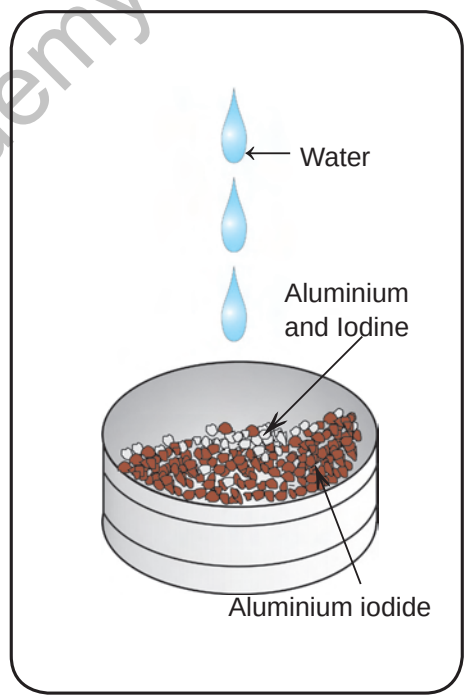


Sulphur combines with oxygen to form a colourless gas sulphur dioxide.

S + O_2 → SO_2
(element) (element) (compound)

ACTIVITY 5.10

Take powdered iodine and aluminium in a bottle lid. Add 2 to 3 drops of water to this mixture. You can see a greyish black compound formed. What is it? (Perform the experiment in outdoor).



The greyish black compound formed is aluminium iodide.

2Al + $3I_2$ → $2AlI_3$
(element) (element) (compound)

The grey brittle compound is iron

SCIENCE

ACTIVITY 5.11

Take 7g of iron powder and 4g of sulphur. Mix the two thoroughly. Take the mixture in a test tube and heat it over a flame. Remove the burner and observe. Then heat it to red hot and let it cool. What do you notice? You can see a grey brittle compound formed. What is it?

The grey brittle compound is iron sulphide

$$Fe + S \rightarrow FeS$$

(element) (element) (compound)

5.5.1. Characteristics of a compound

Now let us take iron sulphide and study the characteristics of a compound by performing simple experiments.

1. Iron sulphide contains iron and sulphur in the ratio 7 : 4. by mass. Hence, we can say that a chemical compound is formed by the **chemical reaction between two or more elements in a fixed proportion by mass.**
2. Iron in iron sulphide cannot be pulled away by using a magnet. Similarly sulphur present in iron sulphide cannot be separated by dissolving it in carbon disulphide because sulphur present in it does not dissolve in carbon disulphide. Hence we can conclude that the **components of the compound cannot be separated by simple physical methods.**
3. When a mixture of iron powder and sulphur is heated it glows red hot, and the glow stays for a while even when bunsen flame is removed. This shows that heat is given out. This reveals that **formation of a compound is associated with evolution or absorption of heat.**
4. Pure iron sulphide melts at a definite temperature. Hence a **compound has a fixed melting and boiling point.**
5. Iron sulphide is not attracted by magnet.When dilute sulphuric acid is added to iron sulphide, a colourless gas with rotten egg smell is produced due to hydrogen sulphide but not hydrogen. Thus iron present in the compound does not show its property. When carbon disulphide is added to Iron sulphide, it does not dissolve in it. This shows that sulphur is also not able to show its characteristic property. Hence we can say **the properties of a compound are different from those of its component elements.**

6. When a sample of iron sulphide is viewed by magnifying lens, it is found to be homogenous throughout its mass. No individual particle of iron and sulphur can be seen in iron sulphide. Hence **compound is homogenous.**

Now can you to list out the characteristics of compounds?

ACTIVITY 5.12

List the characteristics of compounds

1..... .....
2..... .....
3..... .....
4.....
5.....
6.....

5.5.2. Classification of compound

Let us learn to classify the compounds based on the origin or chemical components as

1. **Inorganic compounds**
   Compounds obtained from non living sources such as rock, minerals, etc., are called inorganic compounds. eg. Chalk, marble, baking powder, etc.

2. **Organic compounds**
   Compounds obtained from living sources such as plants, animals etc., are called organic compound.eg.Protein,waxes,oil, carbohydrates, etc.

ACTIVITY 5.13

Check whether sugar is a compound or not.

- Take some sugar in a test tube.
- Heat the test tube on a flame.
- The sugar will melt and turn brown.
- On further heating it starts charring and turning black.
- Look near the rim of the test tube. You will find small droplets of water.
- Since the water droplets have formed upon heating these cannot possibly be result of condensation from air. This shows that water has formed by decomposition of sugar.
- Black residue is carbon.
- So, sugar decomposed into carbon and water.
- We know that water is made up of elements of hydrogen and oxygen.

This shows that sugar is a compound.

MORE TO KNOW

- Talc is the softest known substance.(talcum powder)
- Water expands by about 10% as it freezes.
- It is estimated that plastic containers can resist decomposition for 50,000 years.
- Hydrofluoric acid will dissolve glass.

SCIENCE

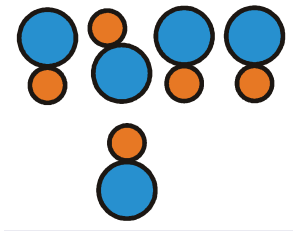
5.5.3. Uses of Compounds

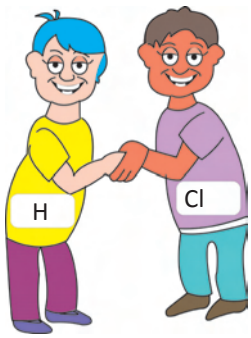
Let us tabulate the some compounds and their components that we use in our daily life.

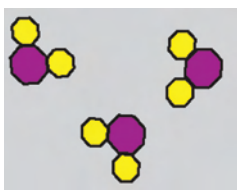
COMMON NAME	CHEMICAL NAME	COMPONENTS	USES
Water	Hydrogen Oxide	Hydrogen and oxygen	For drinking and as solvent
Table salt	Sodium chloride	Sodium and chlorine	Essential component of our daily diet, preservative for meat and fish.
Sugar	Sucrose	Carbon, hydrogen and oxygen	Preparation of sweets, toffees 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 hard water.
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.

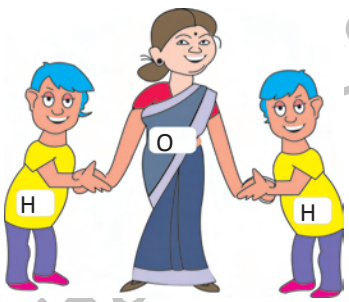
5.5.4. Molecule of compound

The molecule of a compound contains two or more different types of atoms. For example, the molecule of hydrogen chloride contains one atom of hydrogen and one atom of chlorine. Similarly, one molecule of water contains two hydrogen atoms and one atom of oxygen.









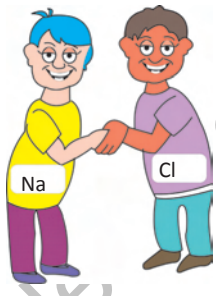
5.6. WHAT IS A FORMULA?

Just as an atom is represented by its symbol, a molecule of element or a compound is represented by means of a formula.

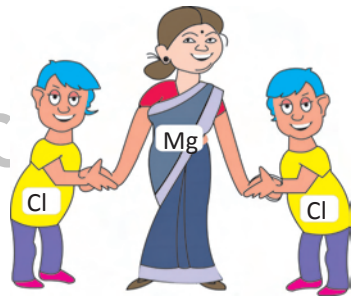
The formula represents the number of atoms of each element in the molecule. For example H_2 represents one molecule of hydrogen formed when two atoms of hydrogen combine.

The formula of water is H_2O. This indicates that two atoms of hydrogen chemically combined with one atom of oxygen to form water. The subscript " 2 " below H indicates the number of atoms of hydrogen present in one molecule of water. Notice that when only one atom is present the subscript "1" is not written.

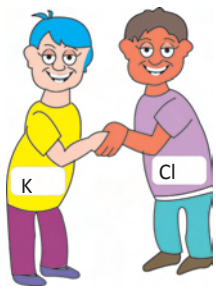
Let us learn to write formula from the following picture.



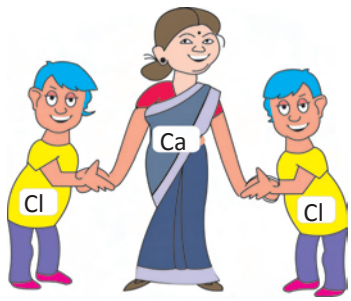
Formula is NaCl



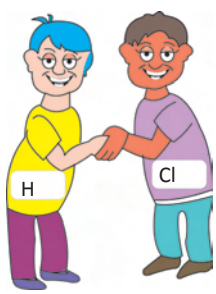
Formula is $MgCl_2$



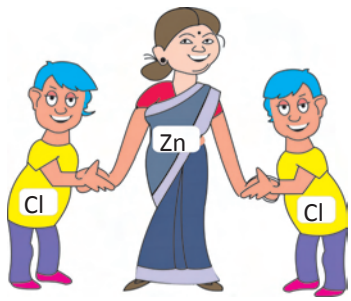
Formula is_____



Formula is _____



Formula is _____



Formula is _____

SCIENCE

SCIENCE

5.7. WHAT IS VALENCY?

Two atoms of hydrogen combine with one atom of oxygen to form a molecule of water. While one atom of hydrogen combines with one atom of chlorine to form a molecule of hydrogen chloride. You could say that oxygen atom has a greater capacity to combine with hydrogen than the chlorine atom. This is somewhat like some people being friendly with many people, while others are satisfied with just one friend.

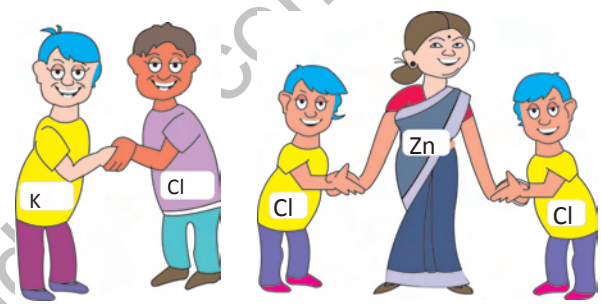
The compounds are formed by combination of atoms of different elements. During the formation of molecules of the compounds, atoms combined in a fixed proportion. This is due to the fact that different atoms have different combining capacities.

Valency can be defined as the combining capacity of an element.

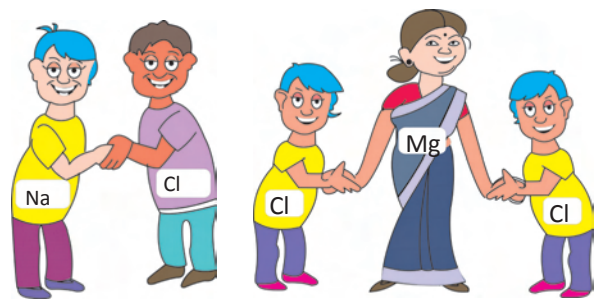
Valency with respect to hydrogen: The valency of hydrogen atom is taken as one and it is selected as the standard. Valency of other elements is expressed in terms of hydrogen. Valency of an element can also be defined as the number of hydrogen atoms which combine with one atom of the element.

Since most of the elements do not combine with hydrogen, the valency or the combining capacity of the element is also defined in terms of chlorine or oxygen.

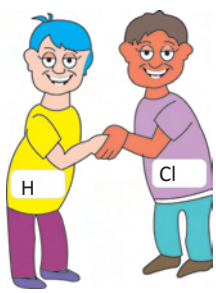
Valency With Respect to Chlorine: Since valency of chlorine is one, the number of chlorine atom with which one atom of an element can combine is called its valency.



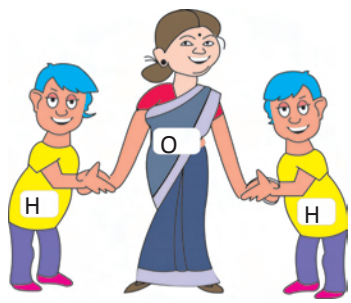
Valency of K is 1 — Valency of Zn is 2



Valency of Na is ____ — Valency of Mg is _____

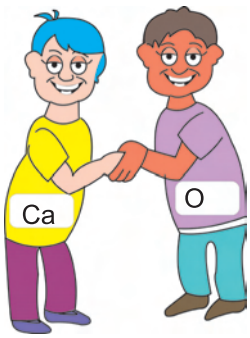


Valency of chlorine is 1

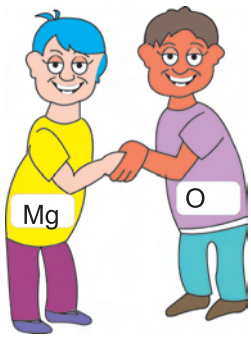


Valency of oxygen is 2

Valency with respect to Oxygen: We know that the valency of oxygen is 2. Double the number of oxygen atoms with which one atom of an element can combine is also called **valency.**

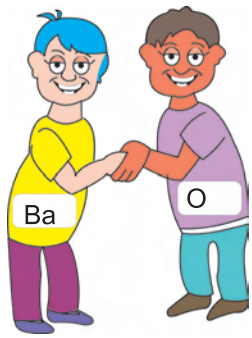


Valency of Ca is 2



Valency of Mg is 2

Valency of Zn is _____



Valency of Ba is _____

Certain elements that exhibit more than one valency, are said to be variable valence elements.

For example,

Valency of Fe in $FeCl_2$ is 2 Valency of Fe in $FeCl_3$ is 3

Some elements, especially rare gases like helium and neon, do not combine with other elements. They have **zero valency**.

ACTIVITY 5.14

List out the zero valency elements from the periodic table.

EXTENDED LEARNING

New elements, till they are given permanent name, or those elements with disputed claims for discovery/synthesis, are named using three letters based on the Latin for their atomic number.

Number	0	1	2	3	4	5	6	7	8	9
symbol	n	u	b	t	q	p	h	s	o	e
Name	nil	un	bi	tri	quad	pent	hex	sept	oct	enn

The “entire symbol” name of elements must end with the suffix –ium.

To illustrate this system,

Let us assign to an element with atomic number	1	1	2
Name	Un	un	bium
Symbol	Uub		

GROUP ACTIVITY 5.15

Here is an interesting game which will help you remember the symbols and valencies of the elements you have learnt in this lesson. Make the cards as instructed and then form small groups with your classmates to play?

Instruction:

1. Prepare 3 cards each for every element given in the list. (3 X 13 =39)

Hydrogen	copper	magnesium	oxygen
Sodium	zinc	iron	sulphur
Potassium	lead	calcium	chlorine
Mercury			

2. Then prepare 3 cards each for the same elements. This time use their symbol instead of their names (3 X13=39)

   H Cu Mg O Na Zn Fe S K Pb Ca Cl Hg

3. Prepare 30 cards with '2' written on them and 12 cards with '1' written on them. The '2' and '1' cards represent the valency.

4. There should be a total 120 cards.

How to Play:

Eight players can play at a time. All the cards are distributed among the players. Each player gets 15 cards. At each turn, a player can do one of the following:

1. Make a set of three cards. One set is made of a card which has the name of an element on it, a card with its symbol and a card with its valency.

2. Draw a card from the person sitting on the left. Check if this card helps to make a set as explained above. If yes, place the set face up on the table.

A person who makes a set with a wrong symbol or valency card will have to skip next turn as a penalty. The round ends when one of the players has used up all the cards. The player who has used up all the cards or has the lowest number of cards left in hand is the winner.

EVALUATION

1. Water is made up of two elements, hydrogen and oxygen. Water is a liquid, whereas hydrogen and oxygen are gases. Hydrogen catches fire easily. Oxygen helps in burning. Water is used to put off the fire.

   From the above information, answer the following questions.

   a) What are the elements present in water?

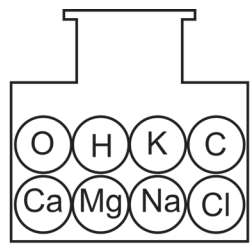
   b) In which state do these elements exist?

   c) Write the property of hydrogen.

   d) Write the property of oxygen.

   e) Do the properties of water differ from hydrogen and oxygen?

2. Using the elements enclosed in the bottle, frame formulae for some compounds.



3. Find the valency of the underlined element in the given formulae.

   i) H_2O ii) KCl iii) Al_2O_3 iv) Fe_2O_3 v) CH_4

4. write the chemical name of the given formulae.

   i) MgO ii) HCl iii) NH_3 iv) ZnO v) NaCl

5. Write the names of the planets(Greek God) after which these elements are named.

   a) Plutonium b) Neptunium c) Uranium

Project Ideas

1. i. Obtain samples of the following materials.
   Sugar, Common salt, Water, Copper wire, Pencil lead, eraser, Iron

   ii. Observe each material and mention its state or appearance.

   iii. Classify the samples into element or compound.

2. List several items that are made of common elements like iron, copper and aluminium,which you find in your home or around your home.Indicate the name of the elements they are made up of and their symbols.

3. Using clay, water colour, tooth pick (small bamboo stick), make models of elements and compounds of your choice.

Experiment

Take three samples namely, iron pieces, copper wire and charcoal. Perform the following tests and tick appropriate observations. Based on the observation classify the samples into metal and non-metal.

Test	Observation		
	Iron	Copperwire	Charcoal
Addition of water	Soluble/insoluble	Soluble/insoluble	Soluble/insoluble
Drop it down	Sonorous/ nonsonorous	Sonorous/ nonsonorous	Sonorous/ nonsonorous
Conductor of electricity(using copper wire, cell and bulb)	Good/bad	Good/bad	Good/bad

Result:

The sample :

Iron is a _____. Copper wire is a _____. Charcoal is a _____

FURTHER REFERENCE

Book

Inorganic chemistry - Puri and Sharma - Vishal publications.

Websites

www.freshney.org

www.authorstream.com

3. ATOMIC STRUCTURE

We see several things in the above picture. All these living and non living things are made up of matter. Atoms are the building blocks of all matter. Atoms are extremely small in size and are expressed in terms of 10^{-10} m (1 A°). Let us learn how ancient scientists and philosophers described the structure of atoms.

3.1. ANCIENT VIEWS ON ATOMIC STRUCTURE

Ancient scholars and philosophers in India, believed that matter consisted of ultimate minute indivisible particles(anu). They further argued that the combination of two or three atoms form a material. This idea is the same as the idea of molecules. Later, in about 400 BC, the Greek Philosopher Democritus, also proposed that matter is made up of atoms. The word **'atom'** is coined because these small particles of matter are assumed to be indivisible. In Greek language, atom means **'incapability of being cut".**

We know that, the smallest portion of a word which is further indivisible is called a letter. Similarly, if we break a magnesium ribbon into several fragments, at one stage it cannot be broken further into smaller particles. This indivisible smallest particle of an element is called an atom.

3.2. LAWS OF CHEMICAL COMBINATION

The ideas of these philosophers were not universally accepted because there was no experimental evidence to support them. Scientists continued

to accumulate the data and as time passed, more and more observations and views regarding the qualitative and quantitative aspects of matter were noticed. These observations led to some general statements which are now known as **Laws of Chemical Combination.** They include

1. Law of Conservation of Mass
2. Law of Definite Proportion
3. Law of Reciprocal Proportion
4. Law of Multiple Proportion and
5. Gay Lussac's Law of Combining Volume

Let us discuss the first two laws of chemical combination.

3.2.1 Law of Conservation of Mass: (LAVOISIER 1774)

Is there a change in mass, when a physical change takes place?

Activity 3.1 — We Observe

Take a piece of ice in a clear tightly closed conical flask and weigh it. Leave the flask for some time. Now you observe the flask. The ice melts and becomes water. This is a physical change. After some time, weigh the flask again. What will you notice?

You will notice that there is no change in mass. Hence, during the physical change the total mass of the matter remains the same.

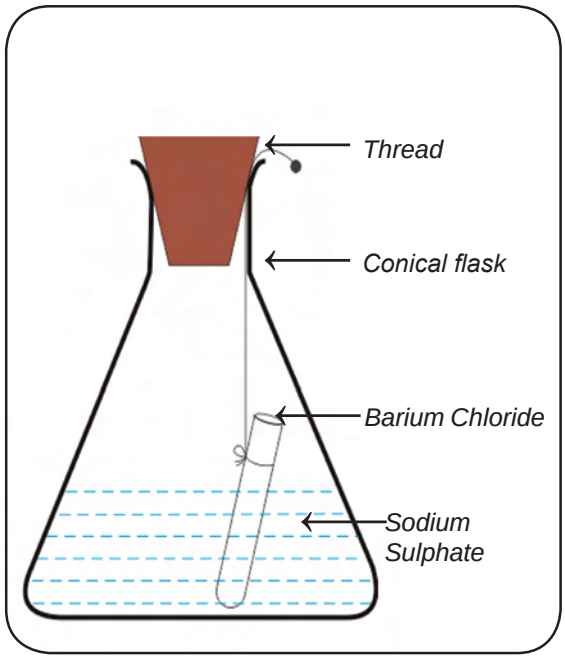
Is there a change in mass when a chemical change(chemical reaction) takes place?

Activity 3.2 — We Observe

Prepare 5% solutions of barium chloride (5g $BaCl_2$ in 100 ml of water) and sodium sulphate 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. Note down the weight. Now mix the two solutions by tilting and swirling the flask. Shake well. Weigh the flask after the chemical reaction has taken place. Note down the weight. Record your observation when the reaction between the two solutions has taken place.

What happens in the conical flask when the two solutions are mixed? Does the weight of the flask before and after the chemical reaction remain the same? What do you conclude from this experiment?

Barium chloride reacts with sodium sulphate solution to form a white precipitate of barium sulphate and sodium chloride .



The mass of flask before and after the chemical reaction was found to be the same.

From the conclusions drawn from the above activities, the law of conservation of mass can be stated as "Mass can neither be created nor destroyed during a physical or a chemical change"

In other words, the total mass of material present after a chemical reaction is the same as the total mass before the chemical reaction.

3.2.2. Law of Definite Proportions: (PROUST 1779)

Joseph Proust noticed that all the compounds were compounds of two or more elements and each such compound 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 not change. It will be in a fixed ratio. Hence, the law of definite proportion can be stated as" A pure chemical compound prepared by any method consists of the same elements combined together in a fixed proportion by mass".

Joseph Louis Proust ***(1754 - 1826)***

3.3. DALTON'S ATOMIC THEORY

Keeping in view, the law of chemical combinations and the work of Greek philosophers, a meaningful atomic theory was finally proposed by an English school teacher John Dalton during the years (1803-1807). His ideas have been summarised (postulated) as.

1. Matter is made up of small, indivisible particles called atoms.

2. Atom can neither be created nor destroyed.
3. Atoms of the same element are identical in all respects.
4. Atoms of different elements are different in all respects.
5. Atoms of different elements may combine with each other in a fixed simple whole number ratio to form “compound atoms” (or molecules).
6. Atom is the smallest particle that takes part in chemical reaction.

3.3.1. Merits of Dalton’s Atomic Theory

1. It gave a satisfactory explanation for the law of chemical combinations (law of conservation of mass and law of definite proportions).
2. It explained most of the properties of gases and liquids known at that time.

3.3.2. Demerits of Dalton’s Atomic Theory

1. It failed to explain why the atoms of different elements differ in their size, mass and valency.
2. It failed to explain how and why atoms of different elements combine together to form the compound atoms.
3. It also did not explain the nature of binding forces that keep the atoms together in a compound.
4. It could not give a clear distinction between the atom and the molecule.

John Dalton, son of a poor weaver, began his career as a village school teacher at the age of 12. He became 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.

3.4. ELECTRICAL NATURE OF MATTER

Before proceeding to understand the composition of an atom, it is better to learn the electrical nature of matter. For understanding the electrical nature of matter, let us carry out the following activities.

Activity 3.3 **I Do**

I need: Bits of paper, plastic comb, glass rod ,a bit of silk cloth and inflated balloon.

1. I take a few bits of paper and place them on the table. I comb my dry hair repeatedly with a plastic comb. Immediately I bring the comb close to small bits of paper. I am able to notice the comb _____ small pieces of paper.
2. I rub a glass rod with silk cloth and bring it near an inflated balloon. I am able to see the glass rod _____ the inflated balloon.

From these activities, we can conclude that on rubbing two objects together, they become electrically charged. Where does this charge come from? This question can be answered by knowing that an atom consists of charged particles.

The first direct experimental evidence for the electrical nature of matter came from the experiments of Michael Faraday.

He proved through his experiments that electricity is composed of particles called '**atoms of electricity'.**

It was George Johnstone Stoney, an Irish Physicist who first proposed the word **'electron'** for atom of electricity' in 1891.His contribution to research in this area laid the foundations for the eventual discovery of particles by J.J. Thomson in 1897.

3.5. DISCOVERY OF FUNDAMENTAL PARTICLES

An experiment to investigate the phenomenon that takes place when high voltage is applied through a tube containing gas at low pressure, laid the foundation to the discovery of fundamental particles.

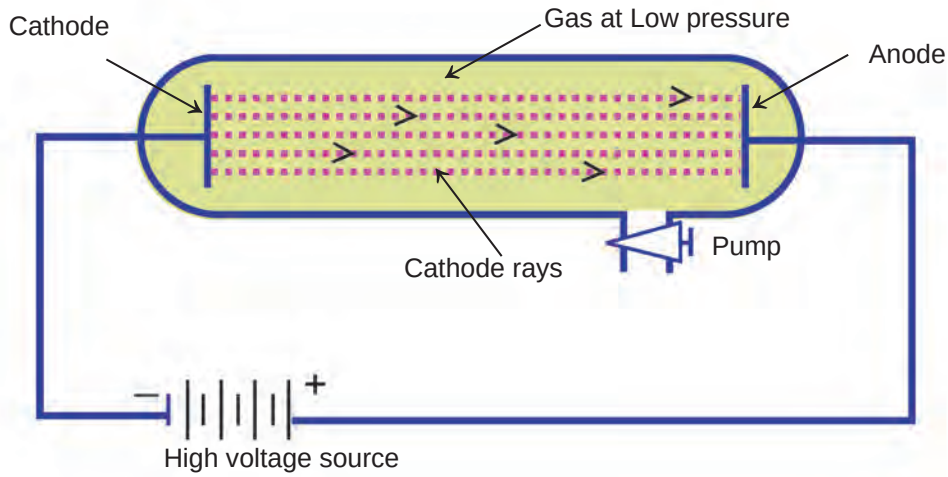
In 1878, Sir William Crooke, while conducting an experiment using a discharge tube, found certain visible rays travelling between two metal electrodes. These rays are known as Crooke's Rays or Cathode Rays. The discharge tube used in the experiment is now referred to as Crookes tube or more popularly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

MORE TO KNOW

The fact that air is a poor conductor of electricity is a blessing in disguise for us. Imagine what might have happened if air had been a good conductor of electricity. All of us might have been electrocuted whenever a minor spark is produced by accident.

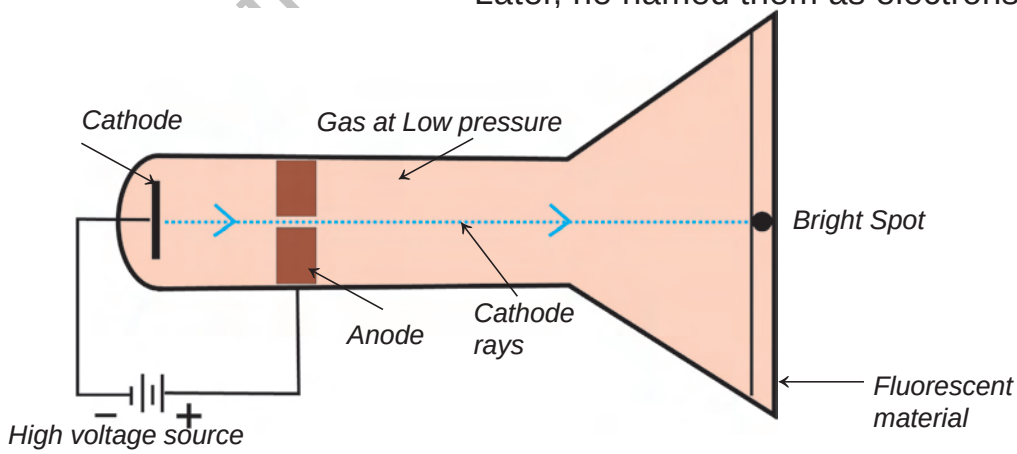
SCIENCE

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.



3.5.1. Discovery of electron

Later, J.J. Thomson also found that when a high voltage of 10,000 V was applied between the electrodes present in a partially evacuated cathode ray tube at a pressure of 0.01mm of mercury, a bright spot of light was formed on the screen coated with a fluorescent material placed at the other end of the tube. The fluorescent material coated on the screen started to glow because it was struck by the ray which originated from the cathode. Since these rays were emitted by the cathode, he named these rays as cathode rays. Later, he named them as electrons.



MORE TO KNOW

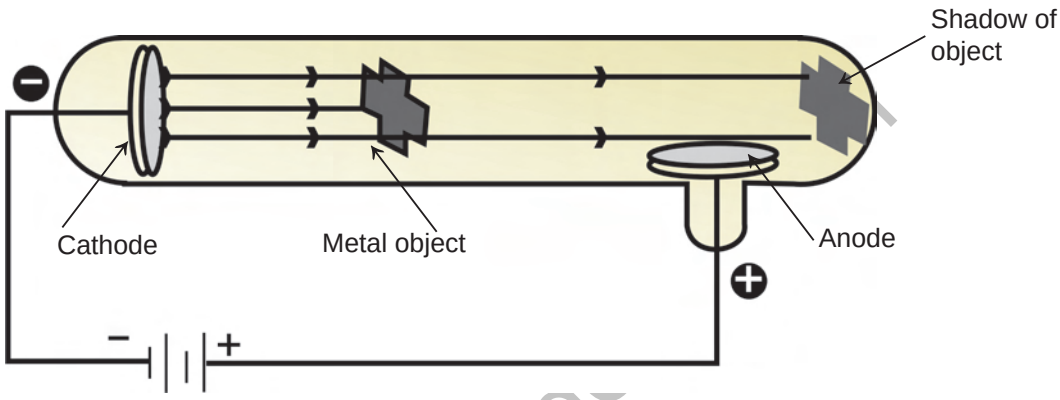
FLUORESCENT MATERIAL :When invisible radiation falls on materials like zinc sulphide, they emit visible light (or glow). This is called fluorescent material.

3.5.2. Properties of Cathode rays

J.J. Thomson and others studied the properties of these cathode rays by conducting the following experiments.

Experiment 1

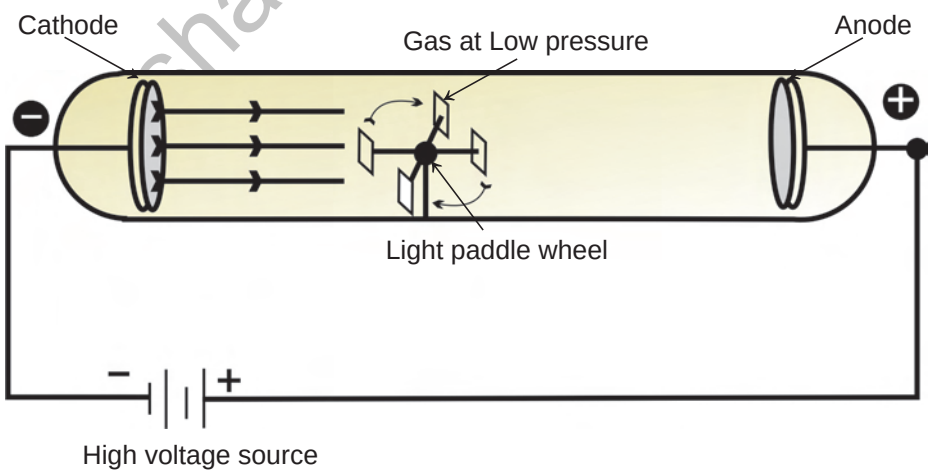
Cathode rays fall on a small object which is placed in between the cathode and anode. A shadow which is of the same size and shape as that of the object is observed on the wall opposite to the cathode.



Conclusion: Cathode rays travel in straight lines parallel to each other.

Experiment 2

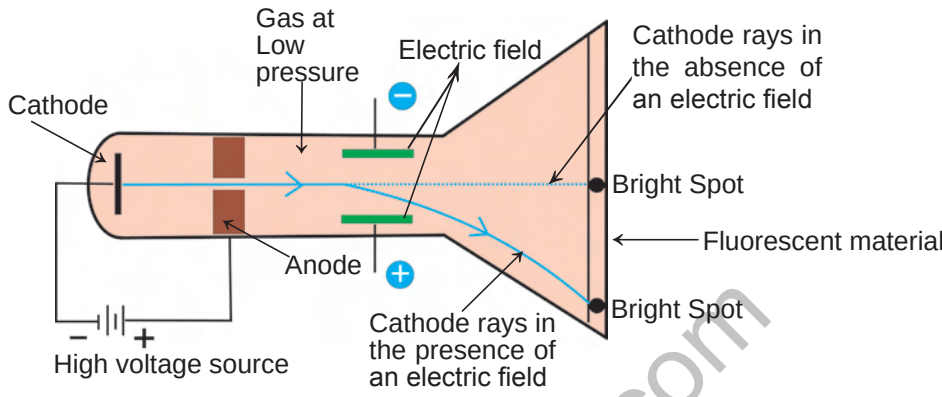
When cathode rays fall on a light paddle wheel which is placed in between the cathode and anode, the wheel starts rotating.



Conclusion: Cathode rays are made up of small particles that have mass and kinetic energy.

Experiment 3

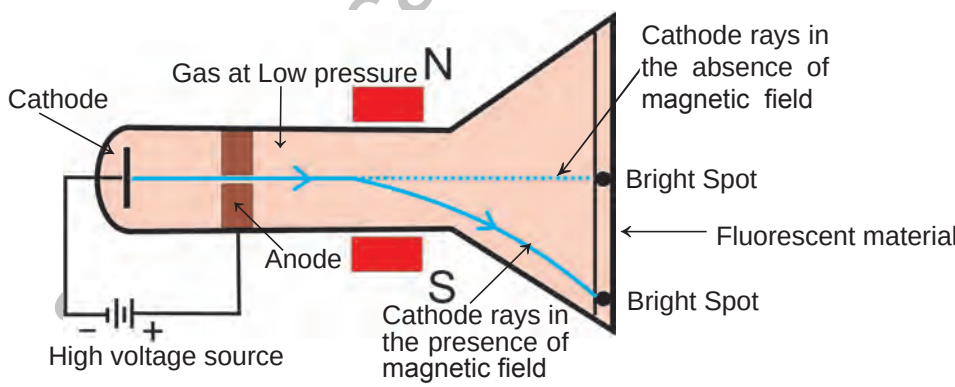
When cathode rays are passed through an electric field they are deflected towards the positive plate of electric field.



Conclusion: Cathode rays are negatively charged particles.

Experiment 4

When cathode rays are passed through a magnetic field, the deflection of the rays is seen perpendicular to the applied magnetic field.



Conclusion: The direction of deflection indicates that the cathode rays are negatively charged particles. These negatively charged particles are called **electrons.**

Experiment 5

These experiments are repeated by taking different gases / different cathodes in the discharge tube.

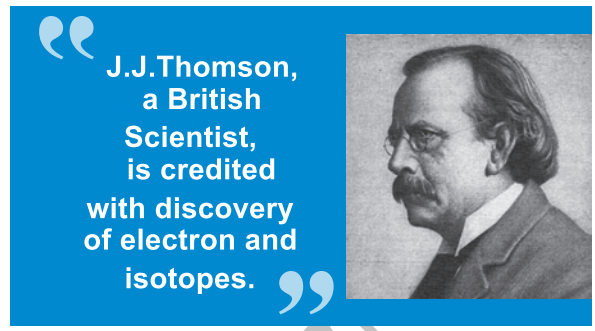
No change in properties.

Conclusion: The nature of the cathode rays does not depend on the nature of the gas inside the tube or the cathode used.

Now shall we write the properties of cathode rays from the conclusions?

List the properties of cathode rays

1.
2.
3.
4.
5.

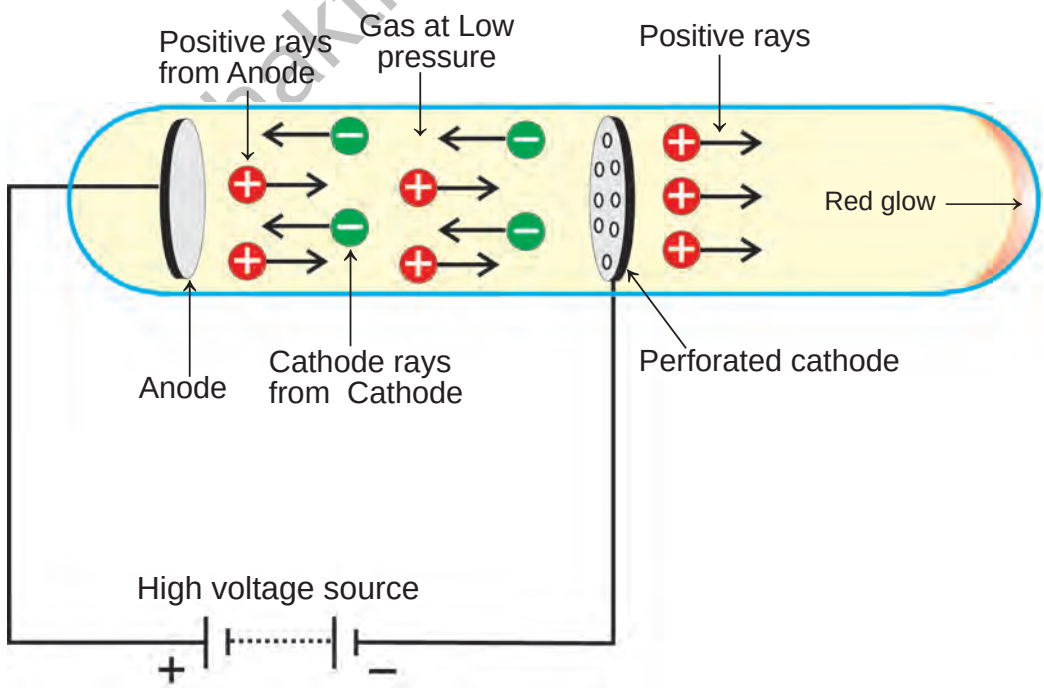


3.5.3. Discovery of protons

The presence of positively charged particles in the atom has been 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's Experiment (1886)

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.

When hydrogen gas was taken in a discharge tube, the positively charged particles obtained from hydrogen gas were called PROTONS. Each of these protons are produced when one electron is removed from one hydrogen atom.

$$H \longrightarrow \underset{\text{Proton}}{H^+} + \underset{\text{electron}}{e^-}$$

Thus, proton can be defined as hydrogen ion (H^+) (Ions are charged particles).

3.5.3.1 Properties of anode rays

1. Anode rays travel in straight lines.
2. Since they rotate the light paddle wheel placed in their path, they consist of material particles.
3. Anode rays are deflected by electric and magnetic field. Since they are deflected towards the negatively charged plate, they consist of positively charged particles.
4. The properties of anode rays depend upon the nature of gas taken in the discharge tube.
5. The mass of the particle is the same as the atomic mass of the gas taken inside the discharge tube.

3.5.4. Properties of fundamental particles

Particle	mass (atomic mass unit)	Relative charge
ELECTRON(e)	0.00054 a.m.u	-1
PROTON(p)	1.00778 a.m.u.	+1

3.6. WHY ATOMIC MODEL?

The study of electrical phenomenon in gases led to the historical conclusion that atom is divisible and is made up of

1. Electrons
2. Protons

The study of the properties of the fundamental particles, like electron and proton, led to the conception of various atom models.

Atom model is the description depicting the arrangement of various fundamental particles inside the atom. The systematic study of various atomic models gives us an insight into the understanding of the primary structure of an atom.

3.6.1. Thomson's atomic model (1904)

Thomson's atomic model can be compared to the watermelon or a ripened guava. In watermelon the red edible portion represents the

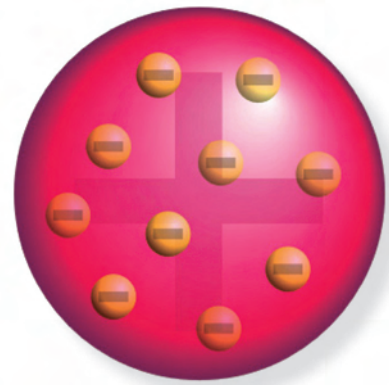
positive sphere, and black seeds are like electrons embedded.

According to J.J. Thomson,

1. An atom consists of a positively charged sphere and electrons are embedded in that sphere.
2. The positive and negative charges are equal in magnitude; hence the atom as a whole is electrically neutral.

Thomson's model of atom is popularly known as plum pudding model.

3.6.2. Limitation of Thomson's model



Thomson's model could successfully explain the electrical neutrality of atom. However, it failed to explain how the positively charged sphere is shielded from the negatively charged electrons without getting neutralised. Apart from electrons and protons, an atom contains a neutral particle called neutron. You will learn more about neutrons in higher classes.

SCIENCE

EVALUATION

I. Choose the correct answer:

1) The same proportion of carbon and oxygen in carbon dioxide obtained from different sources proves the law of_____

a)reciprocal proportion b) definite proportion c) multiple proportion

2) In water, hydrogen and oxygen are in the ratio by mass

a) 1:8 b) 8:1 c) 2:3

3) Which one of the following is a wrong statement, regarding the postulates of Dalton's atomic theory.

a) Matter is made up of small indivisible particles called atoms.

b) Atoms of same element are different in all respects.

c) Atoms of different elements are different in all respects.

4) Dalton's atomic theory successfully explained the _____

i) Law of conservation of mass

ii) Law of definite proportions

iii) Law of radioactivity

iv) Law of multiple proportions

a) (i), (ii) and (iii) b) (i),(iii) and (iv) c) (i) ,(ii) and (iv)

5) In Thomson's model of an atom, which of the following statements are correct?

i) The positive charge is assumed to be uniformly distributed over the atom.

ii) The electrons are uniformly distributed in the positively charged sphere.

iii) The electrons attract each other to stabilize the atom.

iv) The mass of the atom is assumed to be uniformly distributed over the atom.

a) (i) ,(ii) and (iv) b) (i),(ii) and (iii) c) (i) and (iii)

II. Fill in the blanks:

1. _____is a negatively charged particle. (Electron/Proton)
2. Proton is deflected towards the___ charged plate.(positively, negatively)

III. Match the entries of column I with the appropriate entries of column II and column III (Double matching)

Property (Column I)	Cathode rays (Column II)	Anode rays (Column III)
i) Type of charge present	a) independent	A) positive charge
ii) Particle present	b) negative charge	B) depend
iii) Nature of gas taken in the discharge tube	c) cathode	C) proton
iv) Origin	d) electron	D) anode

IV. Identify the wrong statement regarding the properties of cathode rays and correct them.

1. Cathode rays are made up of large particles. They have mass and kinetic energy.
2. Cathode rays are deflected by magnetic field.
3. Cathode rays depend on the nature of the gas inside the tube.

V. Explore and answer:

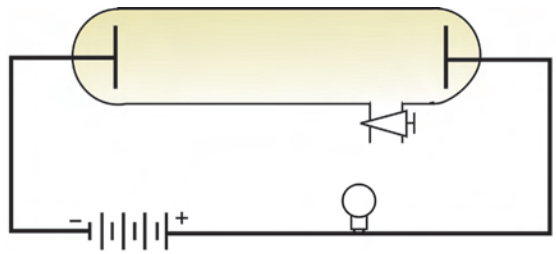
1. Why does a light paddle wheel placed in the path of cathode rays begin to rotate when cathode rays fall on it?
2. a) What happens in the discharge tube if high voltage is applied at a gas pressure of 760 mm mercury?

   b) What will happen if the pressure is reduced to 0.01mm mercury?
3. How can we prove that the electrons carry negative charge?
4. Selvi took a conical flask put some ice cubes into it and closed it with a stopper. Then, she found the weight of the conical flask using a balance. Its weight was 150 g. After sometime, ice started melting and turned into water. She weighed the flask again. The weight was 150 g. What inference would you draw from this experiment?
5. Kannagi, Goutam, David, and Saleem collected different samples of water from a well, a pond, a river and underground. 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?
6. The postulates of Dalton's law are given below;
   a) Atom can neither be created nor destroyed.
   b) Atoms of different elements may combine with each other in a fixed simple whole number ratio to form a compound atom.

   i. Which postulate of Dalton's atomic theory is based on the law of definite proportion?

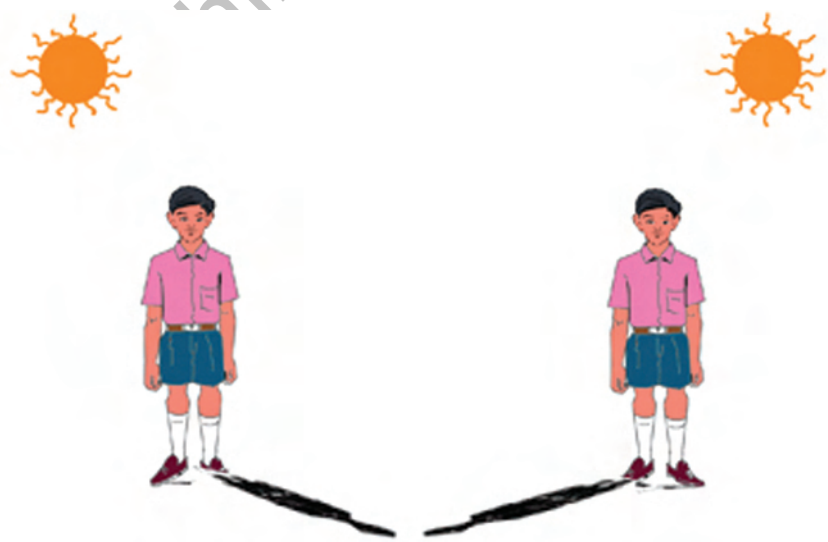
   ii. Which postulate of Dalton's atomic theory is based on the law of conservation of mass?

7. Rani prepared carbon monoxide in the laboratory.It contained 15g of carbon and 20g of oxygen. Ram also prepared carbon monoxide using another method. It contained 42.9% of carbon. Show that the data of Rani and Ram are in accordance with the law of definite proportions.
8. Cathode rays fall on a small object between the cathode and anode. A shadow which is of the same size and shape as that of the object is observed on the wall opposite to the cathode. What conclusion can you draw from the above statement regarding the properties of cathode rays?
9. Gomathi enclosed a certain gas in a discharge tube connected as shown in the figure.



She applied high voltage but the bulb did not glow. What should Gomathi do to make the bulb glow?

10. Observe the size and direction of your shadow, when you stand in the sunlight in the morning and evening.

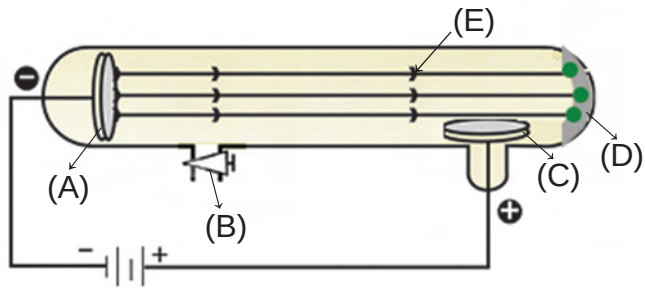


1) Is the length of your shadow the same as your height?

2) What is the direction of the shadow? Is it in the direction of the source of light or is it in the direction opposite to the source of light?

3) Compare the nature of the shadow formed in this activity with that of the shadow formed when an object is kept in the path of the cathode rays.

11. (i) Sketch and label the parts A,B,C,D and E in the figure given below.



(ii) What is the purpose of B?

(iii) What is the function of D?

12. Cathode and Anode rays are negatively and positively charged particles respectively. They travel in a direction opposite to each other. Why don't they get neutralized?

13. Why did Thomson assume that electrons are embedded in a positively charged sphere? Why did he not assume that they are positively charged particles embedded in a negatively charged sphere?

Project Work:

Using a cardboard, chart paper of round shape, gum, cotton, red colour sketch pen / water colour and dry black water melon seed or black beads, construct a model of Thomson's atom. Label the model and display it in your classroom. Write a brief description of the Thomson's model.

FURTHER REFERENCE

Book

Inorganic Chemistry – P.L.Soni - Sultan Chand and Sons

Websites

http://www.chem4kids.com/files-atom-structure

http://www.world of teaching.com/powerpoints/atomic%20structure

hhtp://www.about.chem

3. COAL AND PETROLEUM

Do you know Ram? He is my neighbour who is studying in 8th standard. He goes to school by bicycle. His father goes to office by car. His brother goes to college by bus. Ram's family cooks food using a gas stove.

What are the fuels used in the various modes of transport and for cooking by Ram's family in the above activity? Car uses petrol and the bus uses diesel for cooking LPG (Liquefied Petroleum Gas)

ACTIVITY 3.1 **I DO**

I tabulate the vehicles that use (i) Manpower (ii) Fuel








Manpower	Fuel

Fuels

"Substances that burn in air to give heat energy are called fuels"

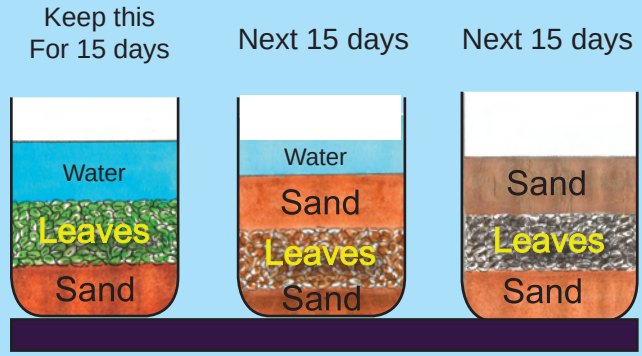
Fossil Fuels

Fossil fuels are formed from the buried remains of decayed plants and animals over millions of years, under the influence of heat and pressure in the absence of air. Coal, petroleum and natural gas are called fossil fuels.

SCIENCE

ACTIVITY 3.2 **I DO**

I need : a glass beaker, sand, water, leaves, twigs pieces of fern



Procedure :

- I take a glass beaker and I spread two inches of sand at the bottom. I pour some water and drop leaves, twigs and pieces of fern on the sand.
- I allow it to stand for two weeks. I note down the change in colour after two weeks.Now I gently put some sand on the top of the plant layer to a depth of two inches.
- I wait for two more weeks and drain the water. Again I allow it to dry for another two weeks.
- I can see the fossil imprint between the sand layers.

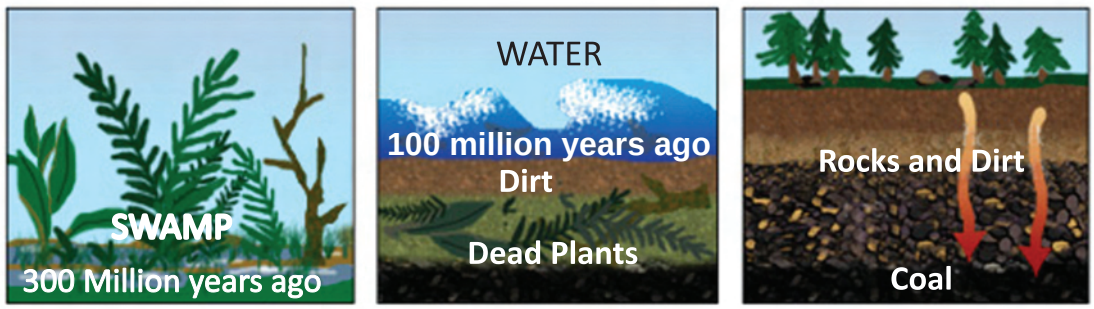
SCIENCE

3.1. COAL

Occurence of coal

Coal mining was started in India in 1774. India now ranks third among the coal producing countries in the world. USA and China have $\frac{2}{3}$ of the world's coal reserve.

Three hundred million years ago, some plants grew into giant ferns and mosses. These plants got buried into the bottom of the soil and were converted as fossil due to high temperature and pressure. The decaying plants were pressed and coal was formed. As coal contains mainly carbon, the slow process of conversion of dead vegetation into coal is called carbonisation.



MORE TO KNOW

- Coal would have a higher sulphur content if it was formed in swamps covered by sea water.
- Combustion is caused by the chemical reaction of hydrocarbon with oxygen. When ignited, the fuel molecules are broken down and release heat energy.

COMPOSITION OF COAL:

Coal is a natural black mineral, which is a mixture of free carbon and compounds of carbon containing hydrogen, oxygen, nitrogen and sulphur.

3.1.1. Types Of Coal

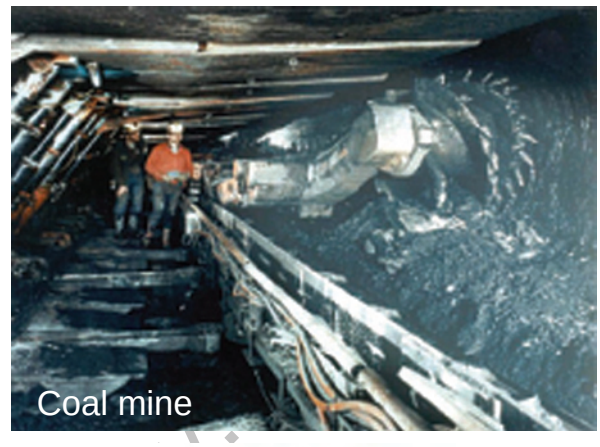
On the basis of carbon content, coal is classified into the following types:

1.PEAT: Peat is the first stage of coal. It is the most inferior variety of coal which contains 10-15% of carbon. When it is burnt, it produces a lot of smoke.

2.LIGNITE: Lignite is brown in colour. It contains 25-35% of carbon. Like peat it also produces a lot of smoke on being ignited. It can be used for power generation.

3.BITUMINOUS COAL: It is also called soft coal. It contains 45-86% of carbon. It is used as a common household fuel and industrial fuel.

4.ANTHRACITE COAL: It is also called hard coal. It is one of the most superior variety. It contains 87-97% carbon. It produces high heat energy.


Coal mine


Peat


Lignite


Bituminous


Anthracite

SCIENCE

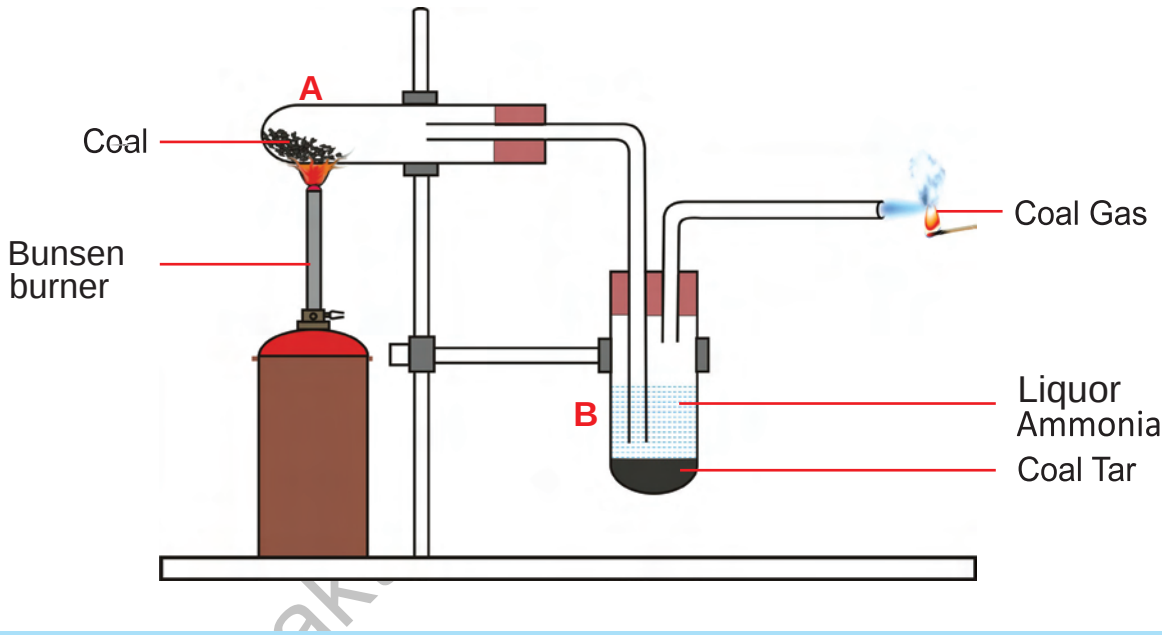
3.1.2 Destructive distillation of coal

Heating coal in the absence of air is called destructive distillation of coal.

ACTIVITY 3.3 **WE OBSERVE**

We need: Powdered coal, two boiling tubes, two delivery tubes, a Bunsen burner, a one holed rubber cork, a two holed rubber cork and some water.

Procedure: Two boiling tubes are taken powdered coal is taken in tube 'A', and water is taken in tube 'B'. The apparatus is arranged as shown in the figure. Tube 'A' is heated first gently and then strongly using Bunsen burner. Now what do we observe?



1. A gas escapes through the delivery tube from the test tube B. On ignition the gas_____. This shows that the gas liberated is coal gas.
2. We can see a _____coloured residue at the bottom of the test tube B. That black residue is coal tar.
3. Now, we take out the liquid present above the coal tar and test it with red litmus paper. Since the liquid turns red litmus paper to _____, it is basic. We smell the liquid, it has a pungent irritating smell. Hence, the liquid obtained is liquor ammonia.
4. We observe a _____ residue in the tube A. The residue is coke.

Our findings: When coal is subjected to destructive distillation it gives coal gas, liquor ammonia, coal tar and coke.

SCIENCE

Products of coal and their uses

Products of coal	Uses
Coal Gas	As a fuel in cooking food
LiquorAmmonia	To make fertilizers
Coal Tar	To make plastics, paints, dyes,naphthalene balls and explosives
Coke	As a fuel and as a reducing agent in steel manufacturing

MORE TO KNOW

On destructive distillation, 1000 kg of coal gives

- 700 kg of coke
- 100 litres of ammonia
- 50 litres of coal tar
- 400 m^3 of coal gas

- The world's first petroleum well was drilled in Pennsylvania, USA(1859.)
- Eight years later in 1867,oil was struck at Makum in Assam

Consumption of Coal : The coal that we consume in one day is what the earth took 1000 years to form.The amount of coal we consume is greater than the amount that we produce.

3.2. PETROLEUM

Millions of years ago, dead plants and animals were buried at the bottom of the sea. They got covered with layers of sand and clay. Due to high pressure and temperature, they transformed into petroleum.

3.2.1. Occurrence of Petroleum

The chief petroleum producing countries are U.S.A Kuwait, Iraq, Iran, Russia and Mexico. In India, petroleum is found in Assam, Gujarat, Maharashtra(Mumbai), Andhra Pradesh (Godavari and Krishna basin) and Tamil Nadu (Cauveri Basins). Petroleum is obtained by drilling through the earth.The crude oil is pumped out from the well as a black liquid.

3.2.2 Refining of crude petroleum

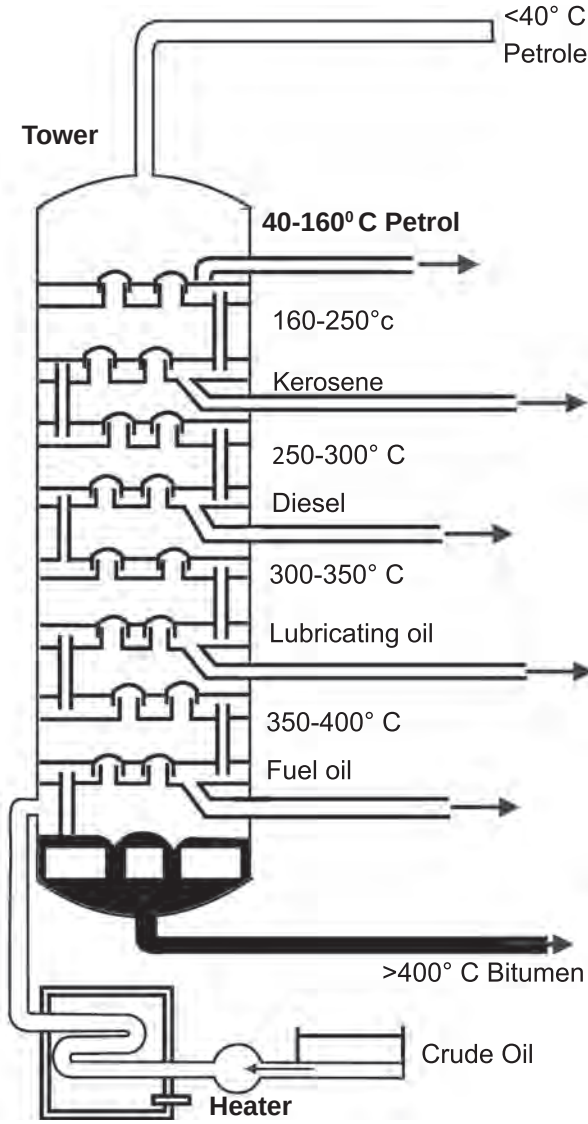
Petroleum is a mixture of various constitutents such as petroleum gas, petrol, diesel, kerosene, lubricating oil, paraffin wax, etc. The process of separation of the various constitutents or fractions of petroleum by fractional distillation in fractionating columns is known as refining of petroleum. The

Petroleum and Natural Gas Formation

SCIENCE

process of heating a mixture of liquids having different boiling points and then separating them by cooling is called fractional distillation.

Crude petroleum is first heated to about 400° C in a furnace. As the vapours of crude oil move up the tower, the various fractions condense according to their boiling point ranges. The various fractions of petroleum obtained are tabulated below;



Fraction	Uses
Petroleum Gas	Fuel for home (LPG)
Petrol	Motor fuel
Kerosene	Fuel for stove and jet aircrafts
Diesel	Fuel for heavy motor vehicles
Lubricating oil	Lubrication
Fuel Oil	Fuel for Power Stations and Ship
Paraffin wax	Candles, Vaseline
Bitumen	Paints, Road surfacing

MORE TO KNOW

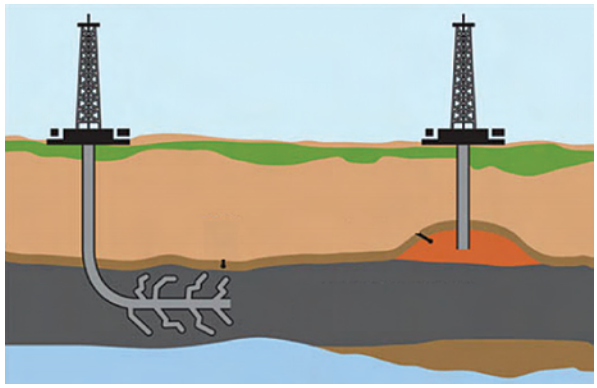
Many useful substances are obtained from petroleum and natural gas. These are termed 'Petrochemicals. These are used in the manufacture of detergents, fibres, and other man-made plastics like polythene. Hydrogen gas obtained from natural gas, is used in the production of fertilizers. Due to its great commercial importance, pertoleum is also called 'black gold'.

SCIENCE

MORE TO KNOW

If we use petroleum rapidly as we do now, in the year 2,050 there may be no petroleum at all.

3.3. NATURAL GAS



Manali

Formation of Natural gas

Natural gas is formed whenever vegetation decomposes in marshy areas and waste sewages. It also occurs in coal mines and petroleum wells.It mainly contains 90% methane.

Neyveli

3.3.1. Occurence

Naturalgas in Tripura, Rajasthan, Maharashtra, Andhra pradesh (Krishna, Godavari Basins) and Tamilnadu (Cauveri Delta.)

ACTIVITY 3.4 **I DO**

I need : A glass bottle, leaves, twigs, waste paper and saw dust

Procedure: I take a glass bottle and put some leaves, twigs, waste paper and saw-dust in it. I pour some water in it and keep it for 20 days. I open the bottle and bring a glowing splinter near the mouth. I can see a gas burning near the mouth.

My finding: The burning gas is due to the evolution of natural gas.

The way of using natural gas

1. CNG (Compressed Natural Gas)
2. LNG (Liquified Natural Gas)

CNG is stored at high pressure whereas LNG is in ultra cold liquid form. CNG can be produced at lower cost.

Advantages and uses of CNG

1. It is a less pollutant fuel.
2. It is directly used as fuel for burning at home and factories.
3. It is the basic material for the manufacture of a number of chemicals and fertilizers.

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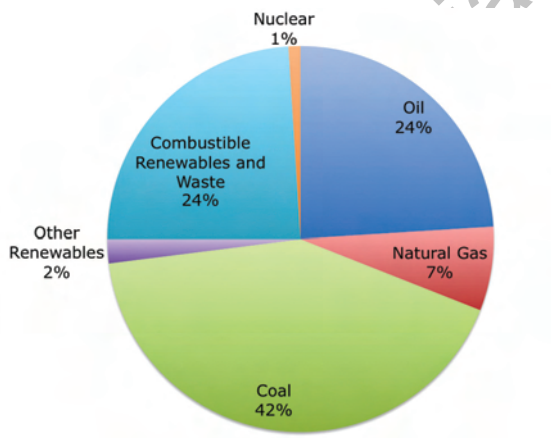
3.4. NATURAL RESOURCES AND LIMITATION

The natural resources in the world have been used by man in a rapid way and so very soon all our exhaustible sources like coal, petroleum and natural gas would be reduced to zero level. So we need to find new alternative sources of energy.

Natural Resources	Lasting period
Coal	148 years
Petroleum	40 years
Natural Gas	61 years

3.4.1. Alternative sources of energy

1. Biodiesel : Biodiesel is a fuel obtained from vegetable oils such as Soyabean oil, Jatropha oil, Cornoil, Sunflower Oil, Cotton seed oil, Rice bran oil and Rubber seed oil.



Energy sources in usage

Not for fun

- My father rode on a cart.
- I drive a car.
- My son flies a jet plane. His son will ride on a cart.

2. Wind Mills : All of you might have seen wind mills. They have long blades connected to a dynamo. When wind blows, they rotate and current is produced in the dynamo. Wind mills are mostly located at Kayathar, Aralvaimozhi, Palladam and Kudimangalam in TamilNadu.

3. Solar Energy : Sun is the foremost energy source that makes life possible on our earth.Solar energy has been used by man from ancient times. Solar energy is harnessed using (i) solar cookers (ii) solar water heaters (iii) solar cells.

4. Gobar Gas: Gobar gas is obtained by the fermentation of cow dung in the absence of air (anaerobic conditions). It mainly contains methane and a little ethane. It is widely used in rural areas for cooking and operating engines.

SCIENCE

3.5. SCIENCE TODAY

3.5.1. Hydrogen - The future fuel

Hydrogen could be the best alternative fuel. It is a clean fuel as it gives out only water while burning. Moreover, it has the highest energy content. It does not pollute air.

3.5.2. Cold Fusion Process

Nuclear fusion is a process in which two or more lighter nuclei of atoms are combined to produce nuclear energy. This process requires very high temperature. If the nuclear fusion process is carried out at room temperature, it is called as cold fusion process.

3.5.3 Methane from sewage

Sewage sludge can be decomposed by microorganisms to produce methane gas along with impurities like carbon dioxide and hydrogen sulphide. After removing these impurities, methane gas can be used as an efficient fuel.

MORE TO KNOW

In India, the Petroleum Conservation Research Association(PCRA) advises people with methods of saving petrol/diesel while driving.

Some tips:

- Drive at a constant and moderate speed as far as possible.
- Switch off the engine at traffic signals or at places where you have to wait.
- Ensure correct tyre pressure.
- Ensure regular maintenance of the vehicle.

"Today's wastage - tomorrow's shortage"

"A mile we walk
we save a litre of petrol
and
a day of life"

SCIENCE

EVALUATION

I.Choose the correct answer :

1. Which type of coal has high content of carbon?

a) lignite b) peat c) bituminous coal d) anthracite coal

2. Which type of coal is used in the household?

a) lignite b) peat c) bituminous coal d) anthracite coal

3. Naphthalene ball is obtained from

a) coal gas b) coke c) coal tar d) liquor ammonia

4. Fuel that is used in jet air craft

a) petrol b) petroleum gas c) kerosene d) diesel

5. Which of these is a fossil fuel?

a) wood b) paper c) petroleum d) phosphorus

II. Fill in the blanks:

1. The expansion of LPG is _____.
2. LPG is stored in _____ form in the gas cylinder.
3. The expansion of CNG is _____.
4. The chief element in coal is _____.
5. Natural gas contains mainly _____.
6. Heating in the absence of air is called _____.
7. _____ is the primary source of energy.
8. The coal obtained in Neyveli is _____.
9. The process of separating individual liquids, from the mixture of liquids which differ in their boiling point is called _____.
10. _____ is used as a reducing agent in steel manufacturing.

III. Answer the following ;

1. Ram's family cooks food quickly as they use LPG gas. Murugan's family takes a longer time to cook food. What could be the reason?

2. Find the relevant pair :

   a) Coal - coal gas; then petroleum - _____

   b) LPG - propane and butane; then natural gas - _____

   c) Diesel - petroleum; then bio-diesel - _____

3. Read the following tabular column carefully and decide which fuel we should use for cooking.

Wood	L.P. Gas
Smoke is produced	Smoke is not produced
Has low calorific value	Has high calorific value
It takes a long time to cook	It takes less time to cook
Ashes are formed	Ashes are not formed

4. What do you understand by the term carbonisation?

5. Point out the difference between coal and coke.

6. Distinguish between petroleum and petrol.

7. The boiling point of three components A, B and C of petroleum are 120°C, 70°C, 250°C respectively. If a mixture of these three is fractionally distilled, which of these will be obtained at the bottom of the distillation column?

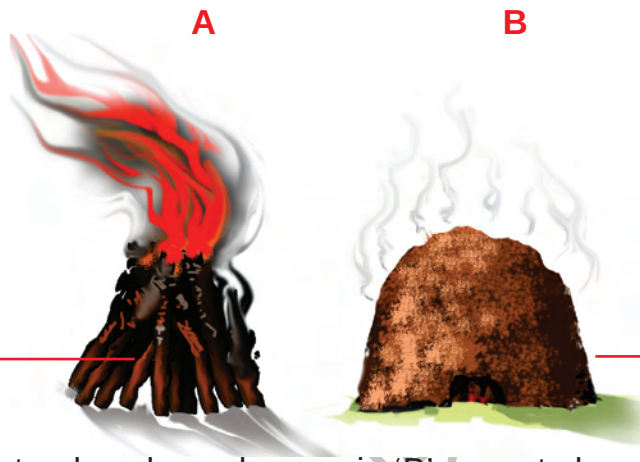
8. Coal, petrol, diesel and LPG are the fuels used by us now. If they are harnessed completely we would be running short of fuels for cooking and using vehicles and working of factories in our near future. So, we need alternative sources of energy. As a young scientist suggest a source of alternative energy.

9. Types of coal and the percentage of carbon in each type is given below. Which type should be used to get high heat energy?

   Lignite - 25 to 35% carbon
   Bituminous - 45 to 86% carbon
   Anthracite - 87 to 97% carbon

IV. Explore:

1. Countries like Dubai, Saudi Arabia, Abu Dhabi etc. have become very rich in recent years. What could be the reason?
2. Why do millions of people turn off their lights on Earth Hour at 8.30pm (20:30 local time) on the last Saturday of March every year ?
3.



In 'A' we get only ashes whereas in 'B' we get charcoal. Give reason.

4. You might have read news items such as the one given below.

Worker dies in septic tank, court ban flouted again

Daniel P George | TNN

Chennai: A 29-year-old man died after inhaling toxic fumes while cleaning a septic tank in a house at Adambakkam on Thursday morning. This is the fourth death of workers involved in manual scavenging, which has been banned by the Madras high court, in the city

out masks or any safety gear. Though the government claims it has abolished scavenging, the practice continues.

"The drainage system should be redesigned and people should be prevented from disposing plastic waste in sewage lines," said Narayanan. "If these steps are taken, workers will not have to enter man-

What is the reason for the tragedy? List out the precautionary measures.

5. Workers in coal mines use battery operated torch lights instead of lanterns. Find out the reason for doing so.
6. If we identify the leakage of LPG in our kitchen, what measures should we take? (make use of the nearest gas dealer)
7. LPG can be lit with a gas lighter whereas wood can not be lit using a gas lighter, why is it so?

V. Field Trip :

1. Pay a visit to the Neyveli coal mine.
2. Pay a visit to the Manali Petroleum Refineries(CPCL).

VI. Choose any one of the following projects that you like most. Complete the project and submit it for FA(a)

1. Collect various petroleum products and display them in your class. (any five)
2. Prepare posters regarding the importance of alternative energy sources. (any two)
3. Prepare slogans for spreading awareness of saving fuel.(any five)
4. Construct a working model of a windmill (Group work).
5. Explore the constituents present in coal gas, producer gas and water gas and find their applications by refering to books or by browsing the internet.
6. Find out the consumption of petrol/diesel/CNG/LPG/kerosene and electricity in your house. Calculate your monthly household expenditure on fuel and electricity. Suggest to your family the measures to be taken to conserve energy.
7. Find out the different types of petrol and diesel that are available at the petrol bunk. What is the composition of each product? Is there any difference in the price of these products ?

FURTHER REFERENCE

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Matter

The entire world around us that we can see, touch and feel is made up of matter. The sweet smelling fresh air that we breathe, the beautiful flowers and trees around us, the tasty fruits that we eat, the pets that we love, the roof and walls that make up our homes, the ground that we walk on, why even our own bodies are all made up of matter.

Matter occupies space. In other words matter has volume. Some are large and some are small.

The quantity of matter contained in any object is referred to as mass. Hence each matter is characterized by mass and volume.

All matter exists in one of the three states - solid, liquid or gas. These are often referred to as the three physical states of matter.

Classification of matter:

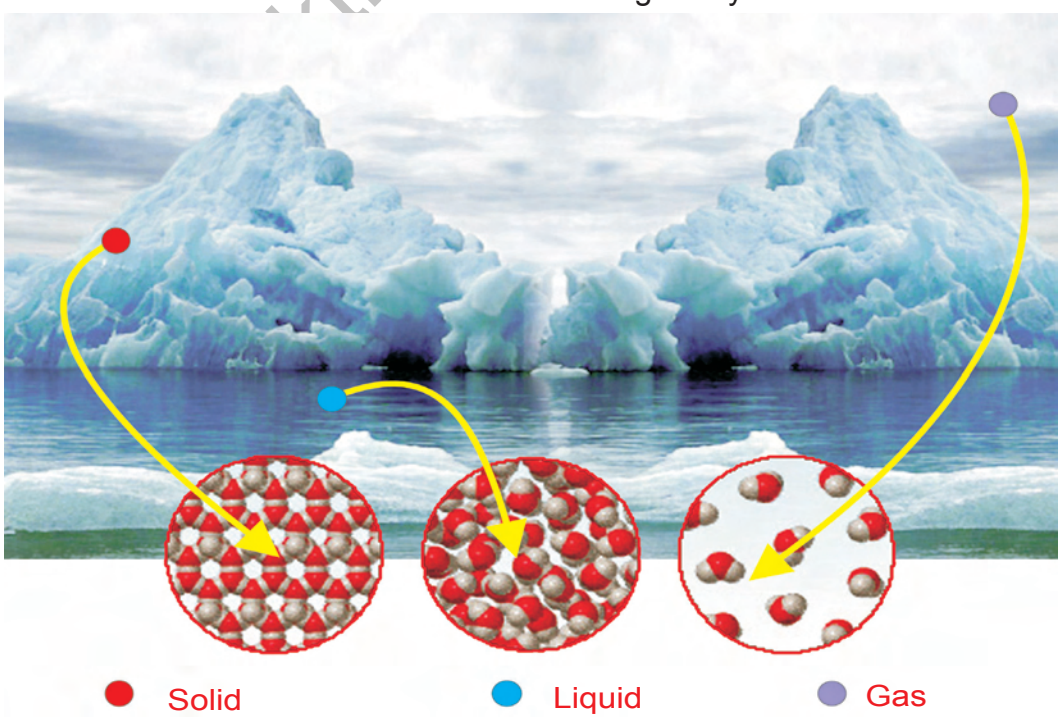
1. According to physical state as solid, liquid and gas.
2. According to its composition as element, compound and mixture.

Physical states of matter

Solid: Solids have a definite shape and a definite volume. They take a lot of energy to change the shape. They are rigid and not compressed appreciably even at high pressures. They usually have high densities and expand only very slightly when heated. In a solid, the molecules are held tightly together in definite arrangements.

Liquid: Liquids have no definite shape and they take the shape of the container. They have a definite volume. They are not appreciably compressed by moderate pressures. They expand more than solids on heating and change into the gaseous state. They have lower densities than solids.

Gas: Gases have no definite shape. They take the shape of the containing vessel. Gases have no definite volume. They have the property to fill the entire space available to them. They are easily compressed by even small pressures and also expand more than liquids on heating. They have low densities.



SHAKTHII ACADEMY

SCIENCE -CHEMISTRY

STANDARD - NINE

Purity of Matter

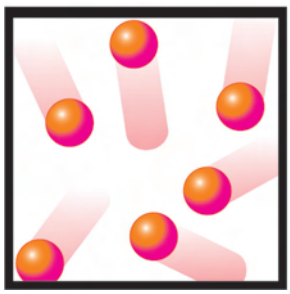
Substances rarely exist in a pure form in nature. Often they are mixed with many other substances or materials. Their physical properties and chemical properties are either altered or are not clearly visible because of the presence of other substances. A pure substance is a distinct type of matter that has the same properties (physical and chemical) throughout the sample.

Elements, Compounds and Mixtures

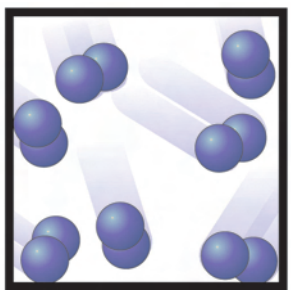
According to its composition, matter can be classified as element, compound and mixture.

Elements

An element is a type of substance that cannot be broken down chemically. When it is pure, the smallest unit of an element that displays all the properties of that element is an atom. Atoms of the same element may be visualized as similar looking tiny little objects (figure (a) below) each particle having the same physical and chemical properties as well. Many elements especially gases do not exist as single atoms. They exist in clusters (usually identical clusters of two or three atoms) as shown in figure (b) below. Examples of such elements are hydrogen, oxygen etc.



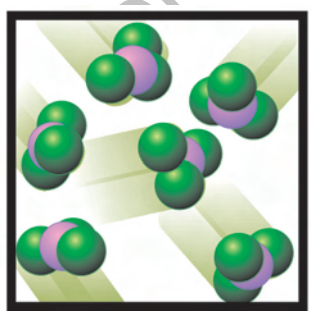
(a) Atoms



(b) Molecules

Compounds

Compounds are substances resulting from the chemical combination of two or more elements in fixed proportions. The elements in compounds are chemically bonded to each other. The physical and chemical properties of such compounds do not resemble the properties of any of the constituent elements. For example when hydrogen gas and oxygen gas are stored together in a container in the ratio 2:1, under certain conditions they would explosively combine to form water which is a liquid and has physical and chemical properties that are totally different from those of either hydrogen or oxygen. Water is a chemical compound. A molecule can be broken down chemically into atoms of the constituent elements. (figure (c)).



(c) Compound

3.1. MIXTURES

When two or more substances are mixed together and the substances retain their individual original identities, the combination is called a mixture. For example if you mix sand and water, sand retains its own properties and water retains its own properties. In a mixture, two or more substances are brought together and no chemical reaction takes

MORE TO KNOW

The purity of a substance is often determined by measuring its physical properties. For example, a colourless, odourless, tasteless liquid which at atmospheric pressure, boils at 100° C, freezes at 0° C and has a density of 1.0 g cm^{-3} is water. A pure substance can exist as element or compound.

SCIENCE

place. For example if hydrogen and oxygen, in any ratio are mixed together in a container gently at low temperatures in the absence of a spark, no chemical reaction would take place and the mixture would display the physical and chemical properties of hydrogen and oxygen.

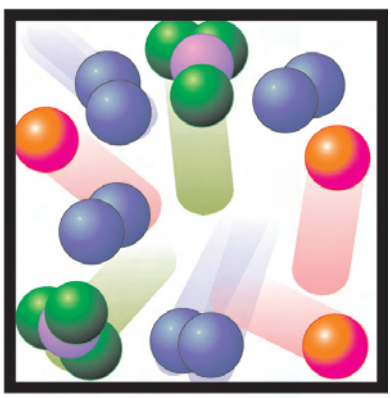
3.2. CHARACTERISTICS OF MIXTURES

Mixtures may consist of substances in the same or different physical states. For example, bronze is an alloy consisting of the two solid metals, copper and tin; both are in the solid state. Most common solutions are mixtures of a solid in a liquid. For example salt dissolved in water.

Mixtures are not pure substances since they are neither single type of distinct matter nor do they display single set of physical and chemical properties throughout the whole sample.

As shown in figure (d) below, we can imagine mixtures to be different types of atoms or molecules held together but essentially retaining their individual physical and chemical properties. In mixtures, elements are physically mixed in any ratio and no new compound is formed.

The substances making up a mixture are called constituents or components.



(d) Mixture

Types of mixtures	Examples
Solid in solid	Coins, alloys
Solid in liquid	Sea water
Solid in gas	Smoke(carbon particles in air)
Liquid in solid	Amalgam (metal + mercury)
Liquid in liquid	Alcohol and water
Liquid in gas	Cloud, fog
Gas in solid	Gas adsorbed by charcoal
Gas in liquid	Soda drinks
Gas in gas	Air

ACTIVITY 3.1 **WE DO**

Left - Sulphur and Iron
Right - Iron sulphide

We mix iron powder and sulphur powder in a china dish.

In another dish, we take the same substances and heat them strongly.

We bring a magnet closely.

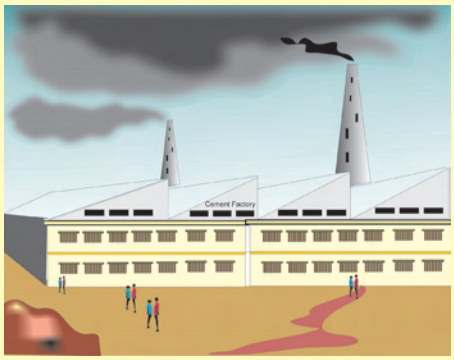
Iron powder is attracted by the magnet and the compound iron sulphide is not.

Now we distinguish a mixture and a compound.

MORE TO KNOW

The lead in your pencil is actually a form of carbon called graphite mixed with clay.

ACTIVITY 3.2 **WE DO**



Is air around us pure?
We discuss the reasons in groups.

Law of constant composition

A pure compound always contains the same elements combined together in the same definite proportions by weight irrespective of its method of preparation.

Is water a mixture or a compound?

Water is a compound because of the following reasons.

- It is homogeneous.
- It has definite physical constants such as boiling point, freezing point, density, etc.
- The properties of water are entirely different from those of its constituents, i.e, hydrogen and oxygen.
- Water has a definite composition by mass. The ratio of H:O by mass is 1:8.

Is air a mixture or a compound?

Air is a mixture because of the following reasons.

- Air does not have a fixed composition. The composition of air varies from place to place.
- Artificial air can be made by mixing the various components of air in the same proportions in which they occur at a place, and when this is done, no energy changes are noticed.
- The components of air can be separated by a physical method such as fractional distillation of liquid air.
- Liquid air does not have a definite boiling point. It boils over a range of temperature between -196ºC and -183ºC.
- If air is a compound, the composition of air expelled from humans should not be different from the composition of air around us. But it is known that during respiration, exhaled air has lower percentage of oxygen than ordinary air.

ACTIVITY 3.3 **I DO**

I classify the following into mixture or compound.

(i) Alloys (ii) Smoke (iii) Juice (iv) Milk (v) Common salt (vi) Coffee (vii) Carbon dioxide (viii) Ice cream.

Composition of inhaled air and exhaled air during respiration.

Inhaled Air	Exhaled Air
Contains 78% nitrogen.	Contains 78% nitrogen.
Contains 20% oxygen.	Contains 16% oxygen.
Contains 0.03% Carbon dioxide.	Contains 4% Carbon dioxide.
Contains very little moisture.	Contains appreciable amount of moisture.

Composition of air

Gas	in mass %
Nitrogen	75.50%
Oxygen	23.20%
Argon	1.0%
Carbon dioxide	0.046%
Neon	Negligible
Helium	Negligible

SCIENCE

3.2.1. DIFFERENCES BETWEEN MIXTURE AND COMPOUND

Mixture	Compound
Elements are physically mixed in any ratio and no new compound is formed.	Elements are chemically combined in a fixed ratio to form a new compound.
They have no sharp or definite melting point, boiling point, density etc.	They have definite melting point, boiling point, density etc.
A mixture exhibits the properties of its constituent or component elements.	Property of a compound is different from its constituent or component elements.
They are either homogeneous or heterogeneous in nature.	They are always homogeneous in nature.
Constituents of a mixture can be separated by physical methods like filtration, magnetic separation etc.	Constituents of a compound cannot be separated by physical methods.

3.3. TYPES OF MIXTURES

There are two types of mixtures. They are,

1. Homogeneous mixture
2. Heterogeneous mixture

3.3.1. HOMOGENEOUS MIXTURES AND THEIR TYPES

Homogeneous mixtures consist of a uniform distribution of the substances throughout the mixture. Samples taken from any part of the mixture would have the same ratio of the ingredient substances and same physical and chemical properties although the properties of different samples may be different. Air is a homogeneous mixture of nitrogen,oxygen, argon and other traces of gases. All the ingredients of homogeneous mixtures necessarily have to be in the same state. Homogeneous mixtures are called solutions.

ACTIVITY 3.4 I DO

Aspirin is a medicine for headache. It is composed of 60% carbon, 4.5% hydrogen and 35.5% oxygen by mass, regardless of its source. I observed that aspirin is a _____(mixture/compound)

There are three types of homogeneous mixtures.

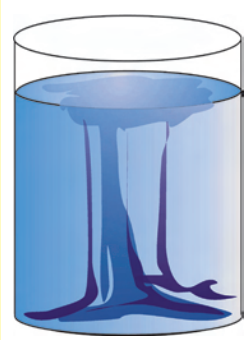
Solid homogeneous mixture - e.g. Alloys
Liquid homogeneous mixture -
e.g Alcohol in water
Gaseous homogeneous mixture - e.g. Air

Homogeneous Mixtures

Salt in water A cup of tea

ACTIVITY 3.5 I DO

- I mix a drop of ink in water.
- I observe whether the colour of the solution is uniform throughout.
- I conclude that it is a _____ (homogeneous mixture/ heterogeneous mixture)



3.3.2. HETEROGENEOUS MIXTURES AND THEIR TYPES

Heterogeneous mixtures do not have an uniform composition. For example if you take dilute buttermilk in a vessel and keep it undisturbed at one place for some time then the particles settle to the bottom and the water comes to the top. The composition is not uniform. Ingredients of a heterogeneous mixture need not necessarily be in the same state, gas, liquid or solid.

Solid - solid heterogeneous mixture - mixture of sugar and salt

Solid - liquid heterogeneous mixture - chalk in water.

Gas - gas heterogeneous mixture - smoke in air.

Liquid - liquid heterogeneous mixture - kerosene in water.

ACTIVITY 3.6 I DO

- I mix a spoonful of sand in water.
- I try to see the particles of sand.
- I observe whether the particles are evenly distributed in the mixture.
- I write my conclusion about the nature of the mixture prepared.

ACTIVITY 3.7

I classify each of the following as homogeneous or heterogeneous mixture

(i) Tea (ii) Ink (iii) Fruit salad (iv) Sugar solution

CLASSIFICATION OF MATTER

Matter

Mixtures
- Variable composition.
- Easily separated by physical methods.
- No definite physical constants.

Pure Substances
- Constant composition.
- Not easily separated by physical methods.
- Have definite physical constants.

Homogeneous Mixtures
- Have the same composition throughout.
- Components are indistinguishable.

Heterogeneous Mixtures
- Do not have the same composition throughout.
- Components are distinguishable.

Elements
- Contain atoms of the same kind.

Compounds
- Contain two or more elements in a definite ratio by mass.

SCIENCE

3.4.SEPARATION OF DIFFERENT COMPONENTS OF A MIXTURE

Mixtures can be separated by simple physical procedures. To be able to separate the ingredients of a mixture we would need to know the physical properties of the individual ingredients. Using the properties that are distinct and different, we can separate them. For example if both the ingredients of a mixture are soluble in water then we cannot separate the ingredients. However if we know that the melting point of two ingredients are different, then we can use that knowledge to separate the ingredients. A good knowledge of physical properties is therefore very important.

Separation of heterogeneous mixture

1. Decantation: Used to separate a liquid from a solid (present as large particles) that does not dissolve in it.
2. Filtration: Used to separate a liquid from a solid (present as very small particles) which does not dissolve in the liquid.
3. Sublimation: Used to separate a volatile solid substance from a mixture containing a non-volatile solid substance.
4. Separating funnel: Used to separate two completely immiscible liquids.

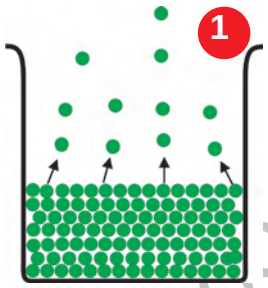
ACTIVITY 3.8 **I DO**

An equal quantity of fine salt and wheat flour are added into the beaker containing water and stirred well. The solubility of flour and salt in water are observed. The flour settles at the bottom of the beaker. I can now mention a suitable method of separation of flour from the salt.

3.4.1. SEPARATION OF MIXTURES BY SUBLIMATION

Sublimation is defined as a process, in which a substance in solid state is directly converted into vapour state.

At high temperature, the molecules of volatile solid move far away from each other making the solid substance into vapour.



1. Solid molecules evaporate

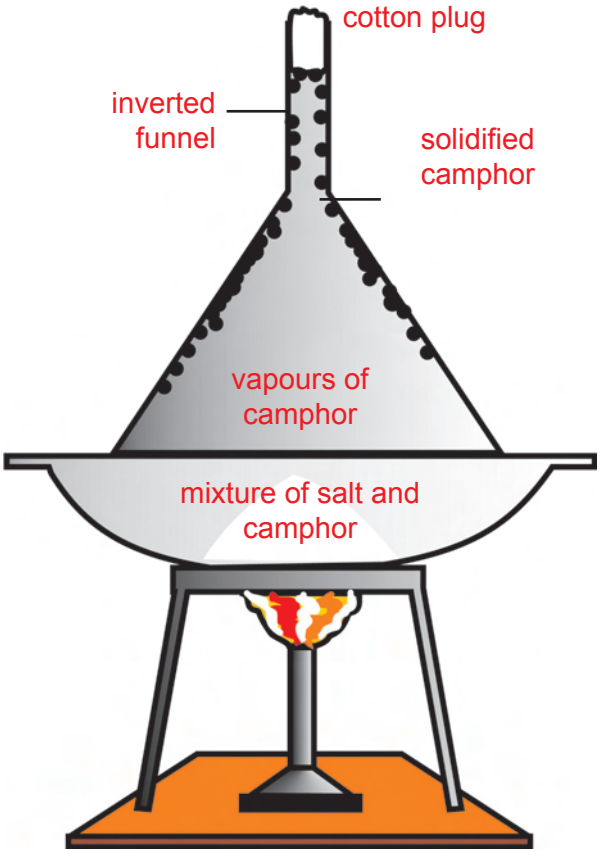
2. Iodine crystal vapourises

3. Sublimation of dry ice (carbon dioxide in ice form)

Consider a mixture containing common salt and camphor. Both common salt and camphor are solid substances. Common salt is a non-volatile substance. It does not undergo sublimation. Camphor undergoes sublimation. Hence camphor can be separated from common salt by sublimation.

ACTIVITY 3.9 **WE OBSERVE**

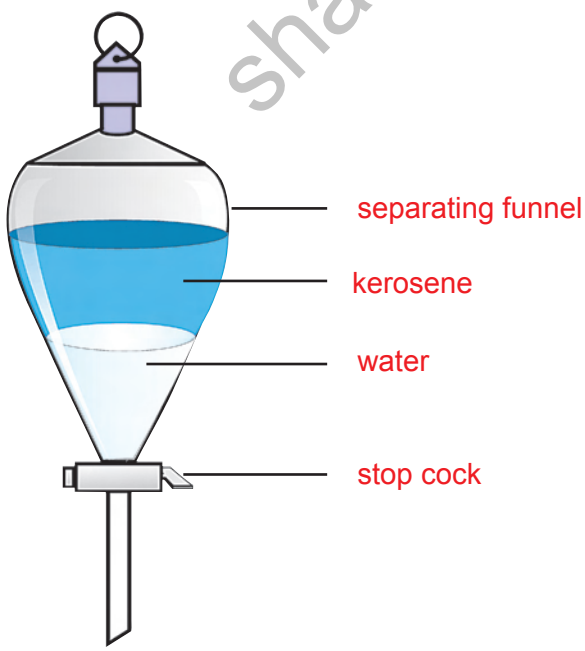
We take a mixture containing common salt and camphor in a china dish placed over a stand and an inverted funnel is kept over it. The funnel stem is closed by means of cotton and the china dish is heated. The observations are recorded.



MORE TO KNOW

Solids that undergo sublimation are camphor, naphthalene, benzoic acid, iodine and ammonium chloride.

3.4.2. SEPARATION OF A MIXTURE CONTAINING IMMISCIBLE LIQUIDS



Immiscible liquids are usually separated by using a "separating funnel".

Consider a mixture containing kerosene and water. Both the liquids are immiscible with each other. By using a separating funnel, one liquid can be separated from the other. Less denser liquid remains in the upper layer while high denser liquid remains in the lower layer.

ACTIVITY 3.10 WE OBSERVE

- Take a mixture containing kerosene and water.
- Pour the mixture into a separating funnel.
- Close the mouth of the separating funnel.
- Shake it for 10 minutes.
- Hold the funnel in a stand for 15 minutes.
- Observe the changes.
- Note the lower and upper layers.
- What is the principle behind it?

SEPARATION OF HOMOGENEOUS MIXTURE

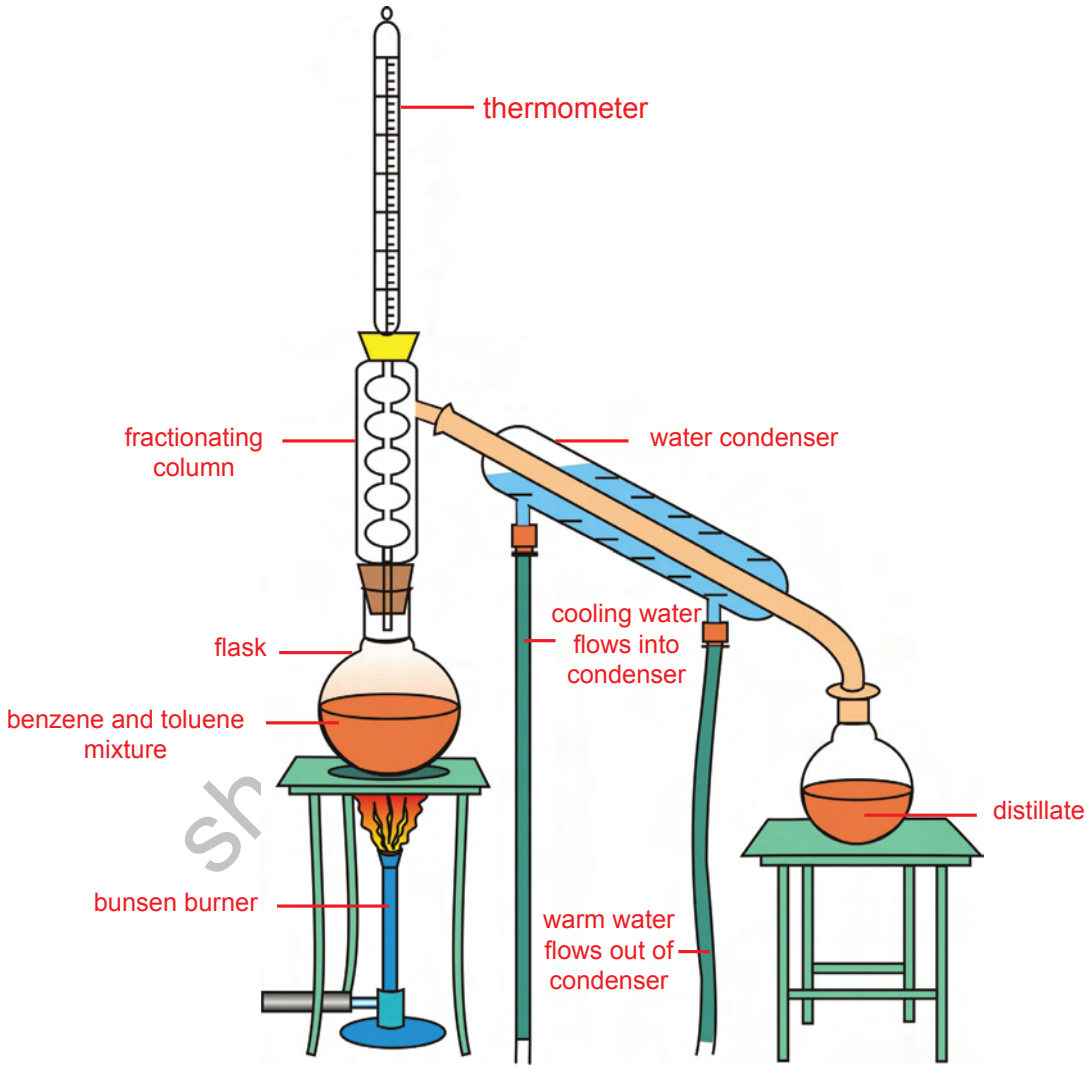
1. Distillation: Used to separate a non-volatile solid and a volatile liquid present together in a solution.
2. Fractional distillation: Used for separating a mixture containing two or more liquids with an appreciable difference in their boiling points.
3. Chromatography: Separation of two or more dissolved solids can be carried out by chromatography. It can be used to separate samples as small as a picogram (10^{-12} g) and as large as several ions. It involves the distribution of solutes between a moving phase and a non-moving phase or stationary phase.

SCIENCE

3.4.3. SEPARATION OF A MIXTURE CONTAINING MISCIBLE LIQUIDS

Fractional distillation is a suitable method for separation of a mixture containing miscible liquids. It works on the principle that the two liquids should vary in their boiling points by 25 K.

- Consider a mixture containing two liquids namely benzene and toluene.
- Both the liquids are miscible with one another.
- They can be separated by fractional distillation.
- Boiling point of benzene is 353 K.
- Boiling point of toluene is 384 K.
- The difference in their boiling points is 31 K.



ACTIVITY 3.11 **WE OBSERVE**

- Take a mixture of alcohol and water in a distillation flask.
- Close the distillation flask with a one holed rubber cork and fit a thermometer.
- Fit a condenser.
- Heat the mixture slowly.
- Alcohol vapourises first and gets condensed in the condenser and is collected.
- Water remains in the flask.

MORE TO KNOW

FILTRATION PROCESSES ADOPTED IN VARIOUS FIELDS:

1. Carbon filter:

Powdered charcoal can be formed in such a way as to be full of tiny holes, which serves as a filter. As air is drawn through the holes, the charcoal traps gases and chemicals . Such carbon filters are put in the gasmasks used by soldiers and fire fighters.

2. Air-Conditioning filter:

It circulates the air with fans and removes dust from air.

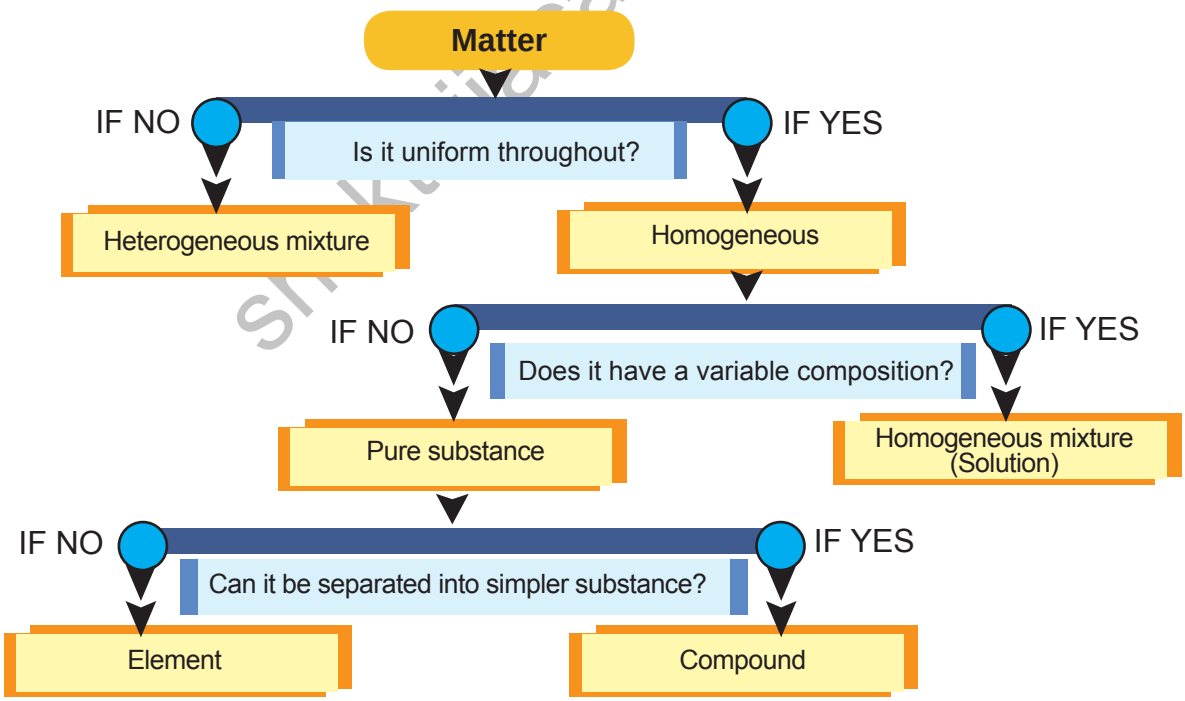
3. Automobile filter:

Filters in the fuel line clean the fuel but they can block the flow of fuel when they get clogged with dirt.

4. Water filter:

Particles of matter suspended in water are removed by the use of chemicals like chlorine, potash alum and powdered carbon and filtered through beds of sand or porous separation.

Identification of element, compound and mixture.



SCIENCE

EVALUATION

Section A

Choose the correct answer:

1. The lead in the pencil we use is made of a material called graphite. Graphite is a mixture of _____ (carbon and clay, clay and nitrogen)

2. Pure water is a compound. It contains 11.19% by mass of hydrogen and oxygen _____ by mass. (88.81% , 31.81%)

3. Coins are mixtures of solid in solid. Smoke is a mixture of _____ (solid in gas, gas in solid)

4. Some pair of items are given below. Could you identify the incorrect pair?

   a) Air - gas in gas

   b) Seawater - solid in liquid

   c) Soft drinks - gas in liquid.

   d) Amalgam - liquid in liquid

5. Components of a given matter can be separated by various purifying techniques. Components of liquid air can be separated by adopting _____ physical method. (fractional distillation, distillation, sublimation)

Section B

6. Sometimes I am hard and cold. Sometimes I am difficult to hold. But, I am always present in air. Who am I?

7. Pure substance contains a single type of particles. Is sea water pure or not? Justify.

8. In a compound two or more elements are combined in a fixed ratio by mass. Mention any two properties of a compound.

9. Homogeneous mixture contains a single type of phase. Heterogeneous mixture contains different types of phases. Quote one example for each type.

10. When a solid camphor is exposed to air, it changes into gaseous state. It is a physical change. Name the process that takes place. Could you give another example for such a process?

11.(a) Separation of a mixture containing water and kerosene can be done by use of _____ (distillation , separating funnel)

(b) _____ (sublimation, chromatography) process is used to separate common salt and ammonium chloride.

12. A liquid 'A' has a boiling point of 353 K and another liquid 'B' has a boiling point of 384K. Both are miscible with each other. They are separated by "fractional distillation". Justify the reason for using fractional distillation method.

Section C

13. In mixtures, components are combined in any ratio.
    (a) How does a mixture differ from a compound?
    (b) What are the types of mixtures?
    (c) Write an example for each type.
14. All matters in the universe exist in three states namely solid, liquid and gas.
    (a) Why do solid substances have definite shape?
    (b) Write any two properties of a solid substance.
    (c) Will the solid substance expand on heating? Why?
15. Heterogeneous mixture is separated by decantation. What is meant by decantation process?
16. In what way does an element differ from a compound?
17. Write a short note on chromatography.

Section D

18. What are heterogeneous mixtures? Mention their types with examples.
19. Classify the following as solution, heterogeneous mixture, compound or element.
    i. Sodium ii. Glucose iii. Lemon juice iv. Coal dust in sand
    v. Common salt
20. Alchohol is mixed with water. Write briefly the separation of the components.
21. How does the process of decantation differ from filtration?
22. How are immiscible liquids separated?

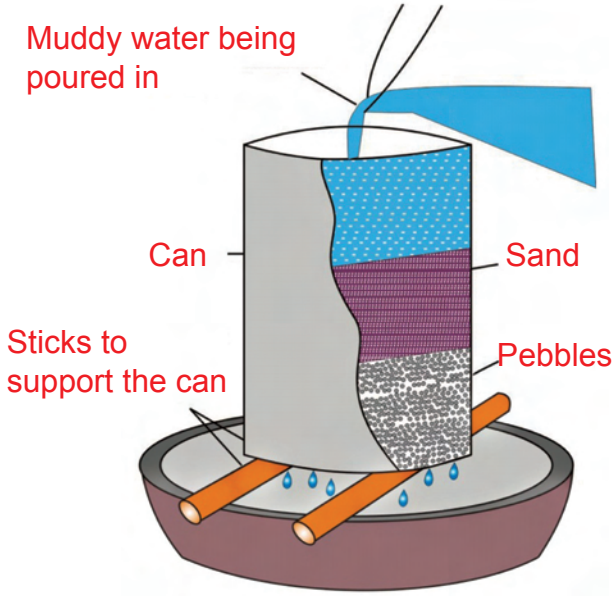
ASSESSMENT ACTIVITY

1.Water purification experiment

Know about the natural way of purifying dirty water.

You can make your own sand and gravel filter and use it to clean a sample of dirty water. Use a large, empty can. Punch eight holes around the bottom of the can with a big nail. Place about 8cm (3 inches) of pebbles in the bottom of the can, and cover the pebbles with the same amount of sand.

Collect some muddy water from a puddle or pond. Hold the can over the bowl and pour the muddy water into the can. Look at the water that comes through the can. It is much clearer than the water you had poured in.



2. Discussion

Aim : To enable the students to know the components of the mixtures used in daily life. Name the components of the mixtures listed below.

Mixtures	Components
1. Air	
2.Crude oil	
3.Milk	
4.Aerated drinks	
5.Stainless steel	

3. Classification

Aim : To enable the students to classify the mixtures as homogeneous or heterogeneous.

Method of preparation of mixture	Type of mixture obtained
Sugar is added to water	
Both sugar and salt are added to water	
Smoke in air	
Mixture containing rice and wheat	

4.Comparative learning

Aim : To enable the students to understand the method of purification involved in separating components of a mixture.

Type of mixture	Method of purification
Salt solution	
Mixture containing petrol and kerosene	
Mixture containing kerosene in water	
Common salt and powdered camphor	
Water containing fine sand	

5.Copy the following table and write an example of a mixture in each empty box. For example, coffee is a mixture of solid and liquid.

	Solid	Liquid	Gas
Solid		Coffee	
Liquid			
Gas			

6. Identify the physical states of the following

Matter	Physical state
Ice	
Air	
Water	
Rice	
Oxygen	

7. Suppose a ship gets wrecked on an island in the Pacific ocean. The passengers, however, manage to bring plenty of firewood, match boxes and some pots ashore. Describe, with the help of diagrams, how the passengers can obtain drinking water from the salty ocean water.

8. A mixture of chalk powder and salt can be separated by combining more than one method. Salt is soluble in water, whereas chalk powder is not. The steps of separation are given below. Arrange them in correct order.

i) Filtration removes the insoluble chalk powder.

ii) Stir well. The salt dissolves in water.

iii) Evaporation of the salt solution removes water.

iv) Add the salt and chalk powder mixture to water.

v) The chalk powder is then dried in sunlight.

SCIENCE

FURTHER REFERENCE

Books: *General Chemistry (Second Edition) - Jean B.Umland & Jon M.Bellama*
West publishing company

Websites : http://www.tutorvista.com
http://www.khanacademy.org

ATOMIC STRUCTURE

Need to study the structure of the atom

John Dalton proposed the idea of the atom as the smallest possible particle of any substance. He never worked with small particles of solids but actually he worked with gases, how they mix with each other, how they form compounds and how they dissolve in water etc. While working with all this, he discovered that whenever elements combine to form more than one compound, the ratio of the masses of elements in the compounds are small whole number ratios of each other. It led him to the idea that the smallest particle of one substance was combining with the smallest part of another substance in a fixed quantities.

The development of modern atomic theories is an excellent example of how science progresses. Many scientists contribute their knowledge for the development. New experiments lead to either changes in the old theories or even to new theories.Theories are useful in providing the basis for further work. Although J.J.Thomson's atomic theory explained electrical neutrality of atoms, it could not reveal the presence of nucleus in an atom, which was later proposed by Ernest Rutherford in 1909.

4.1. DISCOVERY OF THE NUCLEUS

Rutherford's contribution

Rutherford observed what happens to alpha particles projected at a thin metal foil.

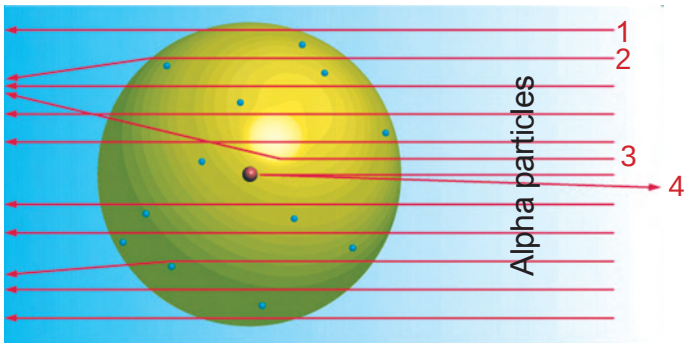
Ernest Rutherford (1871-1937)

Ernest Rutherford, a British physicist probed atoms with alpha particles. He was known as the "father of nuclear physics". He was awarded Nobel prize for his contribution in structure of atom in 1908.

4.2. RUTHERFORD'S EXPERIMENT

A stream of alpha particles was made to pass through a thin gold foil of about $4x10^{-5}$ cm thickness. Most of the alpha particles did go through the foil in a straight line. Some alpha particles were deflected through an average angle of 90^o .Rarely the path of 1 in 20,000 alpha particles scored a direct hit on the nucleus and returned by an angle of 180^o.

Schematic diagram showing alpha particles bombarding one gold atom. The nucleus of the gold atom is shown in the centre.



1. Not scattered at all 2. Slightly scattered
3. More scattered 4. Returned at 180^o

MORE TO KNOW

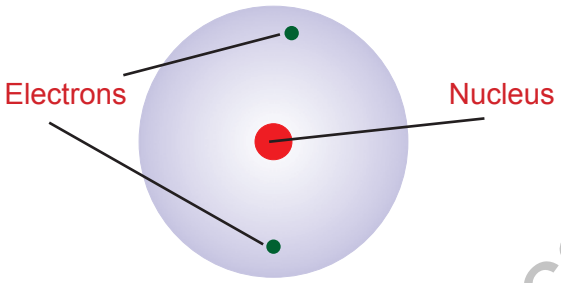
Alpha particles are helium ions He^{2+} (2 protons, 2 neutrons and no electrons)The mass of an alpha particle is about 8000 times the mass of an electron. Velocity of alpha particles is about $2x10^7$ m/s.

SCIENCE

From this experiment, he concluded that there is a heavy positive charge occupying small volume, at the centre of an atom.

4.3. RUTHERFORD'S MODEL OF ATOM

- Atom has a very small nucleus at the centre.
- There is large empty space around the nucleus.
- Entire mass of an atom is due to the mass of nucleus.
- Electrons are distributed in vacant space around the nucleus.
- The electrons are moving in circular paths around the nucleus.

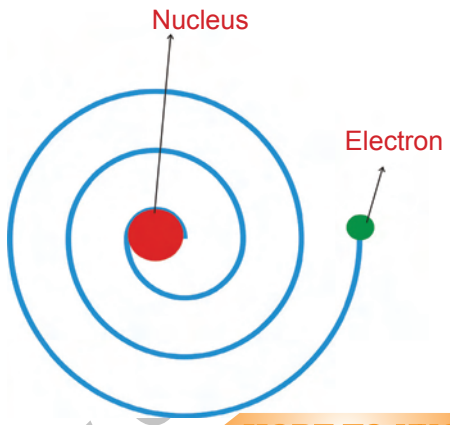


MORE TO KNOW

James Chadwick was one of Rutherford's students.

4.3.1. LIMITATIONS

According to electromagnetic theory, a moving electron should accelerate and continuously lose energy. Due to the loss of energy, path of electron may reduce and finally the electron should fall into nucleus. If it happens so, atom becomes unstable. But atoms are stable. Hence Rutherford's theory does not explain the stability of atom.



MORE TO KNOW

Imagine a small boy swinging a stone on the end of a string around him. The stone is able to occupy a larger volume because it is moving rapidly. Similarly the electrons in an atom are able to occupy a larger volume because they are moving very fast.

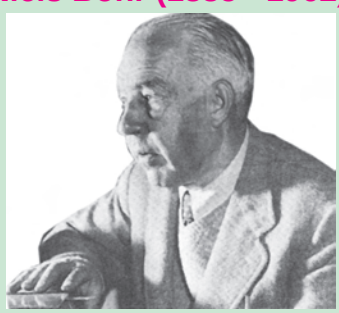
ACTIVITY 4.1

We divide into groups and have a discussion about the following.

In Rutherford's experiment,

1. Why did the majority of alpha particles pass through the foil unaffected?
2. Why were very few alpha particles deflected?
3. Is the size of nucleus small or large with respect to the size of atom?

Niels Bohr (1885 - 1962)

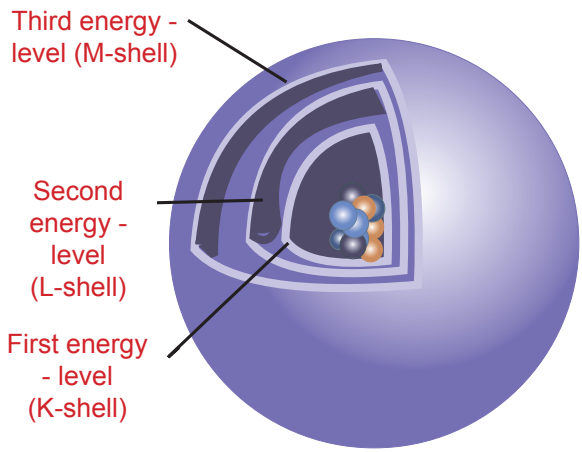


Niels Bohr was born on October 7, 1885 in Copenhagen, Denmark. He was also an outstanding soccer player. He worked with Rutherford at the University of Manchester. Bohr's theory became the basis for modern physics known as Quantum mechanics.Bohr received the Nobel prize for physics in 1922.

4.4. BOHR'S MODEL OF ATOM

Niels Bohr modified Rutherford's atom model and put forth the following postulates.

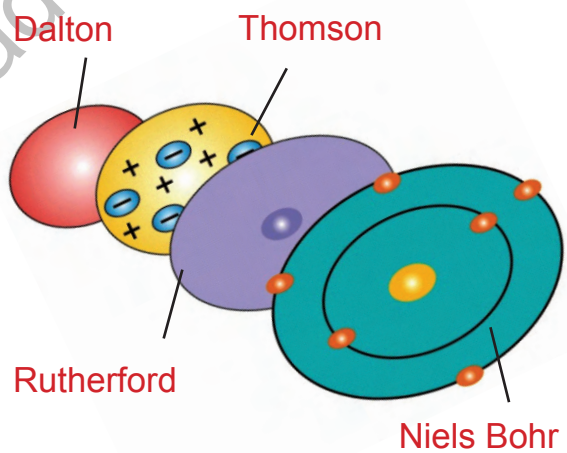
- In atoms, electrons revolve around the nucleus in stationary circular paths. These paths are called orbits or shells or energy levels.
- As long as electrons revolve in the same orbit, it does not lose or gain energy.
- The circular orbits are numbered as 1, 2, 3, 4 or designated as K, L, M, N shells. These numbers are referred to as principal quantum numbers (n).
- As we move away from the nucleus, energy of the orbit is constantly increasing.
- Maximum number of electrons that can be accommodated in an energy level (n) is given by $2n^2$.
- When an electron absorbs energy, it excites from lower energy level to higher energy level.
- When an electron returns from higher energy level to lower energy level, it gives off energy.

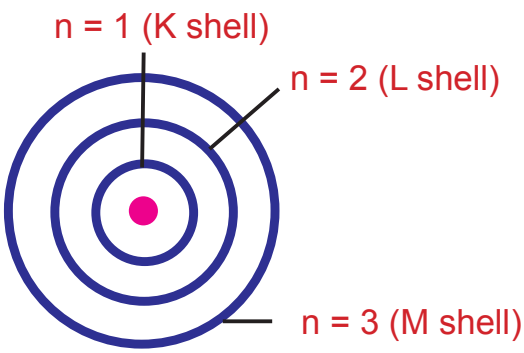


Orbit

Orbit is defined as the path, by which electrons revolve around the nucleus.

DALTON, THOMSON, RUTHERFORD AND NIELS BOHR - ATOM MODELS



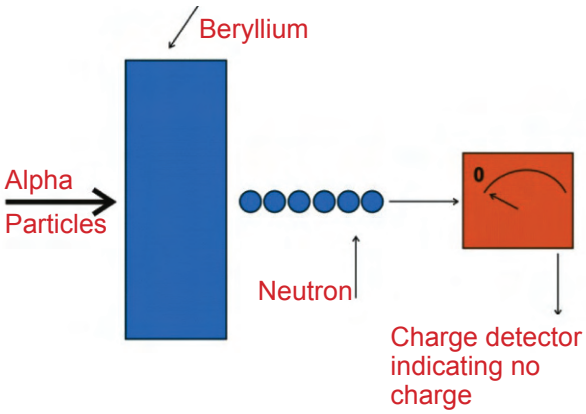


4.5. DISCOVERY OF NEUTRONS

In 1932, James Chadwick observed that when beryllium was exposed to alpha particles, particles with about the same mass as protons were emitted. These emitted particles carried no electrical charge. Hence they were called as neutrons.

Beryllium + alpha ray ⟶ carbon + neutron

SCIENCE



MORE TO KNOW

Number of neutrons = Mass number - Atomic number (Number of protons or number of electrons)

Neutrons are particles with no charge i.e. neutral particles. Neutrons are present in the nuclei of all atoms except hydrogen atom. Mass of a neutron is almost equal to the mass of a proton.

Atoms of the same element with different number of neutrons are called isotopes. Neutron is also regarded as a sub-atomic particle.

4.6. CHARACTERISTICS OF FUNDAMENTAL PARTICLES

Physical and chemical properties of elements and their compounds can be explained by the fundamental particles of an atom. The fundamental particles of an atom are:

Protons: They are positively charged particles. They are present inside the nucleus.

Electrons: They are negatively charged particles. They revolve around the nucleus in circular orbits.

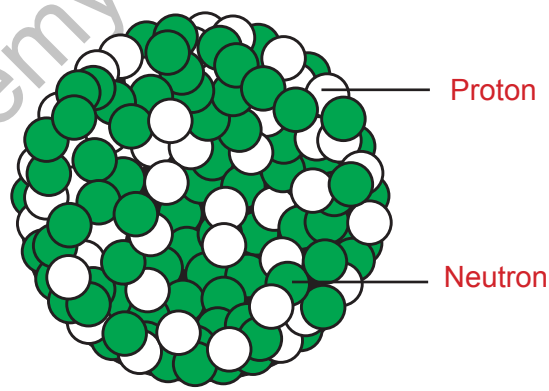
Neutrons: They are neutral particles. They are present inside the nucleus.

4.6.1. COMPOSITION OF NUCLEUS

Electrons have negligible mass. Hence the mass of an atom mainly depends on the mass of the nucleus. Nucleus of an atom consists of two components. They are protons and neutrons.

Protons are positively charged. Protons repel each other because of their like-charges. Hence, more than one proton cannot be packed in a small volume to form a stable nucleus unless neutrons are present.

Neutrons reduce the repulsive force between positively charged protons and contribute to the force that holds the particles in the nucleus together.



Nucleus

OTHER SUBATOMIC PARTICLES

Besides Electrons, Protons and Neutrons, there are many Sub-atomic particles such as;

- Mesons
- Positrons
- Neutrinos
- Quarks
- Pions
- Gluons

Characteristics of sub-atomic particles

	Electron	Proton	Neutron
Discovered by	J.J. Thomson and H.A.Lorentz	E. Goldstein	James Chadwick
Mass	9.1×10^{-28} g	1.672×10^{-24} g	1.674×10^{-24} g
Charge in Units	-1	+1	0

Nucleons

The elementary particles such as protons and neutrons are collectively referred to as nucleons.

4.7. ATOMIC NUMBER AND MASS NUMBER

Atomic number (Z)

Atomic number of an atom can be defined as the number of protons present in the nucleus of the atom or the number of electrons present outside the nucleus of an atom. Thus the atomic number of hydrogen would be one and that for helium would be two. The symbol for Atomic number is Z. No two elements have the same atomic number; hence it is unique to each element. The atomic numbers of some elements are given in the table below:-

Element	H	He	Li	Be	B	C	N	O	F	Ne	Na
Atomic number	1	2	3	4	5	6	7	8	9	10	11

Mass number (A)

Mass number (A) is defined as the sum of the number of protons and neutrons present in the nucleus of an atom of an element. For example the mass number of Sodium is 23 which implies that the total number of protons and neutrons in the sodium atom is 23. The number of neutrons can be obtained by subtracting the atomic number from the mass number (12 for sodium). The mass numbers of some elements are given in the table below:-

Element	H	He	Li	Be	B	C	N	O	F	Ne	Na	Mg
Atomic number	1	2	3	4	5	6	7	8	9	10	11	12
Mass number	1	4	7	9	11	12	14	16	19	20	23	24

ACTIVITY 4.2 **WE DO**

A has 11 protons, 11 electrons and 12 neutrons.
B has 15 protons, 15 electrons and 16 neutrons.
C has 4 protons, 4 electrons and 5 neutrons.
We identify the elements A, B and C.

MORE TO KNOW

In lighter atoms, one neutron per proton is enough. Heavier atoms with more protons in the nucleus need more neutrons in the nucleus, for the nucleus to be stable. Thus the stability of the nucleus is determined by the Neutron-Proton (n/p) ratio.

SCIENCE

ACTIVITY 4.3 I DO

I complete the following table

Species	Atomic number	number of protons	number of electrons
Boron	5		
Sodium	11		
Phosphorus	15		
Neon	10		

Representation of Atomic number and Mass number

$$^{\text{Mass number(A)}}_{\text{Atomic number (Z)}}X$$

For example,

Atomic number of nitrogen is 7.

Mass number of nitrogen is 14.

Representation: $^{14}_{7}N$

ACTIVITY 4.4 I DO

From the following elements, I find which have the same number of neutrons.

1. Lithium - $^{7}_{3}Li$
2. Carbon - $^{12}_{6}C$
3. Nitrogen - $^{14}_{7}N$
4. Beryllium - $^{8}_{4}Be$
5. Oxygen - $^{16}_{8}O$

MORE TO KNOW

Chlorine has fractional atomic mass.

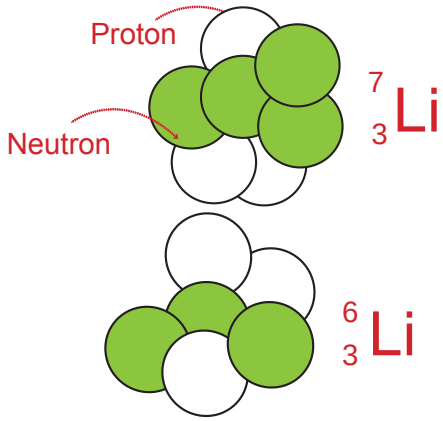
Chlorine-35 exists by 75%

Chlorine-37 exists by 25%

Average atomic mass of chlorine is,

$$\left\{\frac{75}{100}\times 35\right\}+\left\{\frac{25}{100}\times 37\right\} = 35.5$$

4.8. ISOTOPES



Isotopes of lithium

American scientist, T.W.Richards observed to his amazement that Lead samples collected in different places differed in atomic mass. This suggested that all atoms of an element are not exactly alike. It is clear that atoms of an element have the same chemical properties.But they may differ in their masses.

Isotopes are atoms of an element that differ in mass numbers, but have the same atomic number.

Characteristics of isotopes

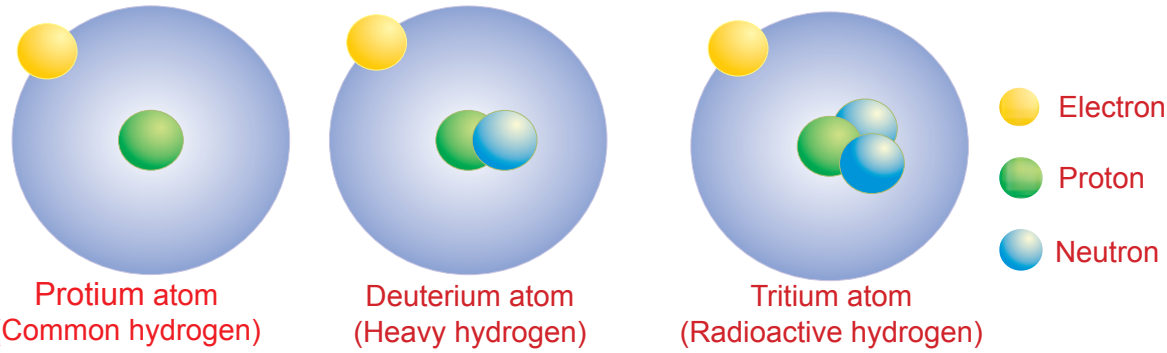
- Isotopes of an element differ in mass numbers only.
- Difference in mass number is due to difference in number of neutrons.
- Isotopes of an element have the same chemical properties.
- However, variation in physical properties are noted in isotopes.
- Elements having isotopes exhibit fractional atomic mass.

ACTIVITY 4.5 I DO

(i) I calculate the number of neutrons in the isotopes.

(a) $^{1}_{1}H$, $^{2}_{1}H$, $^{3}_{1}H$ (b) $^{35}_{17}Cl$, $^{37}_{17}Cl$

(ii) My inference_____



Isotopes of Hydrogen

Element	Isotope	Representation
Hydrogen	Protium	$^{1}_{1}H$
	Deuterium	$^{2}_{1}H$ (or) $^{2}_{1}D$
	Tritium	$^{3}_{1}H$ (or) $^{3}_{1}T$
Chlorine	Chlorine-35	$^{35}_{17}Cl$
	Chlorine-37	$^{37}_{17}Cl$
Carbon	Carbon-12	$^{12}_{6}C$
	Carbon-14	$^{14}_{6}C$
Uranium	Uranium-235	$^{235}_{92}U$
	Uranium-238	$^{238}_{92}U$

ACTIVITY 4.6 **I DO**

The element bromine has the following isotopes.

49.7% of Bromine-79 and 50.3% of Bromine-81

Based on this I calculate the average atomic mass of Bromine.

Uses of Isotopes

Many isotopes find use in medical field.

- Iron-59 isotope is used in the treatment of anaemia.
- Iodine-131 isotope is used for the treatment of goitre.
- Cobalt-60 isotope is used in the treatment of cancer.
- Phosphorous-32 isotope is used in eye treatment.
- Carbon-11 isotope is used in brain scan.

ACTIVITY 4.7 **I DO**

From the given average atomic mass, I find which element does exist with least number of isotopes.

- Chlorine-35.5
- Hydrogen-1.008
- Oxygen-16.0

4.9. ELECTRONIC CONFIGURATION OF ATOMS

It is known that atoms consist of a positively charged nucleus with protons and neutrons in it. Negatively charged electrons constantly revolve around the nucleus in set of orbits. The electron orbits are numbered as 1, 2, 3, etc, starting from the orbit closest to the nucleus. These orbits are also called **K, L, M, N** shells, as mentioned in the atom model proposed by Niels Bohr.

The maximum number of electrons in an orbit is given by $\mathbf{2n^2}$, where **n** is the orbit number.

Shell number or energy level	Maximum number of electrons($2n^2$)
First shell (K)	$2(1^2) = 2$
Second shell (L)	$2(2^2) = 8$
Third shell (M)	$2(3^2) = 18$
Fourth shell (N)	$2(4^2) = 32$

SCIENCE

It must be understood that the second orbit begins to fill with electrons only after the first orbit is filled. The third orbit begins to fill only after the second orbit is filled. But the fourth orbit commences even before the third orbit is completely filled. The reason for this lies in the concept of quantum numbers.

Thus the term electronic configuration or electronic structure refers to the way, the electrons are arranged around the nucleus. Most of the properties of elements and their compounds depend on their electronic configurations.

To write electronic configuration, the principal quantum number of the shells must be known. This number describes the number of orbits present in the atom.

Let us consider sodium atom.

Atomic number of **sodium** = Total number of electrons in sodium = **11**

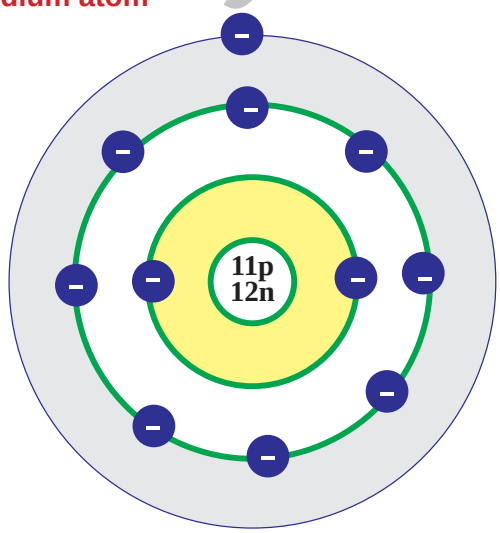
Orbit wise distribution of electrons

Orbit **Number of electrons**

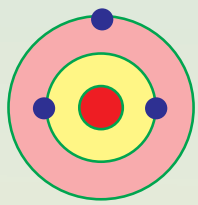
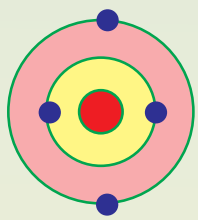
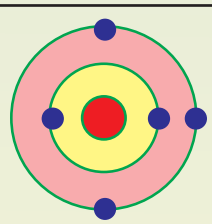
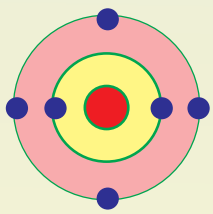
1. **(K-Shell)** $2n^2 = 2x1^2 = 2$ electrons
2. **(L-Shell)** $2n^2 = 2x2^2 = 8$ electrons
3. **(M-Shell)** *Remaining=1 electron*

The electronic distribution in sodium is **2, 8, 1.**

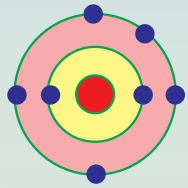
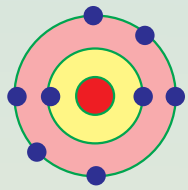
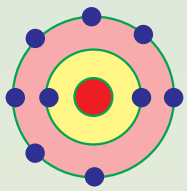
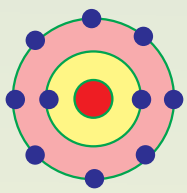
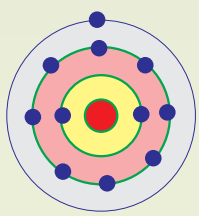
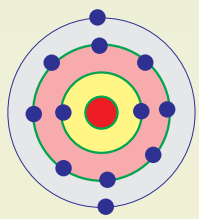
Sodium atom

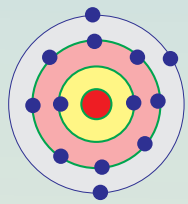
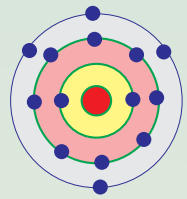
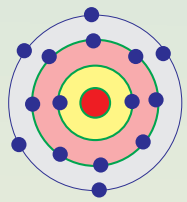
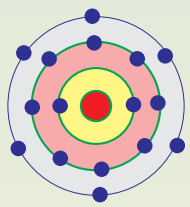
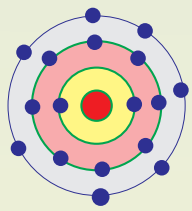
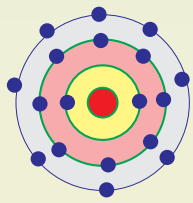


Some elements and their electronic configurations

Element	Atomic Number	Electron dot structure	Electron distribution
Hydrogen (H)	1		1
Helium (He)	2		2
Lithium (Li)	3		2,1
Beryllium (Be)	4		2,2
Boron (B)	5		2,3
Carbon (C)	6		2,4

Some elements and their electronic configurations

Element	Atomic Number	Electron dot structure	Electron distribution
Nitrogen (N)	7		2,5
Oxygen (O)	8		2,6
Fluorine (F)	9		2,7
Neon (Ne)	10		2,8
Sodium (Na)	11		2,8,1
Magnesium (Mg)	12		2,8,2

Element	Atomic Number	Electron dot structure	Electron distribution
Aluminium (Al)	13		2,8,3
Silicon (Si)	14		2,8,4
Phosphorus (P)	15		2,8,5
Sulphur (S)	16		2,8,6
Chlorine (Cl)	17		2,8,7
Argon (Ar)	18		2,8,8

SCIENCE

ACTIVITY 4.8 I DO

I write the electron distribution

Element	Atomic number	Electron distribution		
		K	L	M
Lithium	3			
Boron	5			
Fluorine	9			
Magnesium	12			
Phosphorous	15			

4.9.1. VALENCE ELECTRONS AND VALENCY

The number of electrons in the outer energy level (orbit) of an atom are the ones that can take part in chemical bonding. These electrons are referred to as the valence electrons.

The outermost shell or orbit of an atom is known as valence shell or valence orbit. The electrons present in the outer shell are called valence electrons.

The number representing the valence electrons is used to calculate the valency of the element. This valency is regarded as the combining capacity of elements.

Illustration

Lithium (Atomic number:3) has the electronic distribution,

(n=1) K Shell (2 electrons)

(n=2) L Shell (1electron)

Outer most shell is 'L'.

The valence electron = 1

The valency of Lithium = 1

When the number of electrons in the outermost shell is close to its full capacity, (such as 8 for L shell) valency is then determined by subtracting the valence electron number from the full capacity of 8.

Valency = 8-valence electrons

For example fluorine (atomic number: 9) has the electron distribution,

n	shell	electrons
1	K	2
2	L	7

Outer shell (L) has 7 electrons which is close to the full capacity of 8.

Hence valency = (8 -7) = 1

ACTIVITY 4.9 I DO

I calculate the valence electrons and determine the valency.

Element	Atomic number	Valence electrons	Valency
Hydrogen	1		
Boron	5		
Carbon	6		
Magnesium	12		
Aluminium	13		

EVALUATION

Section A

Choose the correct answer

1. Total number of electrons, that can be accommodated in an orbit is given by $2n^2$ (n = 1, 2, 3....). Maximum number of electrons, that can be present in the first orbit is _____. (8, 2, 18)
2. Goldstein discovered protons. It is present in the nucleus. Charge on the protons are _____ (negative, positive, neutral).
3. A subatomic particle is revolving around the nucleus in orbits. It is negatively charged. It was discovered by J.J.Thomson. The particle is _____. (proton, neutron, electron)
4. Number of neutrons present in $^{7}_{3}Li$ is 4. The number of neutrons present in $^{16}_{8}O$ element is _____. (8, 7, 6)
5. Nucleus of an atom has two components. They are proton and _____ (positron, neutron, electron)
6. The sum of the number of protons and neutrons present in the nucleus is called mass number. Find the number of protons in the following element. (11, 23, 12)

Element	Mass number	Number of protons	Number of neutrons
Sodium (Na)	23	?	12

7. Atomic number and mass number of $^{35}_{17}Cl$ are 17 and 35 respectively. The number of protons present in it is _____ (17, 35, 18)
8. _____ isotope is used for the treatment of goitre. (Iodine – 131, Phosphorus – 32, Iron – 59)
9. The electron distribution of fluorine is 2, 7. The valency of the element is _____ (7, 2, 1)
10. Electron distribution of sodium is 2, 8, 1. The valency of the element is _____ (2, 8, 1)
11. Every atom has equal number of protons and electrons. Both are oppositively charged. Neutron is electrically neutral. The nature of atom is _____ (positive, negative, neutral)

Section B

12. Electrons in an atom revolve around the nucleus in circular stationary paths.
    a) Who proposed such a statement?
    b) What is the name of the circular path?
13. K shell of $^{14}_{7}N$ has 2 electrons. How many electrons are present in the L shell?

14. $^{35}_{17}X$ is a gaseous element. Its atomic number is 17. Its mass number is 35. Find out the number of electrons, protons and neutrons.

15. Many isotopes are used in medical field.
    a) Which isotope is used for the treatment of anaemia?
    b) Which one is used in eye treatment?

16. Write the electron distribution in the following elements.

Element	Atomic number	Electron distribution		
		K	L	M
Boron	5	2	-	-
Magnesium	12	-	8	-

17. Find the valence electrons and valency.

Element	Atomic number	Valence electron	valency
Carbon	6(2,4)		
Aluminium	13(2,8,3)		

18. In the elements given here identify (a) Mass number (b) Atomic number (c) Number of Protons (d) Number of Electrons (e) Number of Neutrons
    $^{4}_{2}He$, $^{7}_{3}Li$, $^{10}_{5}B$, $^{12}_{6}C$, $^{27}_{13}Al$

19. Copy and complete the table by adding the missing information for Uranium isotope.

Isotope	Symbol	Number of Protons	Number of Neutrons	Number of Electrons
Uranium- 235	$^{235}_{92}U$	92	143	92
Uranium- 238		92		

Section C

20. Name the elements with completely filled orbits.

Element	Atomic Number	Electron distribution
Nitrogen	7	
Neon	10	
Magnesium	12	
Sulphur	16	
Argon	18	

21. Correlate the facts with properties.

(i)	More dense part of an atom	Valency
(ii)	Chargeless particle	Atomic number
(iii)	Outermost orbit	Nucleus
(iv)	Number of electrons in outermost orbit	Valence shell
(v)	Number of protons	Neutron
		Proton

22. How many electrons can be accommodated in K, L and M shells?
23. What are the fundamental particles of an atom? Name all the subatomic particles.
24. What are isotopes? Draw the isotopes of Hydrogen.

Section D

25. What are alpha particles? How are they useful in the determination of nucleus of an atom?
26. Write briefly the atomic model concept proposed by Rutherford.
27. List the limitations of Rutherford's atom model.
28. State the postulates of Bohr's atom model?
29. Give experimental evidence about the discovery of neutron.
30. How is valency of an element predicted?
31. Give orbitwise electronic configuration of
    i. Carbon (Atomic Number - 6)
    ii. Fluorine (Atomic Number - 9)
    iii. Magnesium (Atomic Number - 12)
    iv. Phosphorus (Atomic Number - 15)
    v. Argon (Atomic Number - 18)

ASSESSMENT ACTIVITY

1. Assignment

Aim : To enable the students to know about the role of neutrons in the nucleus.
In lighter atoms protons and neutrons are equal in numbers.
In heavier atoms they are not equal in numbers. List out the reasons.

2. Project :

Aim : To construct the model of an atom

Construct the model of an atom using available materials. Your model should have the correct number of shells, and the correct number of electrons in each shell. Use different colour codes to represent electrons, protons and neutrons(Choose any atom of your choice)

3. Discussion

Aim : To enable the students to find out the major similarities and differences between Rutherford and Niels Bohr atom models

Similarities	Differences

4. Album

Aim: To enable the students to draw the atomic models.

Draw the atomic models of Dalton, Thomson, Rutherford and Niels Bohr.

5. How do you assume about the shape of an atom to be? Tick your choice

Square shape

Rectangular shape

Circular shape

Spherical shape

Elliptical shape

FURTHER REFERENCE

Books: *Atomic Structure Advanced Inoganic Chemistry - Satya prakash, GD Tuli - S.Chand & Company Ltd*

Websites : *http://www.shodor.org*
http://www.chemguide.co.uk.

4. CHEMICAL EQUATION

Plants produce their food (carbohydrate) by a chemical reaction called photosynthesis. Photosynthesis requires (i) carbon dioxide, (ii) water, (iii) sunlight and (iv) chlorophyll. This can be represented by an equation

$$\text{Carbon dioxide + Water} \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} \text{Carbohydrate + Oxygen} \uparrow$$

Thus, chemical equations summarize information about chemical reactions. To write a chemical equation, You must know the substances that are present before and after reaction such as reactants and products

4.1 TYPES OF IONS

In general, atoms and molecules take part in chemical reactions.

We know that atoms are made up of particles called protons, neutrons and electrons. Protons are positively charged while electrons are negatively charged. An atom has no net charge i.e. it is said to be electrically neutral, Since it has as an equal number of protons and electrons.

In chemical reactions, the number of protons in an atom remains unchanged whereas the number of electrons may increase or decrease. This leads to a difference in the number of protons and electrons which gives a net charge to the atom. When an atom has a net charge, it is called an ion.

Ions are atoms or group of atoms which carry a net positive or negative charge.

4.1.1 CATIONS

If an atom, which is electrically neutral, loses one or more electrons, it becomes positively charged and is called a cation.

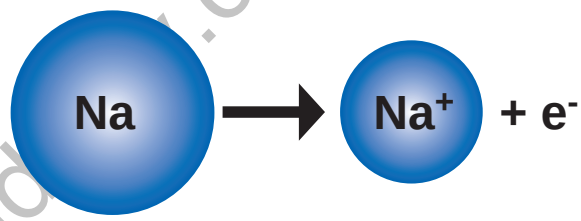
Atom ⟶ cation + electron(s)

Typically, when metals are involved in a chemical reaction, they lose electrons to form cations.

Formation of sodium ion from sodium atom

For example, sodium is a metal. The atomic number of sodium is 11. A sodium atom loses one electron and forms a sodium ion.

cation is +ve



$$Na \longrightarrow Na^+ + e^-$$

Na
Sodium atom
11 protons &
11 electrons

$Na^+ + e^-$
Sodium ion(cation)
11 protons &
10 electrons

MORE TO KNOW

Did you notice that the cation is smaller than the parent atom? This is because the nucleus pulls the electrons towards it as the number of protons is more than the number of electrons.

4.1.2 ANIONS

If an atom, which is electrically neutral, gains one or more electrons, it becomes negatively charged and is called an anion.

Atom + electron(s) ⟶ Anion

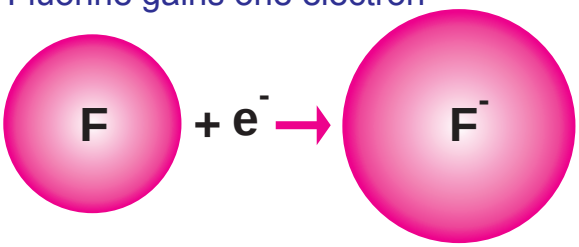
SCIENCE

Typically, when non-metals are involved in a chemical reaction, they gain electrons to form anions.

Formation of fluoride ion from fluorine atom.

For example, fluorine is a non-metal. The atomic number of fluorine is 9. A fluorine atom gains one electron and forms a fluoride ion.

Fluorine gains one electron



F → F⁻

Fluorine atom
9 protons &
9 electrons

Fluoride ion (anion)
9 protons &
10 electrons

MORE TO KNOW

Did you notice that the anion is larger than the parent atom? This is because the number of protons is fewer than electrons and thus the nucleus has lesser influence on the valence electrons. The valence electrons move away from the nucleus which increases the size of an anion.

ACTIVITY – 4.1 **I DO**

I write the cations and anions present in the following compounds.

1. Silver nitrite
2. Magnesium sulphate
3. Aluminium oxide
4. Lead nitrate
5. Potassium carbonate
6. Barium chloride
7. Zinc sulphate
8. Copper nitrate

Monoatomic ions

A monoatomic ion is formed from a single atom.

For example, Sodium ion Na^+ is a monoatomic cation and

Fluoride ion F^- is a monoatomic anion.

ACTIVITY – 4.2 **I DO**

I write the formulae of the following monoatomic anions.

1. Bromide ion
2. Chloride ion
3. Fluoride ion
4. Hydride ion
5. Iodide ion
6. Oxide ion
7. Nitride ion
8. Sulphide ion

MORE TO KNOW

The names of most monoatomic negative ions end with suffix “ide”.

Polyatomic ions

An ion can also be formed from one or more atoms of different elements. This is called a polyatomic ion. A polyatomic ion exists and behaves as a single unit. It may carry either a positive or negative charge.

Example: NH_4^+ is ammonium ion (polyatomic cation)

OH^- is Hydroxide ion (polyatomic anion)

MORE TO KNOW

A molecule formed by combination or association of two molecules is known as a dimer.

Hg_2^{2+} Mercurous ion exists as a dimer only.

4.2. IONS AND VALENCY

The valency of an element is the net charge on the ion of that element. For a polyatomic ion, the net charge of the group is its valency.

	Monoatomic ion		Polyatomic ion	
	cation	anion	cation	anion
Monovalent	Na^+	F^-	NH_4^+	OH^-
Divalent	Ca^{2+}	S^{2-}		SO_4^{2-}
Trivalent	Fe^{3+}	N^{3-}		PO_4^{3-}

Monovalent polyatomic ions

Name	Formula
Bisulphate ion	HSO_4^-
Bisulphite ion	HSO_3^-
Chlorate ion	ClO_3^-
Chlorite ion	ClO_2^-
Cyanide ion	CN^-
Hydroxide ion	OH^-
Hypochlorite ion	ClO^-
Nitrate ion	NO_3^-
Nitrite ion	NO_2^-
Perchlorate ion	ClO_4^-
Permanganate ion	MnO_4^-

MORE TO KNOW

Most of the polyatomic names end with suffixes “-ite”,”-ate”.

Bivalent polyatomic ions

Name	Formula
Carbonate ion	CO_3^{2-}
Chromate ion	CrO_4^{2-}
Dichromate ion	$Cr_2O_7^{2-}$
Manganate ion	MnO_4^{2-}
Peroxide ion	O_2^{2-}
Sulphate ion	SO_4^{2-}
Sulphite ion	SO_3^{2-}
Thiosulphate ion	$S_2O_3^{2-}$

Trivalent polyatomic ions

Name	Formula
Borate ion	BO_3^{3-}
Phosphate ion	PO_4^{3-}

SCIENCE

Multivalent cations or polyvalent cations

Formula	Name	Formula	Name
Au^{+}	Gold (I) or Aurous	Au^{3+}	Gold (III) or Auric
Ce^{3+}	Cerium (III) or Cerous	Ce^{4+}	Cerium (IV) or Ceric
Co^{2+}	Cobalt (II) or Cobaltous	Co^{3+}	Cobalt (III) or Cobaltic
Cr^{2+}	Chromium (II) or Chromous	Cr^{3+}	Chromium (III) or Chromic
Cu^{+}	Copper (I) or Cuprous	Cu^{2+}	Copper (II) or Cupric
Fe^{2+}	Iron (II) or Ferrous	Fe^{3+}	Iron (III) or Ferric
Mn^{2+}	Manganese (II) or Manganous	Mn^{3+}	Manganese (III) or Manganic
Pb^{2+}	Lead (II) or Plumbous	Pb^{4+}	Lead (IV) or Plumbic
Sn^{2+}	Tin (II) or Stannous	Sn^{4+}	Tin (IV) or Stannic

ACTIVITY – 4.3 **I DO**

I write the names of the following cations.

(i) Fe^{2+} _____ (ii) Fe^{3+} _____ (iii) Hg_2^{2+} _____ (iv) Hg^{2+} _____

4.3 CHEMICAL FORMULA

A Chemical formula is a symbolic way to represent a compound. To write the chemical formula of a compound, symbols and valencies of constituent elements must be known.

Chemical symbols and valencies

Valency = 1	Valency = 2	Valency = 3	Valency = 4
Bromine (Br)	Barium (Ba)	Boron (B)	Carbon (C)
Chlorine (Cl)	Calcium (Ca)	Aluminium (Al)	Silicon (Si)
Fluorine (F)	Magnesium (Mg)		
Hydrogen (H)	Oxygen (O)		
Iodine (I)	Sulphur (S)		
Lithium (Li)			
Sodium (Na)			
Potassium (K)			

4.3.1 WRITING A CHEMICAL FORMULA BY VALENCY CRISS-CROSS METHOD

The chemical formula of a compound is electrically neutral. The charge on the cations and the charge on the anions must be equal (remember, the valency can be related to the charge).

The following methods are followed to write a chemical formula.

- The symbols or formulae of the components are written side by side.
- Positive ions are written on the left and negative ions on the right.
- The valencies of ions are written below the respective symbols.
- The criss-cross method is applied to exchange the numerical value of valency of each ion. It is written as subscript of the other ion.

ACTIVITY – 4.4 **WE DO**

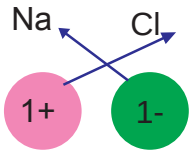
We write the chemical formulae of the following compounds.

1. Sodium hydroxide
2. Sodium carbonate
3. Calcium hydroxide
4. Ammonium sulphate
5. Phosphorous trichloride
6. Sulphur hexafluoride
7. Copper (II) nitrate
8. Cobalt (II) chloride

- For a polyatomic ion, the ion is enclosed in a bracket and the subscript is placed outside the lower right corner.
- The common factor is removed.
- If the subscript of the ion is one, it is omitted.

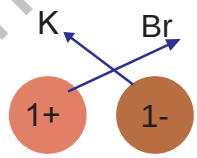
ILLUSTRATIONS

1. Sodium chloride



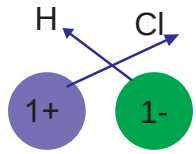
NaCl

2. Potassium bromide



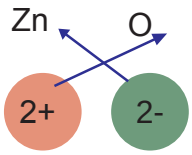
KBr

3. Hydrogen chloride



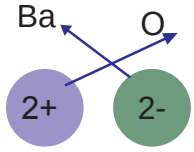
HCl

4. Zinc oxide



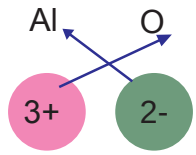
ZnO

5. Barium oxide



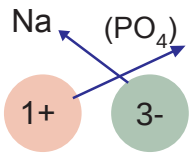
BaO

6. Aluminium oxide



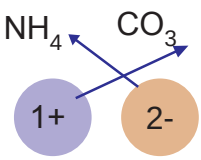
Al_2O_3

7. Sodium phosphate



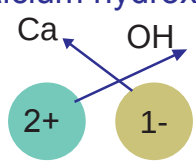
Na_3PO_4

8. Ammonium carbonate



$(NH_4)_2CO_3$

9. Calcium hydroxide



$Ca(OH)_2$

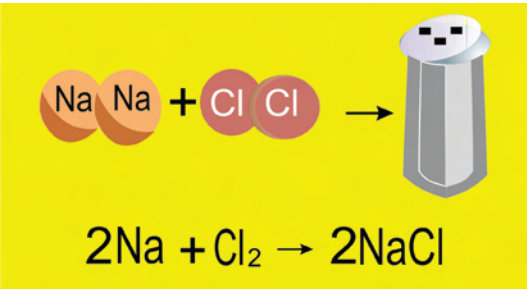
SCIENCE

4.4 INTRODUCTION FOR WRITING CHEMICAL EQUATIONS

The symbolic expression of a chemical reaction, using symbols of reactants and products, is called a chemical equation.

Reactant A+ Reactant B ⟶ Product(s)

- Reactants are the starting substances.
- Products are the substances that are formed in a reaction.
- The arrow sign means "react to form".
- The plus sign means "and"



Remember the following points while writing a chemical equation:

(i) Nature of reactants and products

The physical state of a substance can be indicated using the following symbols as a subscript:

Physical state	Symbol	Example
solid state	(s)	$NaCl_{(s)}$
liquid state	(l)	$H_2O_{(l)}$
gaseous state	(g)	$O_2(g)$
solution in water	(aq)	$NH_{3(aq)}$

The following arrows are used to show the nature of the substances:

(↑) gas is released Example: $O_{2(g)}\uparrow$

(↓) precipitate is formed Example: $BaSO_4\downarrow$

(ii) Reaction conditions:

Favourable conditions like temperature, pressure, presence of catalyst and light can be indicated above or below the arrow

Example:

$$4NH_3 + 5O_2 \xrightarrow[Pt]{750\text{-}900^\circ C} 4NO + 6H_2O$$

(iii) Heat changes:

Some reactions involve heat changes.

Example:

$N_2 + 3H_2 \rightleftarrows 2NH_3 + \text{heat}$

Heat is released. This is an exothermic reaction.

MORE TO KNOW

Common Greek Prefixes

Prefix	Number
Mono -	1
Di -	2
Tri -	3
Tetra -	4
Penta -	5
Hexa -	6
Hepta -	7
Octa -	8
Nona -	9
Deca -	10

4.5 BALANCING THE CHEMICAL EQUATION

The "Law of conservation of mass" requires that the number of atoms present before the reaction (reactants) must be equal to the number of atoms present after the reaction (products). In other words, the equation must be "balanced".

In order to balance an equation:

1. Identify the reactants and products and write the skeleton equation. For example:

   Reactant A + Reactant B ⟶ Product C + Product D

2. Count the number of atoms on either side. If they are not equal, balance them by adjusting the number of reactants or products.

3. If the coefficients have a common divisor, simplify.

Example 1: Balance the reaction between Sodium and Chlorine

Skeleton equation:

$Na + Cl_2 \longrightarrow NaCl$

Balance Cl atom:

$Na + Cl_2 \longrightarrow 2NaCl$

Balance Na atom:

$2Na + Cl_2 \longrightarrow 2NaCl$

Example 2: Balance the reaction of Sodium carbonate with Hydrochloric acid

Skeleton equation:

$Na_2CO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$

Balance sodium atom:

$Na_2CO_3 + HCl \longrightarrow 2NaCl + H_2O + CO_2$

Balance hydrogen, chlorine and oxygen atoms:

$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$

Example 3: Balance the reaction of Aluminium hydroxide with sulphuric acid

Skeleton equation:

$Al(OH)_3 + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$

Balance aluminium atom:

$2\,Al(OH)_3 + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$

Balance sulphate group:

$2\,Al(OH)_3 + 3\,H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2O$

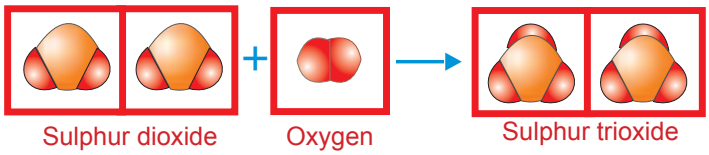
Balance hydrogen and oxygen atoms:

$2\,Al(OH)_3 + 3\,H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6H_2O$

SCIENCE

Illustration : 1

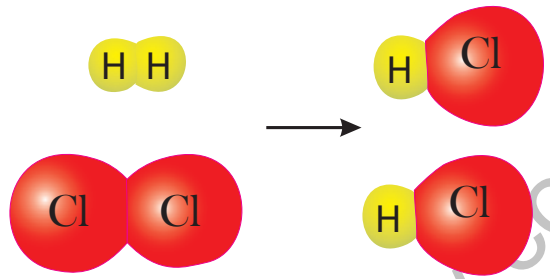
Reaction between sulphur dioxide and oxygen to form sulphur trioxide:



$2SO_2 + O_2 \longrightarrow 2SO_3$

Illustration : 2

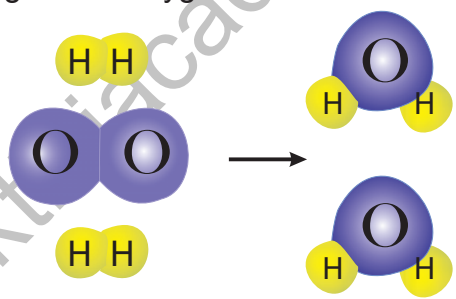
Reaction between hydrogen and chlorine to form Hydrogen chloride:



$H_2 + Cl_2 \longrightarrow 2HCl$

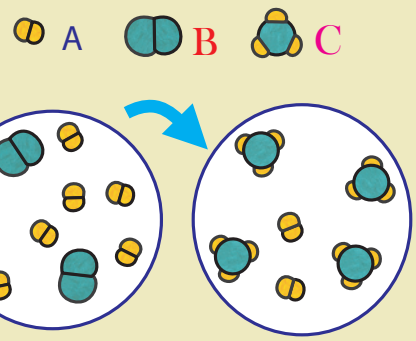
Illustration : 3

Reaction between hydrogen and oxygen to form water:



$2H_2 + O_2 \longrightarrow 2H_2O$

ACTIVITY – 4.5 I DO



From the diagram I write the equation for the reaction between A and B to give the product C.

ACTIVITY – 4.6 WE DO

We balance the chemical equations.

1. $N_2 + O_2 \longrightarrow NO$
2. $CaCO_3 + HCl \longrightarrow CaCl_2 + H_2O + CO_2$
3. $Na + H_2O \longrightarrow NaOH + H_2$
4. $KClO_3 \longrightarrow KCl + O_2$
5. $N_2 + H_2 \longrightarrow NH_3$
6. $NH_3 + O_2 \longrightarrow N_2 + H_2O$

Know the occurrence of natural chemical reaction

Some chemical reactions take place naturally during lightning. Nitrogen in the atmosphere combine with oxygen to form nitrogendioxide.

$$N_2 + 2O_2 \longrightarrow 2NO_2$$

Oxygen present in the atmosphere is converted to ozone.

$$3O_2 \longrightarrow 2O_3$$

This acidic oxide like nitrogendioxide mixes with tiny droplets of water vapour to produce acid rain which is harmful to plants.

$$4NO_2 + O_2 + 2H_2O \longrightarrow 4HNO_3$$

ACTIVITY – 4.7 WE OBSERVE

Mix ammonia solution and hydrochloric acid. Observe. Write a balanced chemical equation for the reaction.

ACTIVITY – 4.8 WE OBSERVE

Mix barium chloride solution and sodium sulphate solution. Observe. Write a balanced chemical equation for the reaction.

SCIENCE

EVALUATION

Section A

I. Choose the correct answer

1. Atomic number of sodium is 11. Then number of electrons in sodium ion is _____ (9,10,12)
2. Number of electrons lost by Fe^{2+} ion is _____ (2,3,0)
3. Identify the polyatomic ion from the following _____ (Cl^- , O^{2-} , Na^+ , NH_4^+)
4. Select the monoatomic anions from the following _____ (CN^- , PO_4^{3-} , I^- , NO_2^-)

5. An ion is produced as a result of gain or loss of electrons by an atom. In Au^{3+} ion, 3 electrons are _____ (gained, lost)
6. Mention the total number of atoms present in CO_3^{2-}
7. If a monovalent polyatomic ion contains one hydrogen atom, one sulphur atom, and three Oxygen atom, then its name is _____ion.
8. Reactants are the substances that are present before the chemical reaction takes place.

   $2Fe + 3Cl_2 \longrightarrow 2FeCl_3$. Name the reactants
9. Construct the formula of the following compounds using crisscrossing valency.

   (a) Calcium hydroxide (b) Ammonium carbonate

   (c) Zinc oxide (d) Aluminium oxide
10. Valency of sodium is 1. Valency of chlorine is 1.
    Write the formula of sodium chloride.
11. The number of atoms of the reactants and products of various elements on both side are equal in a balanced chemical equation. Balance the following equation.

    $HNO_3 \longrightarrow H_2O + NO_2 + O_2$

Section - B

1. $Na \longrightarrow Na^+ + e^-$

   $Cl + e^- \longrightarrow Cl^-$

   a) Is sodium a metal or non-metal?

   b) Write the name of Cl^- ion.
2. A compound is formed by the combination of cations and anions. What are the cations and anions present in the following compounds?

   a) K_2CO_3 b) $BaCl_2$
3. Match the following:

Cl^-	-	polyatomic anion
Cr^{2+}	-	monoatomic anion
NH_4^+	-	monoatomic cation
PO_4^{3-}	-	polyatomic cation

4. Name the cations and anions present in the following compounds.

   a) $MgSO_4$ b) KNO_3

5. Pickout the odd one

a) NO_3^- , NO_2^- , MnO_4^- , Cl^-

b) $Bacl_2$, $NaNo_3$,$Mgso_4$,CuO (based on the charge of the cation)

6. Identify the valency of element X from following compound.

a) XH_3 b) XCl_5

c) X_2O_3 d) XO_2

7. Classify the following into monovalent, divalent and trivalent ions.

a) Ammonium b) Oxide c) nitride

8. An element 'B' is trivalent. Write the formulae of its.

a) Oxide b) Chloride

9. Write all possible chemical formula for the following ions.

Cu^{2+}, Fe^{2+},SO_4^{2-},Cl^-

10. Fill in the blanks.

During lightning oxygen present in the atmosphere is concerted into_____?

$N_2 + 2O_2 \longrightarrow$ _____?

11. Correct the following statements:

a) The valency can not be related to the charge.

b) A ploy atomic ion can be formed from two or more atoms of same elements.

12. The given sentences are wrong. Correct the mistakes and write the correct sentences. While balancing a chemical equation,

a) Change the formulae wherever necessary.

b) If the product formed is a precipitate, use upward arrow mark (↑).

13. Pick up the polyatomic anions from the following and write the formula.

a) Chloride ion, b) Fluoride ion

c) Phosphate ion d) Sulphate ion

14. Atomic number of fluorine is 9. Explain the formation of fluoride ion.

15. Valency of Zn is 2. Valency of Oxygen is 2 Construct the formula for zinc oxide by using the above hints.

16.Formula of Aluminium oxide is Al_2O_3. Find the valency of Aluminium and Oxygen.

Section – C

1.Balance the following equations:

1. $MnO_2 + HCl \longrightarrow MnCl_2 + Cl_2 + H_2O$
2. $NH_4Cl + Ca(OH)_2 \longrightarrow NH_3 + CaCl_2 + H_2O$
3. $BaCl_2 + Al_2(SO_4)_3 \longrightarrow BaSO_4 + AlCl_3$
4. $NaAlO_2 + H_2O + CO_2 \longrightarrow Al(OH)_3 + Na_2CO_3$
5. $NH_3 + O_2 \longrightarrow NO + H_2O$
6. $Zn + HNO_3 \longrightarrow Zn(NO_3)_2 + NO_2 + H_2O$
7. $H_2S + O_2 \longrightarrow H_2O + SO_2$
8. $PbO + C \longrightarrow Pb + CO_2$
9. $BaCl_2 + H_2SO_4 \longrightarrow BaSO_4 + HCl$
10. $CH_4 + O_2 \longrightarrow CO_2 + H_2O$

2. Complete the table:

Ions	Phosphate	Chlorate	Bisulphate
Na^+	_____	$NaClO_3$	_____
Mg^{2+}	$Mg_3(PO_4)_2$	_____	_____
Al^{3+}.	$AlPO_4$	_____	$Al(HSO_4)_3$

FURTHER REFERENCE

Books: *1. General Chemistry - Jean B. Umland & Jon.M.Bellama*
West publishing company

Websites : http://www.visionlearning.com
http://www.chymist.com

4. PERIODIC CLASSIFICATION OF ELEMENTS

When you go to a big library, you see many racks with books. If you need a book on Science, you would go to the section labelled as Science. In the Science section you will find separate racks for various branches like Chemistry, Physics etc. where books are arranged in a certain order. Thus, wherever a large number of items are involved, proper classification is needed for easy identification.

In the early days, when elements were being discovered, scientists tried to classify elements based on their nature, and then according to their atomic mass. This classification of elements is called 'periodic table'. Finally, they succeeded with a classification system based on atomic number. In this periodic table, elements which show similar physical and chemical properties are arranged in rows and columns. This table also led to the discovery of elements not known till then.

4.1. EARLY ATTEMPTS AT CLASSIFICATION OF ELEMENTS

Lavoisier's Classification of Elements

In 1789, Lavoisier first attempted to classify the elements into two divisions, namely Metals and Non-metals. However, this classification was not satisfactory as there were many exceptions in each category.

Dobereiner's Classification of Elements

In 1817, Johann Wolfgang Dobereiner grouped three elements together into what he termed triads.

Elements with similar chemical properties were arranged in a group of three, in which the atomic mass of the middle element was approximately the arithmetic mean of the two extreme elements..

For example, elements like lithium, sodium and potassium were grouped together into a triad as shown below. The atomic mass is shown in brackets.

Li (7)	Na (23)	K (39)

Note that the atomic mass of sodium is the average of atomic masses of lithium and potassium.

Limitation of Dobereiner's Law

After the discovery of elements many of them could not be grouped this way.

MORE TO KNOW

Chemically alike elements could be arranged in a group of three, in which the atomic mass of the middle element would be approximately the arithmetic mean of the two extreme elements.

ACTIVITY 4.1 **I DO**

Element	*Atomic Mass*
Calcium	*40*
Strontium	*88*
Barium	*137*
Chlorine	*35.5*
Bromine	*80.0*
Iodine	*127.0*

I can arrange the above elements in two groups of triads.

SCIENCE

Newland's Classification of Elements

In 1863, John Newland arranged the elements in the increasing order of Atomic Mass. He observed that there appeared to be a repetition of similar properties in every eighth element like that of eighth note in an octave of music.

Therefore, he placed seven elements in each group. Then he classified the 49 elements known at that time into seven groups of seven each. Newland referred to this arrangement as the Law of Octaves.

Note	1 (Sa)	2 (re)	3 (ga)	4 (ma)	5 (pa)	6 (dha)	7 (ni)
Element	Li	Be	B	C	N	O	F
	Na	Mg	Al	Si	P	S	Cl
	K	Ca	Cr	Ti	Mn	Fe	-

Note: Sodium is similar to Lithium. Likewise, Magnesium is similar to Beryllium.

Limitations of Newland's Classification

Inert gases were discovered at a later stage. With the inclusion of inert gas, 'Neon' between 'Fluorine' and 'Sodium', the 9th element became similar to the first one. Similarly, the inclusion of inert gas 'Argon' between 'Chlorine' and 'Potassium' made the 9th element similar to the first one.

ACTIVITY 4.2 ***I DO***

I can write the names of elements with similar properties

Element	*Element with similar property*
Aluminium	
Silicon	
Phosphorous	
Sulphur	
Chlorine	

Lothar Meyer's Classification of Elements

In 1864, Lothar Meyer plotted the atomic weight against the atomic volume of various elements. He found out that the elements with similar properties and valency fell under one another. However, this also could not give a better understanding the sequences.

MORE TO KNOW

Periodicity is the recurrence of similar physical and chemical properties of elements, when they are arranged in a particular order.

Dimitri Ivanovich Mendeleev, a Russian chemist, suggested that the chemical elements can be sorted out based on certain similarities in their properties. The arrangement he proposed is called the Periodic Table. His table proved to be a unifying principle in chemistry and led to the discovery of many new chemical elements.

Mendeleev (1834-1907)

4.2. MENDELEEV'S PERIODIC TABLE

Groups	I	II	III	IV	V	VI	VII	VIII		
Oxide : Hydride:	R_2O RH	RO RH_2	R_2O_3 RH_3	RO_2 RH_4	R_2O_5 RH_3	RO_3 RH_2	R_2O_7 RH	RO_4		
Periods	A B	A B	A B	A B	A B	A B	A B	Transition		Series
1	H 1.008									
2	Li 6.941	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998			
3	Na 22.99	Mg 24.31	Al 26.98	Si 28.09	P 30.97	S 32.06	Cl 35.453			
4 First Series	K 39.10	Ca 40.08	--	Ti 47.90	V 50.94	Cr 52.20	Mn 54.94	Fe 55.85	Co 58.93	Ni 58.69
Second series	Cu 63.55	Zn 65.39	--	--	As 74.92	Se 78.96	Br 79.90			
5 First series	Rb 85.47	Sr 87.62	Y 88.91	Zr 91.22	Nb 92.91	Mo 95.94	Tc 98	Ru 101.07	Rh 102.9	Pd 106.4
Second series	Ag 107.87	Cd 112.41	In 114.82	Sn 118.71	Sb 121.76	Te 127.90	I 126.90			
6. First series	Cs 132.90	Ba 137.34	La 138.91	Hf 178.49	Ta 180.95	W 183.84	--	Os 190.2	Ir 192.2	Pt 195.2
Second series	Au 196.97	Hg 200.59	Tl 204.38	Pb 207.2	Bi 208.98					

Fig: Mendeleev's Periodic Table
("R" is used to represent any of the elements in a group)

4.3. MENDELEEV'S CLASSIFICATION OF ELEMENTS

Mendeleev's periodic table is based on a law called Mendeleev's periodic law which states that :

"The physical and chemical properties of elements are the periodic functions of their atomic masses".

ACTIVITY 4.3 **I DO**

I can answer the following questions. Name the elements missing in the Mendeleev's periodic table with atomic masses 44, 68 and 72. To which group do they belong? Is there any group for noble gases?

SCIENCE

Characteristics of Mendeleev's Periodic Table

- Mendeleev felt that similar properties occurred after periods (horizontal rows) of varying length.
- He created a table with eight columns.
- He left a few cells empty so that all the elements with similar properties could be grouped in the same column.
- Mendeleev inferred that there must be other elements that had not yet been discovered.
- He predicted the properties and atomic masses of several elements that were not discovered at that time. Later on, when these elements were discovered, their properties remarkably agreed with his prediction.

For example, he left a gap below silicon in group IV A, and called the yet undiscovered element as 'Eka Silicon'. The discovery of 'Germanium' later on, during his lifetime, proved him correct.

Property	Mendeleev's prediction in 1871	Actual property of Germanium discovered in 1886
1.Atomic Mass	About 72	72.59
2.Specific Gravity	5.5	5.47
3.Colour	Dark grey	Dark grey
4.Formula of Oxide	EsO_2	GeO_2
5.Nature of Chloride	$EsCl_4$	$GeCl_4$

- Similarly, Scandium for 'eka-boron' and Gallium for 'eka-aluminium' were later discovered.
- Eight out of ten vacant spaces left by Mendeleev were filled by the discovery of new elements.
- Incorrect atomic masses of some of the already arranged elements were corrected. For example, the atomic mass of Beryllium was corrected as 9 from 13.

ACTIVITY 4.4 **I DO**

I can write down the names of elements belonging to groups I and II in Mendeleev's periodic table.

Group	IA	IB	IIA	IIB
Elements				

ACTIVITY 4.5 **WE DO**

Using Mendeleev's periodic table, we can write the formula of oxides of:

1.Lithium 2. Boron 3.Sodium 4.Beryllium 5. Calcium.

MORE TO KNOW

The inadequacy in the Mendeleev's periodic table has been overcome by the introduction of the Modern periodic table. It is also known as Long form of periodic table. In this table, the properties of elements are dependent on their electronic configurations (distributions). Hence, the modern periodic law is defined as: "the properties of elements are the periodic function of their atomic numbers " .

Groups↓ Periods →	I A B	II A B	III A B	IV A B	V A B	VI A B	VII A B	VIII			0 (ZERO)
1	1.008 H 1										4.003 He 2
2	6.941 Li 3	9.012 Be 4	10.81 B 5	12.011 C 6	14.007 N 7	15.999 O 8	18.998 F 9				20.18 Ne 10
3	22.99 Na 11	24.31 Mg 12	26.98 Al 13	28.09 Si 14	30.97 P 15	32.06 S 16	35.45 Cl 17				39.95 Ar 18
4	39.10 K 19	40.08 Ca 20	44.96 Sc 21	47.90 Ti 22	50.94 V 23	52.20 Cr 24	54.94 Mn 25	55.85 Fe 26	58.93 Co 27	58.69 Ni 28	83.90 Kr 36
	63.55 Cu 29	65.39 Zn 30	69.72 Ga 31	72.61 Ge 32	74.92 As 33	78.96 Se 34	79.90 Br 35				
5	85.47 Rb 37	87.62 Sr 38	88.91 Y 39	91.22 Zr 40	92.91 Nb 41	95.94 Mo 42	98 Tc 43	101.07 Ru 44	102.91 Rh 45	106.4 Pd 46	131.30 Xe 54
	107.87 Ag 47	112.41 Cd 48	114.82 In 49	118.71 Sn 50	121.76 Sb 51	127.90 Te 52	126.90 I 53				
6	132.9 Cs 55	137.34 Ba 56	138.9 La* 57	178.49 Hf 72	180.97 Ta 73	183.84 W 74	186.2 Re 75	190.2 Os 76	192.2 Ir 77	195.2 Pt 78	222 Rn 86
	196.97 Au 79	200.59 Hg 80	204.38 Tl 81	207.20 Pb 82	208.98 Bi 83	209 Po 84	210 At 85				
7	223 Fr 87	226 Ra 88	227 Ac** 90								

6	* Lanthanides	140.12 Ce 58	140.91 Pr 59	144.2 Nd 60	145 Pm 61	150.4 Sm 62	152.0 Eu 63	157.3 Gd 64	158.9 Tb 65	162.5 Dy 66	164.9 Ho 67	167.3 Er 68	168.9 Tm 69	173.0 Yb 70	174.9 Lu 71
7	** Actinides	232.04 Th 90	231 Pa 91	238.02 U 92	237 Np 93	244 Pu 94	243 Am 95	247 Cm 96	247 Bk 97	251 Cf 98	252 Es 99	257 Fm 100	258 Md 101	259 No 102	260 Lr 103

Fig: Modified Mendeleev's Periodic Table

Characteristics of modified Mendeleev's Periodic Table

1. Elements are arranged in the increasing order of their atomic masses.
2. Vertical columns are called 'groups' and horizontal rows are called 'periods'.
3. There are 'nine groups' numbered from I to VIII and 0.
4. Groups I to VII are subdivided into subgroups A and B.
5. There are 'seven periods'.
6. The first three periods contain 2, 8, 8 elements respectively. They are called 'short periods'.
7. The fourth, fifth and sixth periods have 18, 18 and 32 elements respectively.
8. The seventh period is an incomplete period.
9. Blank spaces are left for elements yet to be discovered.
10. The series of 'fourteen elements' following lanthanum is called 'Lanthanide series'.
11. The series of 'fourteen elements' following actinium is called 'Actinide series'.
12. Lanthanides and actinides are placed at the bottom of the periodic table.

Limitations of modified Mendeleev's Periodic Table

1. A few elements that have a higher atomic mass were placed before those having a lower atomic mass.

   Example: Argon (39.9) was placed before Potassium (39.1)

   Cobalt (58.9) was placed before Nickel (58.6).

   Tellurium (127.9) was placed before Iodine (126.9).
2. There were no provisions for placing Isotopes.
3. Hydrogen was placed in group IA although its properties resembled elements in group IA as well as group VIIA.
4. Chemically dissimilar elements were placed in the same group.

For example, alkali metals like sodium and potassium were placed along with coinage metals like copper, silver and gold.

MORE TO KNOW

Gallium is a metal. It has a melting point of 29.8°C. The temperature of a human body is enough to melt Gallium.

4.4. METALS AND NON-METALS

All the elements in the periodic table are broadly divided into three categories.

- Metals
- Non-metals
- Metalloid (semi-metals)

Metals

Metals are a group of elements which have similar properties. Most of the

known elements are metals and they occupy a large area in the periodic table. The left side of the periodic table contains metals. Metals are further classified into:

i. Alkali metals
eg. sodium and potassium

ii. Alkaline earth metals
eg. calcium and magnesium

iii. Transition metals
eg. iron and nickel

iv. Other metals
eg. aluminium, tin.

Non-metals

Elements that do not exhibit the properties of metals are called non-metals. Non-metals occupy the left side of the periodic table. Eg. Carbon, Iodine.

Metalloids

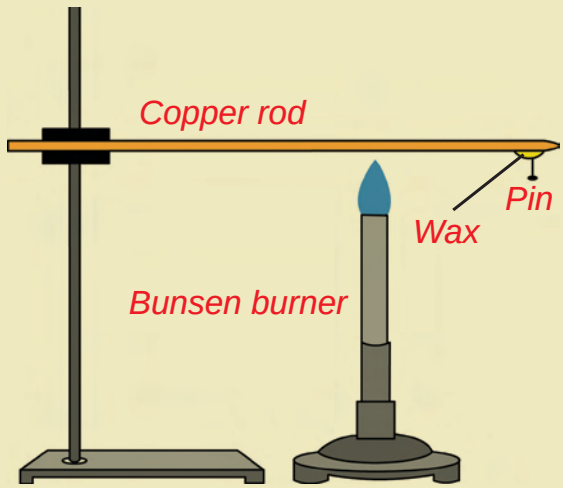
Elements which have the properties of both metals and non-metals are called metalloids. They are very good semi-conductors Eg. Silicon, Germanium.

ACTIVITY 4.6 **WE OBSERVE**

We take samples of iron, copper, aluminium and magnesium. Note the appearance of the samples first. Clean the surface of each sample by rubbing them using sandpaper. Now note the appearance of the samples again. Name the elements in the decreasing order based on their lustrous character.

ACTIVITY 4.7 **WE OBSERVE**

Take a copper rod. Clamp this rod on a stand. Fix a pin to the free end of the rod using wax. Heat the rod using a Bunsen burner as shown in the figure. Observe what happens. Write down the reason.



ACTIVITY 4. 8 **WE DO**

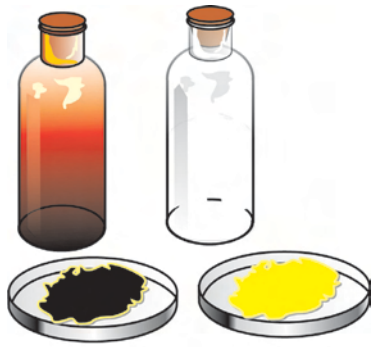
We take an iron rod, a copper rod and an aluminium rod. We strike each rod several times with a hammer and observe the sound produced. We record the sonorous character of these metals.

ACTIVITY 4.9 **I DO**

Ductility is the ability of metals to be drawn into thin wires or filaments. I can write which of the following metals are available in the form of wires: iron, magnesium, lead, copper, aluminium and calcium.

SCIENCE

4.4.1. PHYSICAL PROPERTIES OF METALS AND NON-METALS

S. No.	Properties	Metals	Non-metals
1.	Appearance	Have a lustre, known as metallic lustre. The surface is polishable.  Platinum  Gold  Silver	Have no lustre and look dull. Surface cannot be polished. (Exceptions: Graphite and iodine are lustrous).  Yellow-Sulphur, White-Phosphorous, Red-Bromine, Black-Carbon
2.	Physical state	In general, they are hard crystalline solids. (Exception: Mercury is a liquid).	They exist as soft solids or gases. (Exceptions: Diamond is a hard solid and bromine is a liquid).
3.	Density	They have a high density. (Exceptions: Sodium and Potassium).	They have a low density.
4.	Melting and boiling points	Usually they have high melting and boiling points. (Exceptions: Sodium and Potassium).	They have low melting and boiling points. (Exceptions: Diamond and graphite).
5.	Malleability and ductility	They are malleable and ductile.	Solid non-metals are brittle.
6.	Heat conductivity	They are good conductors	They are bad conductors. (Exception: Diamond).
7.	Electrical conductivity	They are good conductors	They are bad conductors. (Exception: Graphite)
8.	Sonority (phenomenon of producing a characteristic sound when a material is struck)	They are sonorous.	They are non-sonorous. (Exception: Iodine crystals produce a soft metallic clink when they are shaken in a bottle).
9.	Alloy formation	Metals form alloys with each other and also with some non-metals	Non-metals usually do not form alloys. (Exceptions: B, C, Si and P form alloys with metals).

4.4.2. CHEMICAL PROPERTIES OF METALS

1. Electropositivity:

Metals are electropositive. They lose electrons and form cations.

$Na \rightarrow Na^+ + e^-$

$Mg \rightarrow Mg^{2+} + 2e^-$

2. Reaction with Oxygen:

Metals combine with oxygen to form metallic oxides.

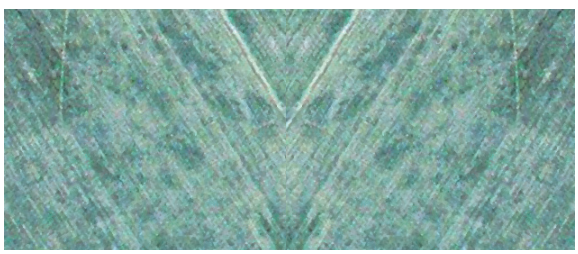
i. Magnesium burns in oxygen to form magnesium oxide.

$2Mg + O_2 \longrightarrow 2MgO$

Magnesium burns in oxygen

ii. Aluminium combines with oxygen to form a layer of aluminium oxide.

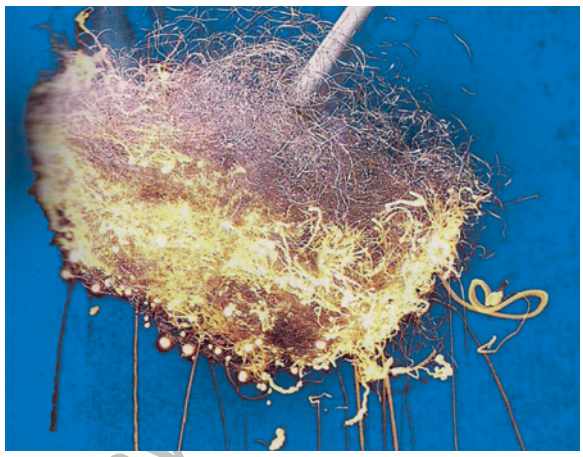
$4Al + 3O_2 \longrightarrow 2Al_2O_3$



Formation of aluminium oxide over a surface of aluminium

iii. Iron wool (thread) burns in oxygen to form iron oxide along with the release of thermal energy and light energy.

$4Fe + 3O_2 \longrightarrow 2Fe_2O_3$



Iron wool (made into thin fibres) burns in oxygen to produce both heat and light energy

Note: Metal oxides are mostly basic in nature though some are amphoteric. (Shows both acidic and basic properties)

MORE TO KNOW

- *Among metals, silver is the best conductor of electricity.*
- *Mercury is a metal with a very low melting point and it turns into a liquid at room temperature.*

MORE TO KNOW

- *Tungsten has the highest melting point of over 3300^oC.*
- *Lithium is the lightest metal. It weighs about half as much as water.*
- *Osmium is the heaviest metal. It is about 22½ times heavier than water and nearly 3 times heavier than iron.*

SCIENCE

3. Action of water

(i) Metals like sodium and potassium react with cold water vigorously and liberate hydrogen gas.

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

$2K + 2H_2O \longrightarrow 2KOH + H_2\uparrow$

(ii) Magnesium and Iron react with steam to form magnesium oxide and iron oxide respectively. Hydrogen gas is liberated.

$Mg + H_2O \longrightarrow MgO + H_2\uparrow$

$3Fe + 4\,H_2O \longrightarrow Fe_3O_4 + 4\,H_2\uparrow$

(iii) Aluminium reacts slowly with steam to form aluminium hydroxide and hydrogen.

$2Al + 6\,H_2O \longrightarrow 2Al(OH)_3 + 3\,H_2\uparrow$

Other metals like copper, nickel, silver and gold do not react with water.

4. Action of acids on metals

Metals such as sodium, magnesium and aluminium react with dilute hydrochloric acid to give the respective salts. Hydrogen gas is liberated.

$Mg + 2HCl \longrightarrow MgCl_2 + H_2\uparrow$

$2Al + 6HCl \longrightarrow 2AlCl_3 + 3H_2\uparrow$

ACTIVITY 4.10 WE OBSERVE

We take 10 ml of diluted hydrochloric acid in a test tube. We drop a small piece of iron into it. We shall observe the changes.

5. Action of halogens

Metals react with halogens to form ionic halides.

$2Na + Cl_2 \longrightarrow 2NaCl$

$2Al + 3\,Br_2 \longrightarrow 2AlBr_3$

6. Reducing property:

When a reactant gains electrons during the reaction, it is said to be reduced.

In a chemical reaction between a metal and a non-metal, the metal loses one or more electrons, which are accepted by the non-metal. So the metal is oxidised and the non-metal is reduced. The metal acts as a reducing agent.

$6Na + Al_2O_3 \xrightarrow{heat} 3Na_2O + 2Al$

$2Mg + CO_2 \xrightarrow{heat} 2MgO + C$

4.4.3. CHEMICAL PROPERTIES OF NON-METALS

1. Electronegativity:

Non-metals are electronegative. They gain electrons and form anions.

$Cl + e^- \longrightarrow Cl^-$

$O + 2e^- \longrightarrow O^{2-}$

2. Reaction with oxygen:

Non-metals when heated with oxygen produce covalent oxides.

1. Sulphur burns in air at 250° C with a pale blue flame to form sulphur dioxide.

   $S + O_2 \longrightarrow SO_2\uparrow$

2. Phosphorous burns in air to form phosphorous pentoxide.

   $4P + 5O_2 \longrightarrow 2P_2O_5$

3. Carbon burns in air to form carbon monoxide and carbon dioxide.

$$2C + O_2 \longrightarrow 2CO\uparrow$$

$$C + O_2 \longrightarrow CO_2\uparrow$$

Note: Most of the non-metal oxides are acidic in nature. Some of them are neutral oxides.

3. Action of water:

Carbon reacts with water to form carbon monoxide and hydrogen.

$$C + H_2O \longrightarrow CO + H_2$$

4. Action of acids on non-metals:

Generally non-metals do not react with acids, but when they are heated with conc.HNO_3 or conc. H_2SO_4, the respective oxides or oxoacids are formed.

$$C + 4HNO_3 \xrightarrow{\text{heat}} 2H_2O + NO_2\uparrow + CO_2\uparrow$$
(conc.)

$$C + 2H_2SO_4 \xrightarrow{\text{heat}} 2H_2O + 2SO_2\uparrow + CO_2\uparrow$$
(conc.)

5. Action of chlorine:

Non-metals react with chlorine to form covalent chlorides.

$$H_2 + Cl_2 \longrightarrow 2HCl$$

$$2P + 3Cl_2 \longrightarrow 2PCl_3$$

$$2P + 5Cl_2 \longrightarrow 2PCl_5$$

6. Oxidising property:

When a reactant loses electrons during a reaction, it is said to be oxidised.

In a chemical reaction between a metal and a non-metal, the metal loses one or more electrons, which are accepted by the non-metal. So the metal is oxidised and the non-metal is reduced. The non-metal acts as an oxidising agent.

$$2Na + Cl_2 \longrightarrow 2NaCl$$

$$2Mg + O_2 \longrightarrow 2MgO$$

ACTIVITY 4.11 — **I DO**

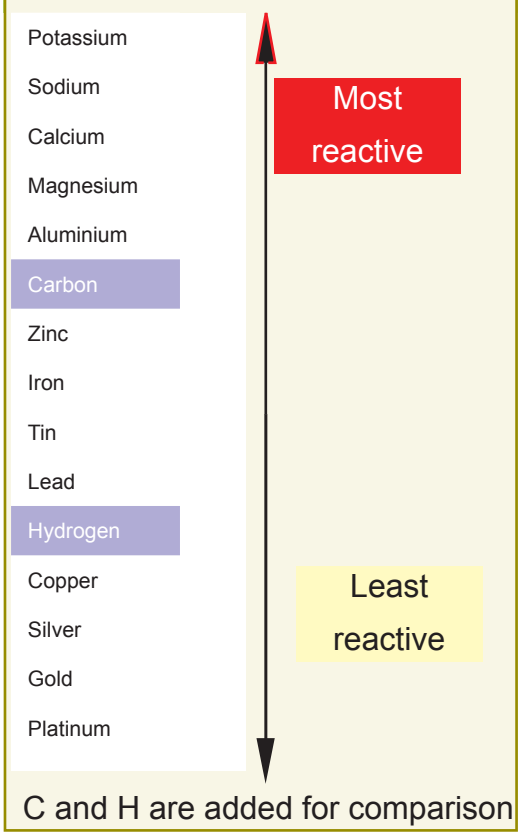
I can classify the following oxides into acidic or basic.

1. *Sodium oxide*
2. *Zinc oxide*
3. *Aluminium oxide*
4. *Carbon dioxide*
5. *Sulphur dioxide*

4.4.4. REACTIVITY SERIES

The reactivity series or activity series is the arrangement of some common metals according to their reactivity. The reactivity of the metals decreases as we go down. The two non-metals, hydrogen and carbon, are included in the series to compare the reactivity of the metals above and below them in specific reactions.

Reactivity series of metals:



C and H are added for comparison

SCIENCE

4.4.5. USES OF REACTIVITY SERIES

1. Highly reactive metals occupy the top portion of the series. They readily react with other chemical compounds. Most of the reactions are exothermic.
2. The electropositive nature of metals decreases as the reactivity decreases. So the reducing nature of metals decreases too.
3. The metals above hydrogen in the reactivity series displace hydrogen from water.
4. The metals above hydrogen in the reactivity series react with dilute acids and liberate hydrogen gas. Lead is an exception.
5. A more reactive metal can displace a less reactive metal from its salt solution.

Example:

$$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$$

6. The reactive metals are susceptible to corrosion.
7. Metals above carbon cannot be extracted from their carbon ores.

4.4.6. ALLOYS

The idea of making alloys is not new. It was known to people of ancient times. Thousands of years ago, people discovered that they could use copper instead of stone to make tools. Around 3500 B.C., people discovered the alloy called “bronze”. They combined tin, a fairly soft metal, with copper to produce bronze. Bronze is a very hard alloy and is used for many purposes. Bronze prove to be a better material, when compared to tin or copper.

An alloy is a homogeneous mixture consisting of two or more metals fused together in the molten state in a fixed ratio.

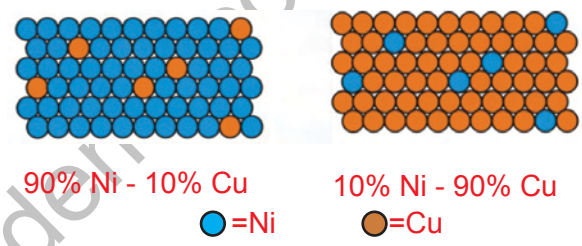
Composition of Alloys

There are two types of alloys. They are,

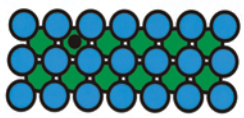
(i) Substitutional alloys

(ii) Interstitial alloys

In substitutional alloys, atoms of one metal randomly take the place of atoms of another metal.



Substitutional alloy



Interstitial alloy

In interstitial alloys, small non-metallic atoms such as H(Hydrogen), B(Boron), C(Carbon) and N(Nitrogen) occupy the holes in the crystal structure of the metal.

MORE TO KNOW

Ferrous alloys contain iron as the base metal.

Non-ferrous alloys contain a little iron or no iron.

MORE TO KNOW

Amalgam is an alloy in which one of the constituents is mercury.

4.4.7. USES OF ALLOYS

Name of the alloy	Metals present in it	Uses
Brass	Copper, Zinc	To make screws, windows and door fittings
Bronze	Copper, Tin	To mould statues, machine parts
Solder	Tin, Lead	In electrical and plumbing industries, to join metal surfaces without melting them.
Steel	Iron, Carbon, Chromium, Nickel, Tungsten	In construction of bridges, buildings, household products, cooking utensils
Duralumin	Aluminium, Copper, Manganese, Magnesium	To manufacture aircraft parts, cars, ships and nails.

Characteristics of alloys

1. An alloy is harder than the metals in it.
2. An alloy enhances the tensile strength of the base metal.
3. An alloy improves corrosion resistance.
4. The density and melting point of the individual metal is different from the density and melting point of the alloy.
5. An alloy enables better castability.

MODEL EVALUATION

Section A

Choose the correct answer:

1. *Classification of elements into two divisions, namely metals and non-metals was first attempted by_____(Dobereiner, Lavoisier, Mendeleev).*
2. *As per Newland's 'Law of Octaves', which of the two elements in the given table have repetition of similar properties?*

1	2	3	4	5	6	7	8
Na	Mg	Al	Si	P	S	Cl	K

3. *In Mendeleev's periodic table, all the elements are sorted by the periodic functions of their _____ (Mass number, Atomic number).*
4. *One of the coinage metals is _____ (Copper, Sodium, Nickel).*
5. *Liquid metal at room temperature is _____ (Mercury, Bromine, Tin).*
6. *Osmium is the heaviest metal. It is _____ (22½, 3, about half) times heavier than iron.*
7. *Metalloids have some metallic properties and some non-metallic properties. An example of a metalloid is_____ (Silicon, Argon, Iodine).*
8. *Complete the reaction: $Mg+O_2 \longrightarrow$ _____.*
9. *Sodium reacts with water and gives sodium hydroxide and _____(O_2, H_2, Cl_2).*

SCIENCE

10. Arrange the following elements in the increasing order of reactivity. (Na, Ca, Mg)
11. Bronze is an alloy of _____ (copper and tin, silver and tin, copper and silver).
12. An alloy used in manufacturing aircraft parts is _____ (solder, brass, duralumin).
13. Write a balanced chemical equation for the reaction between zinc and iron(II) sulphate.
14. Choose the correct word:

    A _____ (more/less) reactive metal displaces a _____ (more/less) reactive metal from its salt solution.
15. From the following metals, pick out the ones which can displace hydrogen from dilute acids. (zinc, copper, calcium, aluminium, gold, silver, magnesium).
16. Which of the following metal does not liberate H_2 from dilute acids? (Zinc , Iron,Tin, Lead)
17. Which of the following metal/metals can be displaced by Zn to form their salt solutions? (Iron, Copper, Silver, Gold)

Section B

1. Mendeleev's periodic table is constructed into vertical columns and horizontal rows.
    a) Mention the name of the vertical columns.
    b) Mention the name of the horizontal rows.
2. In the periodic table, the position of hydrogen is not certain. Give reason.
3. Pick the odd one out:
    a) Coins, Brass, Copper, Gold ornaments
    b) Bromine, Carbon, Hydrogen, Aluminium
4. What is an alloy? Give an example.
5. $2Na + Cl_2 \longrightarrow 2NaCl$
    a) Name the product. b) What is the colour of Cl_2 gas.
6. Complete and balance the following reactions:
    1. $Na + Al_2O_3 \longrightarrow$ _____ 2. $Mg + O_2 \longrightarrow$ _____
    3. $C + HNO_3$ (conc.) $\longrightarrow$ _____ 4. $K + H_2O \longrightarrow$ _____
7. What will happen if a metal reacts with a non-metal?
8. What are the metallic properties shown by the non-metal graphite?

9. Answer the following:

a) Name the alloy that is used to make statues.

b) Write the composition of solder.

10. X and Y are two elements which have similar properties and obey Newland's law of Octaves. How many elements are there between X and Y ?

11. Rewrite the following statements after correction, if necessary.

a) Groups have element with consecutive atomic number.

b) The elements of group II A are called noble gases.

12. An element A has atomic number 20 :

a) Write the electronic configuration.

b) To which group and period does it belong?

c) What is its valency?

13. Arrange the following statements in chronological order.

a) Chemically alike elements could be arranged in a group of three in which atomic mass of the middle element was approximately the arithmetic mean of the two extreme elements.

b) The properties of the element are periodic function of their atomic numbers.

c) The properties of the element are periodic function of their atomic masses.

d) If elements be arranged in the ascending order of their atomic masses, then every eighth element is a kind of repetition of the first one either succeeding or preceding it, like the eighth note in octave of music.

14. List out the metals and non-metals from the following:

Carbon, Sodium,Iron, Iodine, Fluorine, Aluminium.

15. Fill in the blanks.

a) Number of groups in Mendeleev's Periodic Table is _____ (8,9,10)

b) Number of periods in Mendeleev's Periodic Table is _____ (6,7,8)

16. Pick out the alkali metals.

Sodium, Potassium, Calcium, Magnesium, Nickel, Aluminium, Tin, Silicon.

17. Identify the incorrect combinations:

i) Brass	a) Sn, pb	k) construction of bridges
ii) Duralumin	b) Fe, C, Cr, Ni,W	l) plumbing industries to join metal surface
iii) Bronze	c) Cu, Sn	m) statues
iv) Solder	d) Cu, Zn	n) aircraft parts

18. Pick the odd one out and give reasons for your answer.

a) Na_2O b) MgO c) SO_2 d) CaO

19. Before the development of Modern Periodic Table, a German scientist, Dobereiner, noticed that some elements could be grouped into sets of three with similar properties. He called these sets of three elements triads.

Complete the following triads by inserting the missing element.

Chlorine (cl), _____ , Iodine (I)

Lithium (Li), _____ , Potassium (K)

Calcium (Ca), _____ , Barium

20. Give one suitable example to show that:

a) Sodium is a good reducing agent

b) Chlorine is a good oxidizing agent.

Write the balanced equation for the reaction.

21. Name the gases that are released when carbon is heated with concentrated HNO_3 and concentrated H_2SO_4. Write an equation for the reaction.

22. Pick out the incorrect statement regarding the characteristics of alloys:

i) An alloy improves corrosion resistance.

ii) An alloy enhances the tensile strength of the base metal.

iii) An alloy is softer than the metals in it.

iv) An alloy provides better castability.

23. Gallium and Cesium melt when kept on the palm. Why?

Section C

1. Choose one metal or non-metal that fits each of the descriptions given below and name it. Then write a balanced equation for the reaction that takes place.

(i) A metal that burns in oxygen.

(ii) A Non-metal that burns in oxygen and forms a gas which is used to extinguish a fire.

(iii) A metal that reacts gently with dilute hydrochloric acid.

(iv) A metal that displaces Copper from Copper (II) Sulphate solution.

(v) A metal that floats on water and reacts vigorously with it.

(vi) A metal and a non-metal that reacts between themselves and forms common salt.

2. Use the reactivity series:

a) Calcium is not used for household articles.

b) Copper is used for making water pipes and not lead. Why?

c) Powdered magnesium is used in fireworks.

d) Gold is an excellent material for filling the cavity in teeth.

3. The following statements are about elements from the families of alkali metals, alkaline earth metals, transition metals, halogens and noble gases. Identify them.

a) It is a soft silvery metal that reacts violently with cold water.

b) It is a gas at room temperature. It reacts violently with other elements, without heating. It is the most electronegative element.

c) It is a liquid metal with a very low melting point.

d) It is the heaviest metal. It is about nearly 3 times heavier than iron.

e) It is the best conductor of electricity and it is used for making coins along with copper.

f) It is a gas used for inflating aeroplane tyres and it is also used by deep sea divers.

g) It is a metal present in the chlorophyll of a plant and it reacts with steam to form corresponding oxide with the liberation of H_2.

(i) For each of the elements above, say which of the listed families it belongs to.

(ii) Comment on the position of elements a,b,c and g in the modified Mendeleev's Periodic Table.

(iii) Name the elements that fit descriptions a to f.

4. Read the following passage about metals.

Elements are divided into metals and non-metals. All metals are electrical conductors. Many of them have a high density and they are usually ductile and malleable. All these properties influence the way the metals are used. Some metals are sonorous and so they are used for special purposes.

a) Explain the underlined terms?

b) Copper is ductile . How is this property useful in everyday life?

c) Aluminium is hammered and bent to make large structures for use in ships and planes. What property allows it to be shaped like this?

d) Name one metal that has a low density?

e) Some metals are cast into bells. What property must the chosen metals have?

f) Complete the statement with correct words.

Metals are good conductors of _____ and _____.

5. Based on the order of reactivity.

a) Which element is stored in oil?

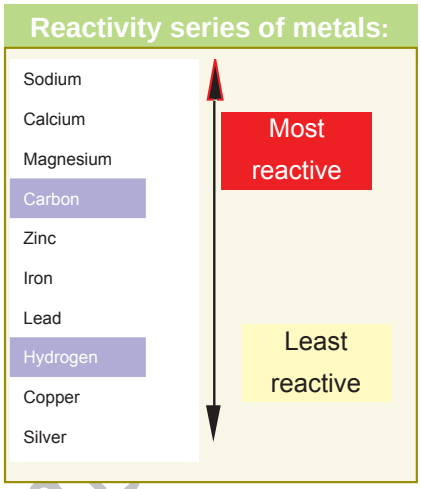
b) Which element will react with cold water?

c) Choose one metal that will react with steam but not with cold water.

d) Name the gas given off during reaction in b and c.

e) Name another reagent that reacts with many metals to emit the same gas.

f) Write balanced chemical equations for the reactions in b, c and e.



6. Based on the order of reactivity of metals, answer the following questions: Iron is more reactive than copper. It removes the sulphate from copper sulphate.

a) Write a word equation for the reaction.

b) Will these react together when heated?

(i) Magnesium + lead (II) oxide.

(ii) Iron + Magnesium oxide.

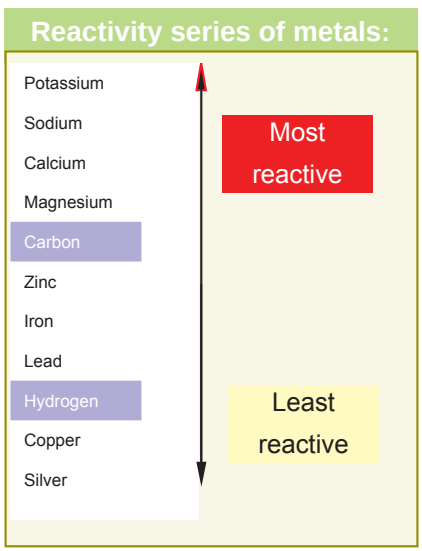
(iii) Zn + iron (III) oxide.

c) For those pairs that react:

(i) Describe what you would see.

(ii) Write a balanced equation.

d) What are the reaction of this type called?



7. *There are 115 elements known till today. Some are metals and some are non-metals. Metals are usually hard, malleable and ductile and have a metallic lustre. Non-metals are usually soft, do not possess lustre and are not malleable and ductile, but iodine is a non-metal which has metallic lustre. Iodine is also important for our body.*

   a) *Why is iodine important for us?*

   b) *Name a non-metal which is a good conductor of heat and electricity.*

   c) *Comment on the statement "Iodised salt is good for health". Give any two reasons.*

8. *Relate the names of the following scientists with the statements given below. (Lavoisier, Dobereiner, Lothar Meyer, Mendeleev, Newlands)*

   a) *Arranged elements with similar chemical properties in a group of three.*

   b) *Arranged elements in the increasing order of their atomic mass.*

   c) *Classified the elements as metals and non-metals.*

   d) *Arranged elements in a groups of seven with increasing atomic masses and eight elements with similar chemical properties kept below the first like eight note in an octave of music.*

   e) *Plotted atomic weight against atomic Volume.*

Further reference:

Book : *Textbook of Inorganic Chemistry - P.L. Soni Sultan Chand & Sons*

Webliography : *http://www.chymist.com* *http://www.khanacademy.org*

5. CHEMICAL BONDS

In a garland, flowers are stringed together with a thread. Unless the flowers are tied, they cannot be held together. The role of the thread is to hold all the flowers together. Similarly, a bond holds the atoms in a molecule together.

Two or more atoms are joined together by a force to form a stable molecule. This force is referred to as a chemical bond.

A chemical bond is defined as a force that acts between two or more atoms to hold them together as a stable molecule.

5.1. OCTET RULE

Gilbert Newton Lewis used the knowledge of electronic configuration of elements to explain "why atoms are joined to form molecules". He visualized that inert (noble) gases have a stable electronic configuration, while atoms of all other elements have an unstable or incomplete electronic configuration.

In 1916, G.N.Lewis gave the "electronic theory of valence". This electronic theory of valence could well be named as the "octet theory of valence".

Atoms interact either by electron-transfer or by electron-sharing, so as to achieve the stable outer shell of eight electrons. This tendency of atoms to have eight electrons in the outer shell is known as the "octet rule" or "Rule of eight".

MORE TO KNOW

Elements with stable electronic configurations have eight electrons in their outermost shell. They are called inert gases.

Ne (Atomic number 10) = 2, 8 and Ar (Atomic number 18) = 2, 8, 8

ACTIVITY 5.2 **I DO**

The following elements have no stable electronic configuration. I can write the electron distribution.

Element	Atomic number	Electron distribution
Sodium		
Carbon		
Fluorine		
Chlorine		

MORE TO KNOW

Lewis used dot-symbols to represent the valence electrons which make bonds.

Lewis Symbol	Electron distribution	Valence electrons
H	(1)	1
Be	(2,2)	2
B	(2,3)	3
C	(2,4)	4
N	(2,5)	5

ACTIVITY 5.1 **I DO**

I can pick out the elements which either share or transfer electrons to obey the octet rule.

1. Helium *2. Argon* *3. Lithium* *4. Chlorine*

SCIENCE

5.2. TYPES OF CHEMICAL BOND

Scientists have recognized three different types of bonds.

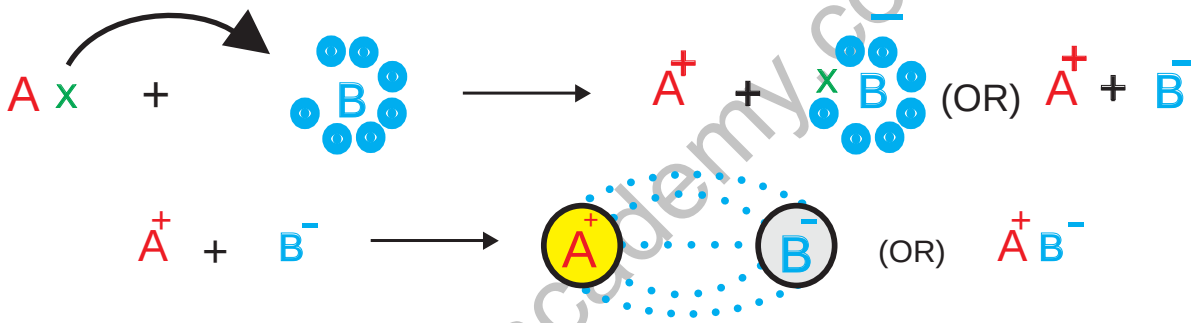
They are:

- Ionic or electrovalent bond
- Covalent bond
- Co-ordinate covalent bond

5.3. FORMATION OF IONIC AND COVALENT BONDS

1. Formation of ionic (or) electrovalent bond

Let us consider two atoms A and B. Atom A has 1 electron in its valence (outermost) shell. Atom B has 7 electrons in its valence shell. A has 1 electron more and B has 1 electron less than the stable octet configuration. Therefore, A transfers an electron to B. In this transaction, both the atoms A and B acquire a stable electron-octet configuration. 'A' becomes a positive ion (cation) and 'B' becomes a negative ion (anion). Both the ions are held together by electrostatic force of attraction. The formation of ionic bond between A and B can be shown as:



Thus the electrostatic attraction between cation (+) and anion (-) produced by electron transfer constitutes an ionic or electrovalent bond. The compounds containing such a bond are referred to as "ionic or electrovalent compounds".

ACTIVITY 5.3 **I DO**

The atom which gives off electron becomes cation and that which accepts electron becomes anion. I can write which atoms form cations or anions.

1. *Lithium*
2. *Sodium*
3. *Fluorine*
4. *Chlorine*

MORE TO KNOW

Electronegativity is the tendency of an atom to attract bonded pairs of electrons towards itself in a molecule.

Electrostatic attraction is found between oppositely charged ions. It is also known as coulombic force of attraction.

Factors favourable for the formation of ionic bond:

(i) Number of valence electrons

The atom A should possess 1, 2 or 3 valence electrons, while the atom B should have 5, 6 or 7 valence electrons.

(ii) Low ionisation energy

If the ionisation energy of A is lower, it easily loses electrons and forms a cation. So, metals which have low ionisation energy tend to form ionic bonds.

(iii) Net lowering of energy

To form a stable ionic compound, there must be a net lowering of energy. In other words, energy must be released as a result of electron transfer from one atom to another.

(iv) Attraction towards electrons

Atoms A and B should differ in their attracting powers towards electrons.

'A' has less attraction for electrons and hence gives off the electron while 'B' has more attraction towards electrons and hence gains electrons.

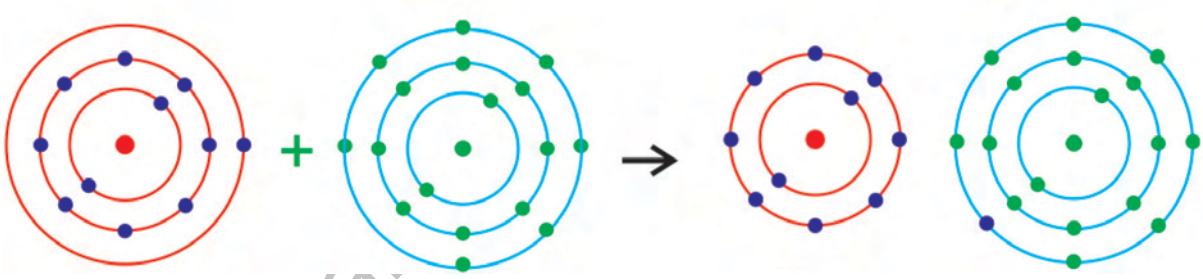
Illustration: 1

Formation of Sodium chloride

Atom	Atomic number	Electron distribution
Sodium	11	2,8,1
Chlorine	17	2,8,7

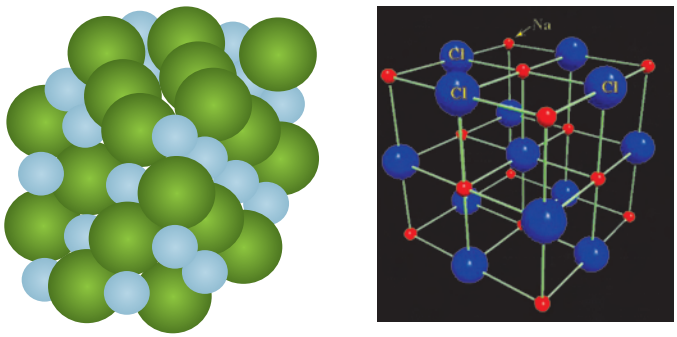
Sodium has one valence electron while chlorine has 7 valence electrons.

Sodium atom transfers the electron to chlorine atom and thus both the atoms achieve stable octet electronic configuration.



2,8,1 Sodium atom (Na) | 2,8,7 Chlorine atom (Cl) | 2,8 Sodium cation (Na^+) | 2,8,8 Chloride anion (Cl^-)

Sodium (Na) becomes sodium cation (Na^+) and chlorine (Cl) becomes chloride anion (Cl^-). Both the ions are joined together by an electrostatic force of attraction to make an ionic bond. In the crystalline state, each Na^+ ion is surrounded by 6 Cl^- ions and each Cl^- ion is surrounded by 6 Na^+ ions.



Structure of sodium chloride

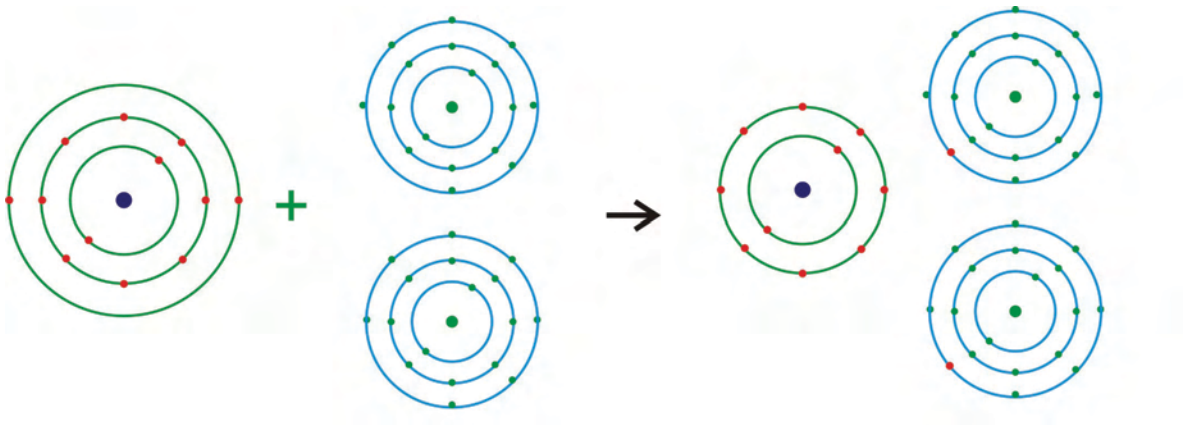
Illustration: 2

Formation of Magnesium chloride

Atoms	Atomic number	Electron distribution
Magnesium	12	2,8,2
Chlorine	17	2,8,7

Magnesium has 2 valence electrons while chlorine has 7 valence electrons. Magnesium atom gives 2 electrons. Each chlorine atom receives one electron and thus all three atoms achieve the stable octet electronic configuration.

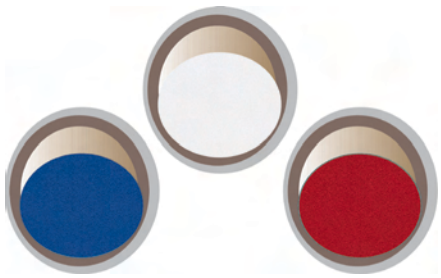
Magnesium atom becomes Mg^{2+} ion and the 2 chlorine atoms become 2 Cl^- ions forming Magnesium chloride as $MgCl_2$.



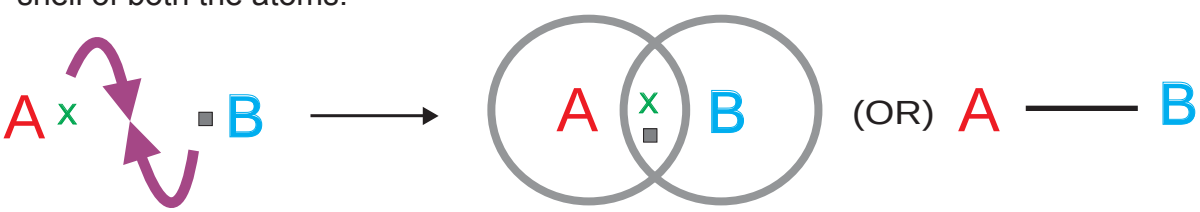
2,8,2 Magnesium atom | 2,8,7 Chlorine atom | 2,8 Magnesium cation | 2,8,8 Chloride anion

2. Formation of Covalent bonds

G.N.Lewis suggested that two atoms could achieve stable 2 or 8 electrons in the outer shell by sharing electrons between them. Atom A has 1 valence electron and atom B has 1 valence electron. As they approach each other, each atom contributes one electron and the resulting electron pair fills the outer shell of both the atoms.



Blue - copper sulphate
White - sodium chloride
Red - cobalt chloride
} Ionic compounds



Thus a shared pair of electrons contributes a covalent bond or an electron pair bond.

The compounds containing a covalent bond are called covalent compounds.

Factors which favour the formation of covalent bond:

(i) Number of valence electrons

A and B should have 5, 6 or 7 valence electrons so that both of them achieve a stable (octet) electronic configuration by sharing 3, 2 or 1 electron pair.

(ii) High ionisation energy

If A has high ionisation energy, it is unable to lose its valence electrons easily. The cation formation is difficult. So A prefers covalent bonding.

(iii) Equal electronegativities

When A and B have equal electronegativities, electron transfer from one atom to another does not take place. Thus the bond formed between A and B is covalent.

(iv) Equal electron gain enthalpy

When A and B have equal electron gain enthalpies, A and B exhibit an equal attraction towards the bonded pair of electrons. So the bond formed between A and B is covalent.

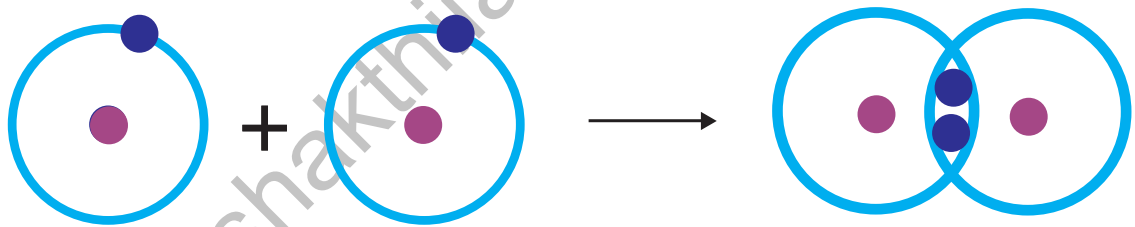
MORE TO KNOW

Multiple bonds enable more atoms to achieve an octet electronic configuration.

Illustration: 1

Formation of hydrogen molecule

Hydrogen molecule is made up of two hydrogen atoms. Each hydrogen atom has one valence electron. Each hydrogen atom contributes an electron to the shared pair and both the atoms attain a stable electronic configuration.

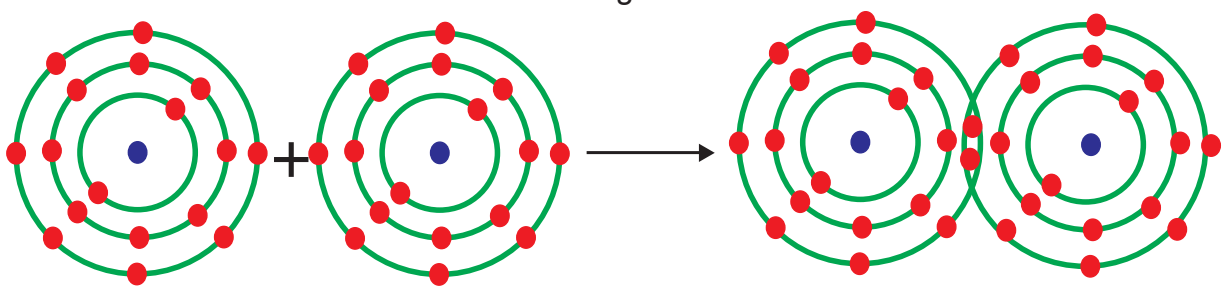


Hydrogen atom Hydrogen atom Hydrogen molecule

Illustration: 2

Formation of chlorine molecule

Each chlorine atom (2, 8, 7) has seven valence electrons. Each of them shares an electron and attains stable electronic configuration.

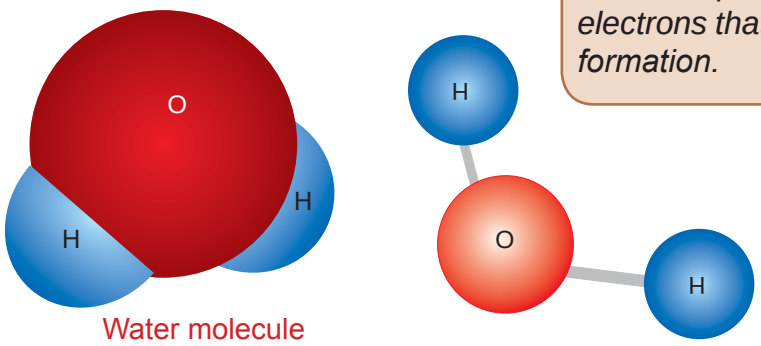


Chlorine atom Chlorine atom Chlorine molecule

SCIENCE

Illustration: 3

Formation of water molecule

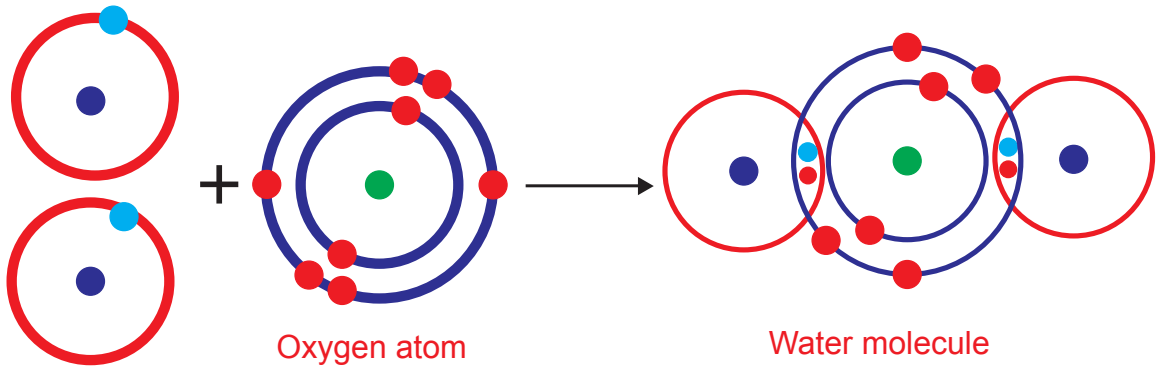


Water molecule

MORE TO KNOW

Lone pair of electrons are the electrons that are not involved in bond formation.

Oxygen atom (2, 6) has six valence electrons. Hydrogen atom has one valence electron each. Oxygen atom shares two electrons, one each with two hydrogen atoms.



Hydrogen atoms

Oxygen atom

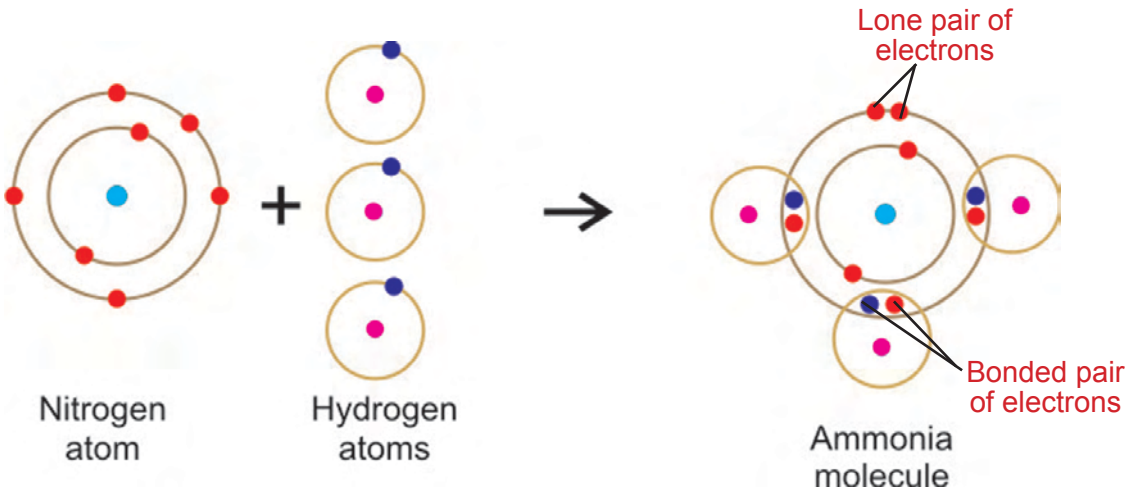
Water molecule

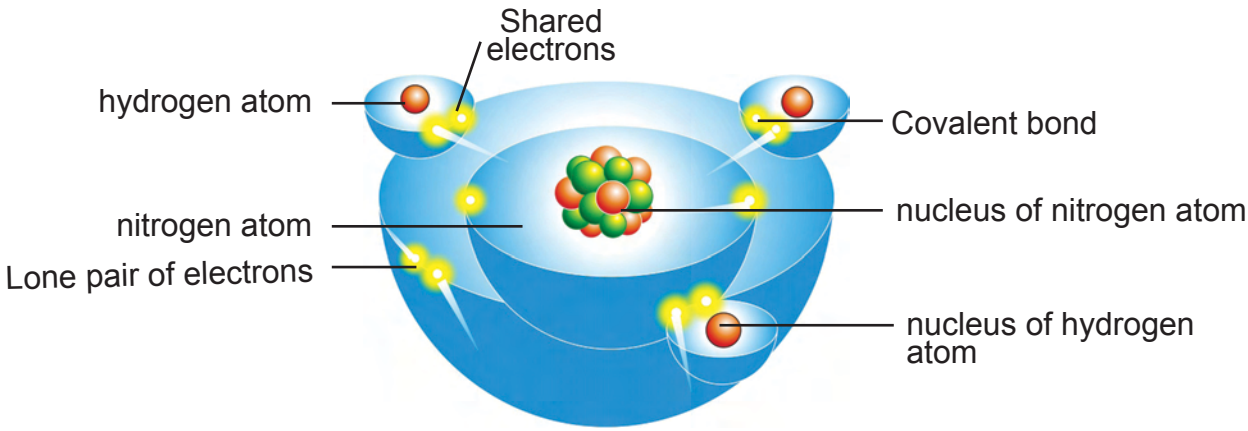
Illustration: 4

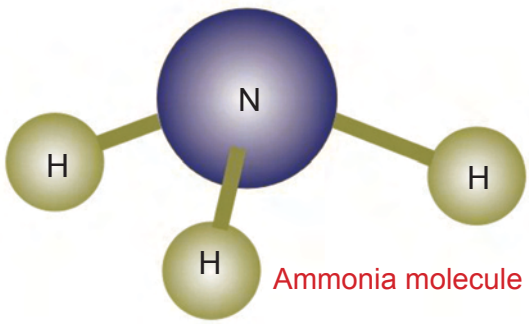
Formation of ammonia molecule

Nitrogen atom (2, 5) has five valence electrons.

Hydrogen atom has one valence electron. Nitrogen atom shares three electrons, one each with three hydrogen atoms.







Ammonia molecule

ACTIVITY 5.4 I DO

I can write the Lewis' formula and predict the number of covalent bonds in:

1. Chlorine *2. Ammonia*

3. Fluorine

5.3.1. COMMON PROPERTIES OF IONIC COMPOUNDS

Solids at room temperature

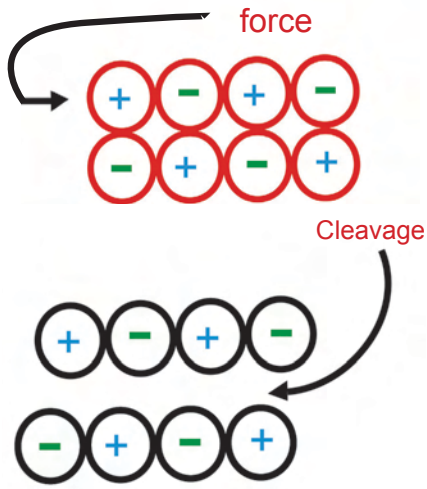
On account of strong electrostatic force between the opposite ions, these ions do not have a free movement. Hence ionic compounds are solid at room temperature.

High melting point

Since the (+) and (-) ions are tightly held in their positions, only at high temperature, these ions acquire sufficient energy to overcome the attractive force causing movement. Hence ionic compounds have high melting point.

Hard and brittle

Their hardness is due to strong electrostatic force of attraction. When external force is applied, a slight shift takes place bringing like-ions in front of each other. It causes repulsion and cleavage.



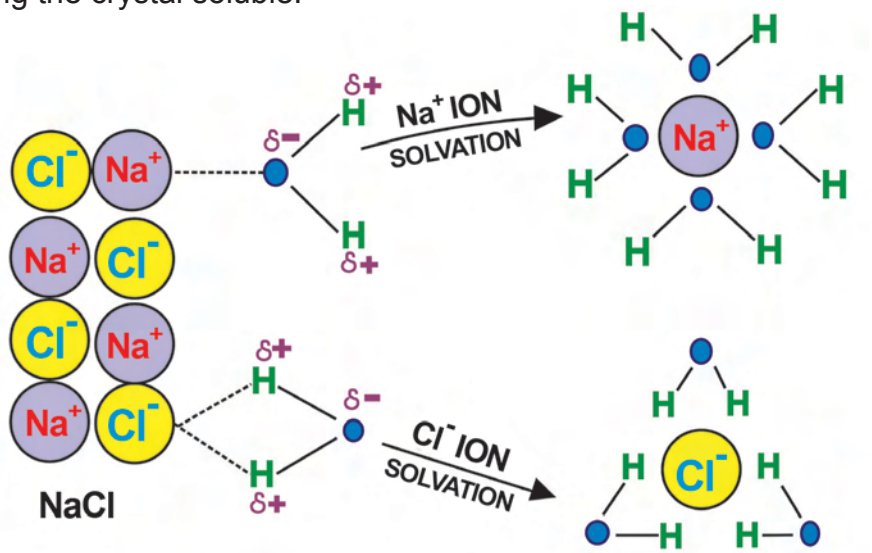
MORE TO KNOW

Refractory materials are heat resistant materials. They have very high melting points. They are used in the extraction of metals from their ores. Some refractory materials are ionic compounds.

SCIENCE

Soluble in water

When a crystal is put in water, the polar water molecules separate the (+) and (-) ions making the crystal soluble.



ACTIVITY 5.5 **WE DO**

1. *We take two beakers.*
2. *We take a little water in one beaker and a little kerosene in another beaker.*
3. *We add sodium chloride salt to each of the beakers.*
4. *We observe the solubility.*

Conductors of electricity

In the solid state, the ions are fixed in their positions. Hence they are poor conductors of electricity. In molten state and in aqueous solutions, the ions are free to move.Therefore, they conduct electricity in molten state or in aqueous solutions.

Ionic reactions are fast

Ionic compounds give reactions between ions. Hence their reactions are fast.

MORE TO KNOW

Bonds in which electron pairs are equally shared are non-polar bonds. Bonds in which electron pairs are not equally shared are polar bonds.

5.3.2. COMMON PROPERTIES OF COVALENT COMPOUNDS

Gases, liquids or solids at room temperature

Due to weak intermolecular forces between the molecules, covalent compounds exist as gases, liquids or relatively soft solids.

Low boiling point

In solids, the molecules are held by weak forces of attraction. When heat is applied, the molecules are readily pulled out and get free movement as in liquids.

Soft solids

A molecular layer in the crystal easily slips relative to adjacent layers. Thus the crystals are easily broken.

Soluble in organic solvents

These compounds readily dissolve in non-polar solvents like toluene, benzene etc. The solvent molecules easily overcome the weak inter-molecular forces of attraction.

ACTIVITY 5.6 **WE DO**

We can classify the following solvents into polar and non-polar.

1. *Benzene*
2. *Water*
3. *Ether*
4. *Chloroform*

ACTIVITY 5.7 **WE DO**

- *We take two beakers of water.*
- *We add sodium chloride in one and paraffin wax in another.*
- *We observe the solubility.*
- *We take two beakers of turpentine.*
- *We add sodium chloride in one and paraffin wax in another.*
- *We observe the solubility.*

Non-conductors of electricity

Since there are no (+) and (-) ions in covalent molecules, they are not capable of conducting electricity in molten state or in solution state.

Molecular reactions are slow

In reaction of covalent compounds, the molecules as a whole undergo a change. Therefore there is no electrical force to speed up the reactions, these reactions are slow.

5.4. DIFFERENCES BETWEEN IONIC AND COVALENT COMPOUNDS

Ionic bond	Covalent bond
Formed by transfer of electrons from a metal to a non-metal atom.	Formed by sharing of electrons between non-metal atoms.
Consists of electrostatic force of attraction between (+) and (-) ions.	Consists of weak force of attraction between atoms.
Non-rigid and non-directional.	Rigid and directional.
Properties of compound	**Properties of compound**
Solids at room temperature.	Gases, liquids or soft solids at room temperature.
Has high melting and boiling points.	Has low melting and boiling points.
Hard and brittle.	Soft and much readily broken.
Soluble in polar solvents and insoluble in organic solvents.	Soluble in non-polar solvents and insoluble in polar solvents.
Conductor of electricity in molten or solution state.	Non-conductor of electricity in molten or solution state.
Undergoes ionic reactions which are fast.	Undergoes molecular reactions which are slow.

SCIENCE

5.5. COORDINATE COVALENT BOND

In a normal covalent bond, the bond is formed by mutual sharing of electrons between the combining elements. If the shared pair of electrons are contributed only by one of the combining elements, the covalent bond is called coordinate covalent bond or coordinate bond or dative bond.

Thus, the coordinate covalent bond is a covalent bond in which both the electrons of the shared pair come from one of the two atoms or ions. The compounds containing a coordinate bond are called coordinate compounds. The atom which donates electron pair is called 'donor atom' and the atom which accepts electron pair is called 'acceptor atom'. A coordinate covalent bond is represented by an arrow '→'.

If an atom 'A' has an unshared pair of electrons (lone pair) and another atom 'B' is in short of two electrons, then a coordinate bond is formed. 'A' donates the lone pair (2 electrons) to 'B' which in turn accepts it.

MORE TO KNOW

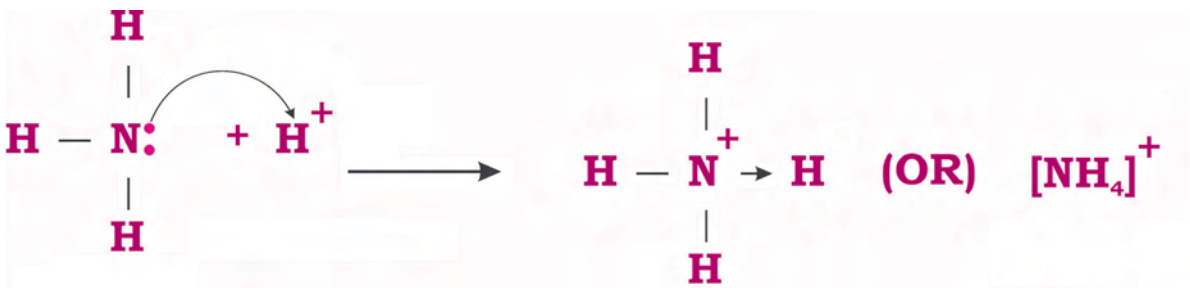
Sharing of two pairs of electrons makes a double bond. Sharing of three pairs of electrons makes a triple bond. These are called multiple covalent bonds.

1. *Carbon dioxide O=C =O (two double bonds)*
2. *Oxygen O=O (one double bond)*
3. *Nitrogen N≡N (one triple bond)*

Illustration

Ammonium ion (NH_4^+)

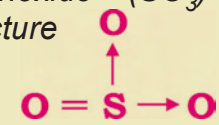
Ammonium ion is formed by the addition of hydrogen ion (H^+) with ammonia (NH_3). In ammonia molecule, the central nitrogen atom is linked to three hydrogen atoms and still nitrogen has an unshared pair of electrons. Nitrogen donates this lone pair of electrons to hydrogen ion of an acid forming ammonium ion.



(Ammonia) (Hydrogen ion) (Ammonium ion)

ACTIVITY 5.8 I DO

Sulphur trioxide (SO_3) has the following structure



I can write how many coordinate linkages are present in this molecule.I can identify the acceptor and the donor atoms.

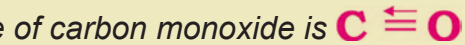
MORE TO KNOW

Under ordinary conditions of temperature and pressure, carbon dioxide is a gas because molecules of carbon dioxide are non-polar.

Water is in a liquid state as a result of the great polarity of water molecules.

ACTIVITY 5.9 I DO

Carbon monoxide is a gas. It is a coordinate compound.

Structure of carbon monoxide is 

I can identify the donor and the acceptor atoms.

5.5.1. COMMON PROPERTIES OF COORDINATE COMPOUNDS

Conductors of electricity

They do not give individual ions in water and are poor conductors of electricity.

Soluble in organic solvents

They are sparingly soluble in water and dissolve in organic solvents.

Melting and boiling points

They are semi polar in nature. They possess melting and boiling points higher than those of purely covalent compounds, but lower than that of ionic compounds.

Exceptions to the Octet Rule

It is true that quite a few molecules had non-octet structure. Atoms in these molecules could have a number of electrons in the valence orbit, in short of the octet or in excess of the octet.

(i) Four electrons around the central atom

Berylliumdichloride ($BeCl_2$)

	Beryllium	Chlorine
Atomic number	4	17
Electron distribution	2,2	2,8,7
Valence electrons	2	7

SCIENCE

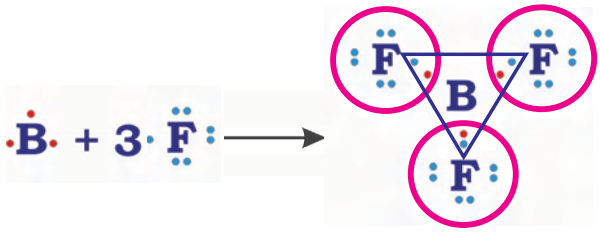
Each chlorine atom is surrounded by 8 electrons but a beryllium atom has only 4 electrons around it.

(ii) Six electrons around the central atom

Borontrifluoride (BF_3)

	Boron	Fluorine
Atomic number	5	9
Electron distribution	2,3	2,7
Valence electrons	3	7

Each fluorine atom is surrounded by 8 electrons but a boron atom has only 6 electrons around it.



ACTIVITY 5.10 **I DO**

The Atomic number of phosphorous is 15. I can write the electron distribution of phosphorous`. The Atomic number of chlorine is 17. I can write the electron distribution of chlorine. One phosphorous atom combines with five chlorine atoms to form phosphorous penta chloride (PCl_5). I can draw the electron dot structure of PCl_5.

MORE TO KNOW

The Nobel Prize in Chemistry 2014 was awarded jointly to the following Scientists "for the development of super-resolved fluorescence microscopy".

Field : Physical Chemistry

Eric Betzig

Born : 1960, Ann Arbor, Michigan, USA.
Affiliation at the time of the award : Janelia Research Campus, Howard Hughes Medical Institute, Ashburn, Virginia, USA.

William E. Moerner

Born : 1953.
Affiliation at the time of the award : Stanford University, Stanford, California, USA.

Stefan W. Hell

Born : 1962, Arad, Romania.
Affiliation at the time of the award : Max Planck Institute for Biophysical Chemistry, Göttingen, Germany, German Cancer Research Center, Heidelberg, Germany.

MODEL EVALUATION

Section A

Choose the correct answer:

1. As per the octet rule, noble gases are stable in nature. This is due to the presence of _____ (eight, seven, six) electrons in their outermost shell.
2. The element that would form cation due to loss of electron during the chemical reaction is _____ (chlorine, lithium, fluorine).
3. The Atomic number of magnesium is 12. Then its electron distribution is _____ (2,2,8 / 2,8,2 / 8,2,2).
4. An element X has 6 electrons in its outermost shell. Then the number of electrons shared by X with another atom to form a covalent bond is _____ (3, 2, 6).
5. The compound that possesses high melting point is _____ (NH_3, NaF).
6. The bond in which the electrons are equally shared is _____ (polar bond, non-polar bond, ionic bond).
7. Pick out the wrong statement about the properties of covalent compounds.

   a) They are neither hard nor brittle. b) Molecular reactions are fast.
8. CH_4 is a /an _____ (covalent / ionic) compound.

Section B

1. NaCl is an ionic compound. How is an ionic bond formed?
2. All the elements tend to attain eight electrons in their outermost shell either by sharing or by transfer of electron. The electronic distribution of X = 2, 7 and Y = 2, 8, 1. What is the bond formed between X and Y? How is it formed?
3. Which of the following compound does not obey the octet rule?

   i. $BeCl_2$ ii. NaCl iii. $MgCl_2$ iv. NH_4Cl
4. Explain coordinate covalent bond with an example.
5. Differentiate an ionic bond from a covalent bond.
6. What is an octet rule?
7. Why are noble gases inert in nature?
8. Draw the electron dot diagram of CH_4 and justify your answer.
9. Find the odd one out:

   a) NaCl, $MgCl_2$, H_2 (based on type of bonding)

   b) Li, Na, F (based on metals and non-metals)

10. Correct the wrong statement.

a) Bonds in which electrons are polar bonds.

b) Sharing of 3 pairs of electrons make a double bond.

11. Match the following:

a) $MgCl_2$ - Co-ordinate Covalent

b) Cl_2 - Ionic Compound

c) NH_4^+ - Covalent Compound

12. Fill in the blanks:

a) If an atom loses an electron, it forms a _____.(Cation/Anion)

b) Ionic compounds are _____ in nature. (solids/liquid)

Section C

1. $Na + Cl \longrightarrow Na^+ + Cl^- \longrightarrow Na^+Cl^-$

(2,8,1) (2,8,7) (2,8) (2,8,8)

The above equation represents the formation of sodium chloride. Observe the equation and answer the following:

a) How many electrons are transferred from Na to Cl?

b) Name the force acting between Na^+ and Cl^-.

c) Name the nearest noble gas to Cl^-.

d) Name the bond between Na^+ and Cl^- .

e) How many electrons are present in Na^+ ion?

2. a) Complete the table:

Atoms	Atomic Number	Electronic Distribution
Na	11	_____
Mg	12	_____
Cl	_____	2,8,7

b) Draw the structure of H_2O and NH_3 molecules.

3. Ionic bond is formed between sodium (Atomic No. 11) and chlorine (Atomic No: 17) to form sodium chloride molecule. Answer the following questions based on this.

   a) How many electrons are present in the sodium atom? Represent it diagrammatically.

   b) Draw the structure of a sodium ion.

   c) How does chlorine become an anion?

   d) Give the two properties of this compound.

   e) Which force exists between sodium and chlorine ions?

   f) Sodium Chloride is a good conductor of electricity in the molten state but does not conduct electricity in the solid state. Give reason.

4. Name the following :

   a) An element which forms triple covalent bond.

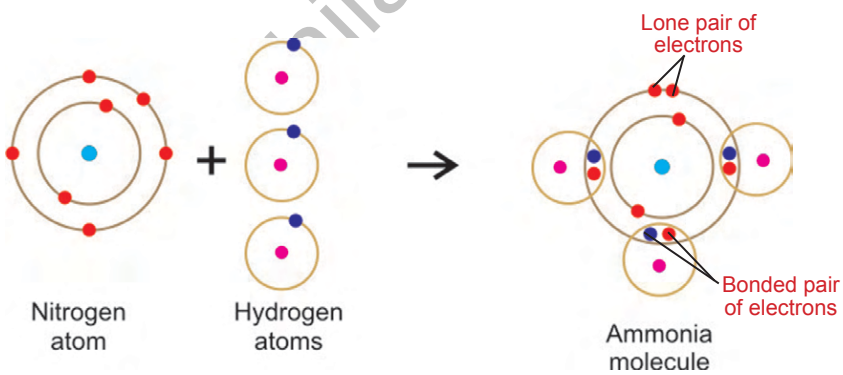
   b) An element which obtains the noble gas configuration of Neon by losing three electrons.

   c) An element which gains two electrons to obtain noble gas configuration of Neon.

   d) Name a compound which is an exception to the octet rule.

   e) In SO_2 molecule, which element is a donor of electrons.

5.



Refer to the diagram of Ammonia molecule and answer the following questions (based on the above diagram).

   a) Name the gas and give its formula.

   b) Which type of bond holds the atoms together?

   c) What happens when the above gas is treated with hydrochloric acid?

   d) What type of bond is formed when Nitrogen donates its lone pair of electrons to Hydrogen ion.

   e) Does ammonia conduct electricity. Why?

SCIENCE

6. *Identify the incorrect statements and correct them.*

   a) *When two elements have equal electro negatives, the electron transfer does not take place from one atom to another.*

   b) *When an element has high Ionisation energy, it prefers to form Ionic bond.*

   c) *The electrons which are not involved in bonding are called valence electrons.*

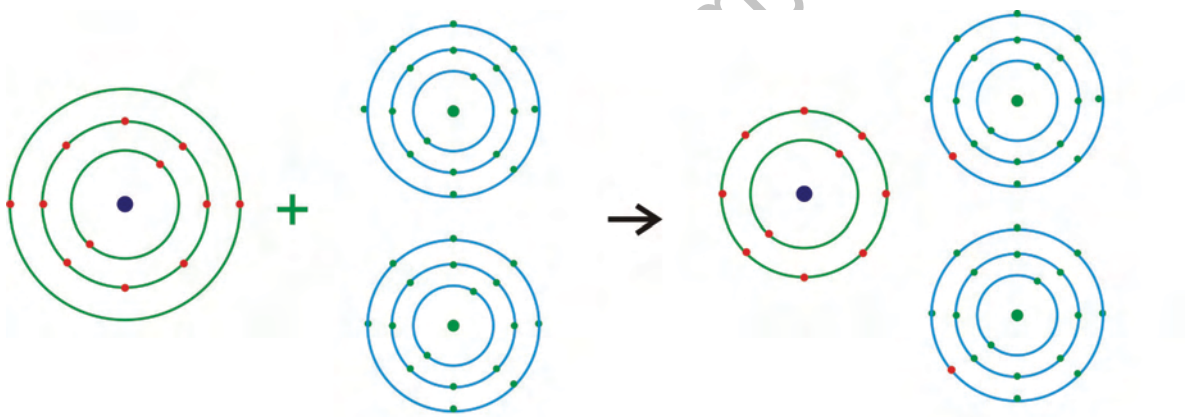
   d) *Benzene is a non polar solvent.*

   e) *Ionic bonds are rigid and directional.*

7. *Complete the following Table:*

Element	Electronic Configuration	Bond it forms	Valency
Magnesium			
Oxygen			
Chlorine			

8. *The following shows the electronic arrangement of two elements, magnesium and chlorine. These elements react to form an ionic compound called magnesium chloride.*



   a) *Answer these questions about magnesium atom and chlorine atom:*

      (i) Do they gain or lose electons, to form an ion?

      (ii) How many electrons are transferred?

      (iii) Is the ion that is formed positive or negative?

      (iv) What is the name of the ion formed?

   b) *Which noble gas configurations do these ions resemble.*

   c) *Name another non-metal that forms an ionic compound with magnesium, in a similar reaction with chlorine.*

9. *Give a single term for the following statements:*

   a) *The tendency of atoms to have eight electrons in the outer shell.*

   b) *Energy required to remove a valence electron to have an isolated atom.*

   c) *The pair of electrons that are not involved in bond formation.*

   d) *Tendency of an atom to attract bonded pairs of electrons towards itself in a molecule.*

   e) *Bonds in which shared electron pair comes from one of the bonded atoms.*

10. a) *The electronic configurations of a neon atom and an argon atom are (2,8) and (2,8,8) respectively. What is special about the outer shell of the neon atom and the argon atom.*

    b) *The electronic configuration of a calcium atom is (2,8,8,2). What must happen to the calcium atom for it to achieve a noble gas structure?*

    c) *Draw a diagram of an oxygen atom. Show eight protons(p), eight neutrons (n) and eight electrons(e).*

    d) *What happens to the outer shell electrons of a calcium atom, when it reacts with an oxygen atom?*

    e) *Name the compound that is formed when calcium and oxygen react together. Which type of bonding does it contain?*

    f) *Write the formula for the compound.*

    g) *Does this compound have a high or low melting point? Explain your answer.*

11. *Which of the following statement is incorrect about coordinate compounds?*

    a) *Sparingly soluble in water.*

    b) *Soluble in organic solvents.*

    c) *Poor conductor of electricity.*

    d) *Their boiling points are higher than ionic compounds.*

SCIENCE

Further reference:

Book : *Essentials of Physical Chemistry - B.S.Bahl,G.D.Tuli,Arun Bahl.S. Chand & Company Ltd*

Webliography : *http://www.beyondbooks.com http://www. visionlearning.com*

SHAKTHII ACADEMY

SCIENCE - CHEMISTRY

STANDARD - TEN

9. Solutions

Result of health drink

Health drink

Anu has got back home from playfield after winning a match. She is received by her mother cheerfully with a glass of health drink.

Anu: Mother! What is this?

Mother: This is your health drink – a solution of fruit juice and sugar for your revitalisation.

Solutions are of great importance in **everyday** life. The process of food assimilation by man is in the form of solution. Blood and lymph are in the form of solution to decide the physiological activity of human beings.

A solution is a homogeneous mixture of two (or) more substances.

All solutions exist in homogeneous form. **Homogeneous** refers to the state in which two (or) more substances, that are uniformly present in a given mixture. If a solution contains two components, then it is called as a **Binary Solution**.

Salt solution containing common salt in water is a suitable example for binary solution.

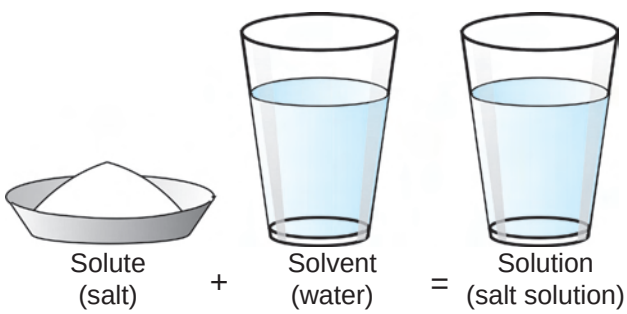


Fig. 9.1 A solution is a homogenous mixture of solute and solvent

9.1. SOLUTE AND SOLVENT

In a solution, the component present in lesser amount by weight is called **solute** and the component present in a larger amount by weight is called **solvent.** Generally a solvent is a dissolving medium. It surrounds the particles of solute to form solution.

In short, a solution can be represented, as follows

(Solute + Solvent → Solution)

9.2. TYPES OF SOLUTIONS

9.2.1. Based on the particle size

Based on the particle size of the substance, the solutions are divided into three types.

1. **True solutions:** It is a homogeneous mixture that contains small solute particles that are dissolved throughout the solvent eg. Sugar in water.

2. **Colloidal solutions:** It is a heterogeneous mixture made up of two phases namely, dispersed phase and dispersion medium. The substance distributed as particles is called **dispersed phase.** The continuous phase in which the colloidal particles are dispersed is called **dispersion medium.**

(Dispersed phase + Dispersion medium → Colloidal solution)

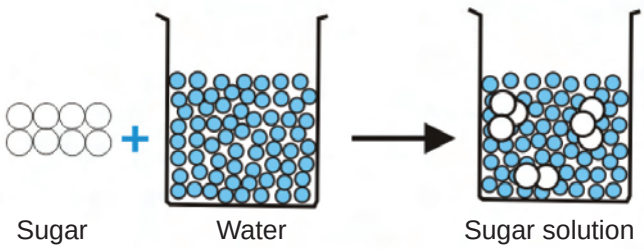
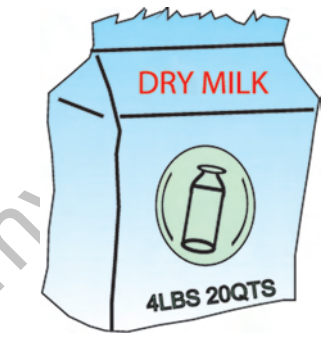
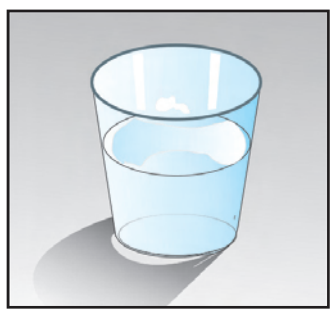


Fig. 9.2 Mixture of sugar and water forming true solution



Fat, vitamin, protein

+



Water

Milk

Fig. 9.3 A mixture of milk powder and water forming colloid

CHAPTER 9

3. Suspensions: It is a heterogeneous mixture of small insoluble particles in a solvent. In a suspension, the particles of solid stay in clusters that are large enough to be seen (e.g. Chalk powder in water).

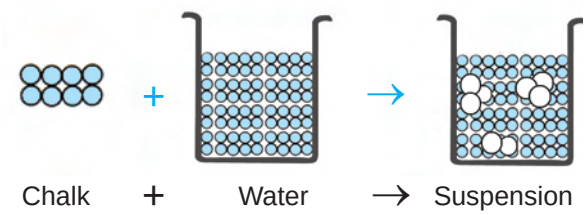


Fig. 9.4 A mixture of chalk and water forming suspension

ACTIVITY 9.1

Students may be asked to observe the scattering of light (Tyndall effect) when sunlight passes through the window of the class rooms. The dust particles scatter the light making the path of the light visible.

Fig. 9.5 Tyndall effect in nature

MORE TO KNOW

Tyndall effect, The phenomenon by which colloidal particles scatter light is called **Tyndall effect**. If a beam of light is allowed to pass through a true solution, some of the light will be absorbed and some will be transmitted. The particles in true solution are not large enough to scatter the light. However if light is passed through a colloid, the light is scattered by the larger colloidal particles and the beam becomes visible. This effect is called TYNDALL EFFECT

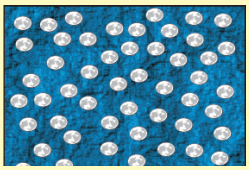
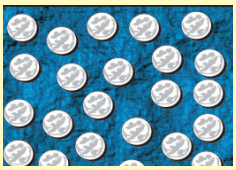
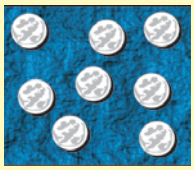
MORE TO KNOW

Brownian movement: The phenomenon by which the colloidal particles are in continuous random motion is called **Brownian movement.**

Brownian motion is named in honour of ROBERT BROWN a biologist.He observed the motion of the particles in suspension of pollen grains in water.

Fig. 9.6 Brownian movement

Comparing the properties of true solution,colloidal solution and suspension

Property	True Solution	Colloidal Solution	Suspension
Particle size in A^o ($1A^o = 10^{-10}m$)	 $1A^o$ to $10\ A^o$	 $10A^o$ to $2000\ A^o$	 More than $2000\ A^o$
Appearance	Transparent	Translucent	Opaque
Visibility of particles	Not visible even under ultra microscope	Visible under ultra microscope	Visible to the naked eye
Nature	Homogeneous	Heterogeneous	Heterogeneous
Diffusion of particles	diffuses rapidly	diffuses slowly	diffusion does not occur
Scattering effect	Does not scatter light	It scatters light	It does not scatter light

9.2.2. Based on the type of solvent

Based on the type of solvent solutions are classified into two types

1. **Aqueous solution:** The solution in which water acts as a solvent, is called **aqueous solution**. For e.g., sugar solution.
2. **Non-aqueous solution:** The solution in which any liquid other than water acts as a solvent is called **non-aqueous solution**. Solution of sulphur in carbon disulphide is a suitable example for non-aqueous solution. (Benzene, ether, CS_2, are some of the examples for non aqueous solvents.)

9.2.3. Based on the amount of solute in the given solution

Based on the amount of solute in the given amount of solvent, solutions are classified into the following types.

1. Unsaturated solution
2. Saturated solution
3. Super saturated solution

1. **Unsaturated solution:** A solution in which the solute is in lesser amount in comparison with the solvent is called unsaturated solution. In this, addition of solute is possible till the solution reaches the point of saturation.

   e.g., 5g or 10g or 20g of NaCl in 100g water

2. **Saturated solution:** A solution in which no more solute can be dissolved in a definite amount of solvent at a given temperature is called a saturated solution e.g.,

i) A saturated solution of CO_2 in H_2O

ii) 36g of NaCl in 100g of water at room temperature forms saturated solution

3. **Super saturated solution:** A solution which has more of solute at a given temperature than that of saturated solution is called **super saturated solution**.

MORE TO KNOW

Nitrogen in earth soil is an example for saturated solution in nature. (Earth soil cannot store more N_2 than it can hold)

ACTIVITY 9.2

Test whether a solution is saturated, unsaturated or super-saturated with respect to the addition of salt at a particular temperature to the solution.

Take a glass containing 100ml of water, three packets of salts each weighing 20g, 16g, and 1g and a table spoon (see fig 9.7).

Record your observations after the addition of each packet in the given order followed by stirring at each stage.

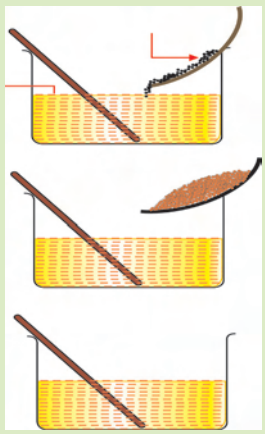


Fig. 9.7 To test Unsaturation, Saturation and Super Saturation in a given solution

9.2.4 Based on the physical state of the solute and the solvent the solutions are of 9 types

Solute	Solvent	Examples
Solid	Solid	Alloys
Solid	Liquid	Sugar solution
Solid	Gas	smoke
Liquid	Solid	cheese
Liquid	Liquid	Milk
Liquid	Gas	Cloud
Gas	Solid	Cork
Gas	Liquid	Soda water
Gas	Gas	Helium-oxygen mixture (for deep sea diving)

CHEMISTRY

9.3. SOLUBILITY

Solubility of a solute in a given solvent at a particular temperature is defined as the number of grams of solute necessary to saturate 100g of the solvent at that temperature. For example

Solubility of $CuSO_4$ in H_2O is 20.7g at 20°C

MORE TO KNOW

Dilute and concentrated solutions: Concentration of a solution is the amount of solute dissolved in a given amount of solvent. A solution containing less amount of solute is known as dilute solution whereas a solution containing large amount of solute is known as concentrated solution. It may be noted that dilute and concentrated are the relative terms and they have only quantitative meaning.

ACTIVITY 9.3

Determine the solubility of a solid (say KCl) in water at room temperature.

- Prepare saturated solution of KCl in about 30 ml of water at room temperature. Add more of KCl ensuring that solution is saturated and some KCl is left undissolved.
- Filter the solution to remove solid KCl.
- Find temperature of the solution by dipping a thermometer in it.
- Evaporate the solution to dryness by using a low flame to avoid bumping.
- Allow the dish and solid to cool to room temperature. Place the dish and solid in a dessicator containing anhydrous calcium chloride (calcium chloride is dehydrating agent, it absorbs moisture).

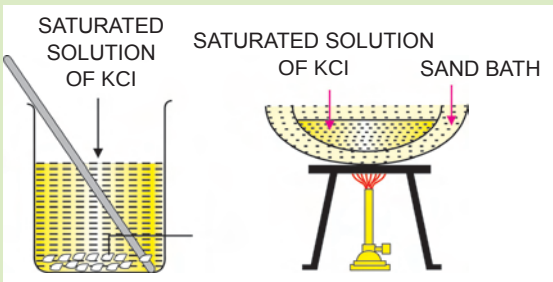


Fig. 9.8 Determination of solubility

- Take out the evaporating dish and again weigh it.
- The observation and calculation are given as follows.

Observation

Weight of the dish = W g

Weight of dish + saturated solution of KCl = W_1 g

Weight of dish + dry KCl = W_2 g

Calculation

Weight of saturated solution = $(W_1 - W)$ g

Weight of KCl = $(W_2 - W)$ g

Weight of water present in saturated solution

$= [(W_1 - W) - (W_2 - W)]$ g

$= [(W_1 - W_2)$ g

$$\text{Solubility of KCl} = \frac{\text{Weight of KCl}}{\text{Weight of solvent}} \times 100$$

$$= \frac{(W_2 - W)}{(W_1 - W_2)} \times 100$$

CHAPTER 9

Tit Bit

100ml of water can dissolve 36g of NaCl at 25^{0}C to attain saturation.

Solubility of some ionic compounds at 25°c

Substance	Solubility (g per 100g water)
NaCl	36 g
NaBr	95 g
NaI	184 g
$NaNO_3$	92 g

9.4. FACTORS AFFECTING SOLUBILITY

1. Temperature
2. Nature of solute (or) solvent
3. Pressure

1. Effect of Temperature

In endothermic process, solubility increases with increase in temperature.

e.g., Solubility of KNO_3 increases with the increase in temperature.

In exothermic process, solubility decreases with increase in temperature.

e.g., Solubility of CaO decreases with increase in temperature.

2. Nature of solute and solvent

Solubility of a solute in a solvent depends on the nature of both solute and solvent. A polar compound dissolves in a polar solvent.

e.g., Common salt dissolves in water. A polar compound is less soluble (or) insoluble in a non polar solvent.

3. Effect of pressure

Effect of pressure is observed only in the case of gases. An increase in pressure increases the solubility of a gas in a liquid. For eg. CO_2 gas is filled in soft drinks using the effect of pressure.

Fig. 9.9 CO_2 filled in soft drinks

MORE TO KNOW

Increase in pressure increases the solubility of gases. At a given temperature, the mass of gas dissolved in a fixed volume of liquid is directly proportional to the pressure of the gas on the surface of the liquid. This is called **Henry's Law.**

PROBLEM 1

Take 10g of common salt and dissolve it in 40g of water. Find the concentration of solution in terms of weight percent.

Weight percent

$$= \frac{\text{Weight of the solute}}{\text{Weight of solute + Weight of solvent}} \times 100$$

$$= \frac{10}{10 + 40} \times 100 = 20\%$$

PROBLEM 2

2g of potassium sulphate was dissolved in 12.5 ml of water. On cooling, the first crystals appeared at 60°C. What is the solubility of potassium sulphate in water at 60°C?

SOLUTION

12.5 ml of water weighs 12.5g.

In 12.5g of water, amount of potassium sulphate dissolved, is 2g

In 1g of water, amount of potassium sulphate dissolved, is 2/12.5 g

Hence in 100g of water, amount of potassium sulphate dissolved, is (2 x 100)/12.5=16g.

The solubility of potassium sulphate in water at 60ºC is 16g.

PROBLEM 3

50g of saturated solution of NaCl at 30ºC is evaporated to dryness when 13.2g of dry NaCl was obtained. Find the solubility of NaCl at 30ºC in water.

Mass of water in solution = 50-13.2 = 36.8g

Solubility of NaCl =

$$\frac{\text{Mass of NaCl}}{\text{Mass of water}} \times 100 = \frac{13.2}{36.8} \times 100 = 36g$$

Solubility of NaCl = 36g (appx.)

PROBLEM 4

An empty evaporating dish weighs 20.0g On the addition of saturated solution of $NaNO_3$, the dish weighs 66.0g. When evaporated to dryness, the dish with crystals weighs 41.5g. Find the solubility of $NaNO_3$ at 20ºC.

SOLUTION

Weight of saturated solution of $NaNO_3$ = (66.0 – 20.0) g = 46.0g

Weight of crystals of $NaNO_3$ = (41.5-20.0) g = 21.5g

Weight of water in saturated solution = (46.0-21.5) g = 24.5g

Solubility of $NaNO_3$ =

$$\frac{\text{Weight of } NaNO_3 \text{ Crystals}}{\text{Weight of water}} \times 100$$

$$= \frac{21.5}{24.5} \times 100 = 87.7g$$

Solubility of $NaNO_3$ at 20ºC is = 87.7g in 100g H_2O

EVALUATION

PART - A

1. A true solution is a homogeneous mixture of solute and solvent. Chalk powder in water is a heterogenous mixture. Is it a true solution?
2. Solution that contains water as the solvent is called aqueous solution. If carbon disulphide is a solvent in a given solution, then the solution is called _____.
3. Solubility of common salt in 100g water is 36g. If 20g of salt is dissolved in it how much more is required to attain saturation.
4. If two liquids are mutually soluble, they are called _____ liquids. (miscible, immiscible)
5. When sunlight passes through window of the classrooms its path is visible. This is due to _____of light. (reflection, scattering)
6. The particles in various forms are visible only under ultramicroscope. A solution containing such particles is called _____. (True solution, colloidal solution)
7. The mixture of gases used by deep sea divers is _____(Helium-oxygen, oxygen-nitrogen)
8. Earth soil cannot store more nitrogen than it can hold. Hence earth soil is referred to be in a state of _____. (saturation, unsaturation)
9. In an endothermic process, solubility increases with _____ in temperature. (increase, decrease)

PART - B

10. From the table given below, furnish your points of inferences.

Substance	Solubility at 25°C
NaCl	36g
NaBr	95g
NaI	184g

11. Distinguish between the saturated and unsaturated solution using the data given below at a temperature of 25°C

    A. 16g NaCl in 100g water
    B. 36g NaCl in 100g water

Note : Solubility of NaCl is 36g

12. You have prepared a saturated solution of sugar at room temperature. Is it possible to dissolve some more grams of sugar to this solution? Justify your stand.
13. Find the concentration of solution in terms of weight percent if 20 gram of common salt is dissolved in 50 gram of water.

FURTHER REFERENCE :

Books : 1. Physical Chemistry by : **Puri & Sharma** - Vishal Publication
2. Advanced Chemistry by: **Bahl & Arun Bahl** - S.Chand publishers

Website : www.chemistry explained.com www.sparknotes.com

10. Atoms and molecules

ATOMS AND MOLECULES

Rani shows a piece of chalk to Vani & asks her to break it into minute particles. The breaking spree, goes on and on endlessly and finally they come to conclude that the minute particle is a group of invisible atoms. They get set to probe further.

EXPLORING THE ATOM

The word atom is derived from the Greek word **"Atomos"** which means indivisible. John Dalton modelled atoms as hard indivisible spheres.

His theory remained undisputed for about a century without any changes. However towards the end of 19th and in the beginning of 20th centuries, the introduction of matter wave concept by de Broglie, the principle of uncertainty by Heisenberg etc., paved the way for **modern atomic theory or modified atomic theory.**

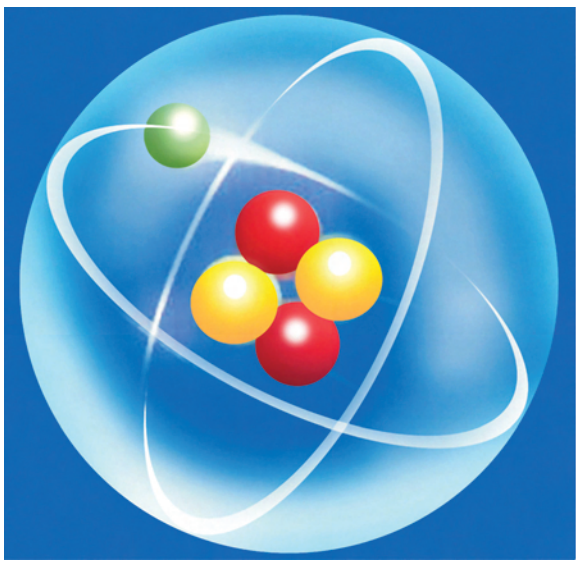


Fig. 10.1 Inner View of an atom

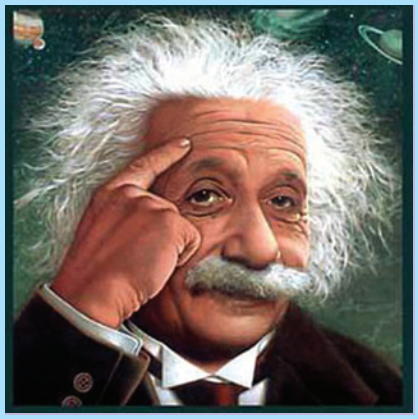
CHAPTER10

10.1. MODERN ATOMIC THEORY

The findings of **modern atomic theory** are given as follows.

- Atom is considered to be a divisible particle.
- Atoms of the same element may not be similar in all respects.
  eg: Isotopes ($_{17}Cl^{35}$, $_{17}Cl^{37}$)
- Atoms of different elements may be similar in some respects
  eg. Isobars ($_{18}Ar^{40}$; $_{20}Ca^{40}$)
- Atom is the smallest particle which takes part in chemical reactions.
- The ratio of atoms in a molecule may be fixed and integral but may not be simple
  e.g., $C_{12}H_{22}O_{11}$ is not a simple ratio (Sucrose)

ALBERT EINSTEIN



When a nuclear reaction occurs the mass of the product is found to be less than the mass of the reactants. The difference in mass is converted into energy in accordance with the equation $E = mc^2$, where E = energy liberated, m = disappeared mass and c = speed of light. This famous equation of Einstein, made revolution in nuclear science.

- Atoms of one element can be changed into atoms of other element by transmutation.
- The mass of an atom can be converted into energy. This is in accordance with Einstein's equation $E = mc^2$

10.2. AVOGADRO'S HYPOTHESIS

Amedeo Avogadro put forward hypothesis and is based on the relation between number of molecules and volume of gases.

Avogadro's Law: Equal volumes of all gases under the same conditions of temperature and pressure. contain the equal number of molecules.

10.2.1. Atomicity

The number of atoms present in one molecule of an element is called the atomicity of an element.

Depending upon the number of atoms in one molecule of an element, molecules are classified into monoatomic, diatomic, triatomic, and poly atomic molecules.

For any homo atomic molecule atomicity can be deduced using the formula

$$\text{Atomicity} = \frac{\text{Molecular Mass}}{\text{Atomic mass}}$$

Avogadro's Law enables us to change over directly from a statement about volume of gases to a statement about molecules of gases and vice-versa.

MORE TO KNOW

Isotopes ⇒ These are the atoms of same element with same atomic number (Z) but different mass number (A). example ($_{17}Cl^{35}$, $_{17}Cl^{37}$)

Isobars ⇒ These are the Atoms of the different element with same mass number but different atomic number. example ($_{18}Ar^{40}$, $_{20}Ca^{40}$)

Isotones ⇒ These are the atoms of different elements with same number of neutrons Example : ($_{6}C^{13}$, $_{7}N^{14}$)

Atomicity	No. of atoms per molecule	Eg
Monoatomic	1	Helium (He) Neon (Ne) Metals
Diatomic	2	Hydrogen H_2 Chlorine Cl_2
Triatomic	3	Ozone (O_3)
Polyatomic	>3	phosphorous P_4 Sulphur S_8

e.g.,

N_2 + O_2 → 2 NO

Nitrogen (1 Vol) Oxygen (1 Vol) Nitric oxide (2 Vols)

After applying Avogadro's Law, the equation,becomes

N_2 + O_2 → 2 NO

1 Molecule 1 Molecule 2 Molecules

MORE TO KNOW

Avogadro an Italian Scientist (1766 – 1856) He was the One to propose that volume of a gas at a given temperature and pressure is proportional to the number of particles.

TEST YOUR UNDERSTANDING SKILL

1. Find the atomicity of chlorine if its atomic mass is 35.5 and its molecular mass is 71
2. Find the atomicity of ozone if its atomic mass is 16 and its molecular mass is 48

It is found that two molecules of nitric oxide contains 2 atoms of nitrogen and 2 atoms of oxygen.

These two atoms of nitrogen and the two atoms of oxygen should have come from 1 molecule of nitrogen and 1 molecule of oxygen, respectively.

CHAPTER10

Hence, nitrogen and oxygen are called **diatomic molecules** and are written as N_2 and O_2.

This proves that, atomicity of Nitrogen is 2 and the atomicity of oxygen is 2

Thus Avogadro's hypothesis is used in the deduction of atomicity of elementary gases.

To establish the relationship between vapour density and relative molecular mass of a gas

i. **Relative Molecular Mass:** It is defined as the ratio of the mass of 1 molecule of the gas or vapour to the mass of 1 atom of hydrogen.

$$\text{Relative molecular mass of a gas} = \frac{\text{Mass of 1molecule of the gas or vapour}}{\text{Mass of 1 atom of hydrogen}}$$

ii. **Vapour Density (V.D):** It is defined as the ratio of the mass of a certain volume of the gas or vapour to the mass of the same volume of hydrogen at the same temperature and pressure.

$$\text{V.D} = \frac{\text{Mass of 1 volume of gas or vapour}}{\text{Mass of 1 volume of hydrogen}}$$

Applying Avogadro's Law,

$$\text{V.D} = \frac{\text{Mass of 1 molecule of gas or vapour}}{\text{Mass of 1 molecule of hydrogen}}$$

Since hydrogen is diatomic,

$$\text{V.D} = \frac{\text{Mass of 1 molecule of gas or vapour}}{2 \times \text{Mass of 1 atom of hydrogen}}$$

Multiplying both sides by 2, we get

$$2 \times \text{V.D} = \frac{\text{Mass of 1 molecule of gas or vapour}}{\text{Mass of 1 atom of hydrogen}}$$

2 x V.D = relative molecular mass of a gas or vapour

2 x Vapour density = Relative molecular mass

How to arrive at the value of *GRAM MOLAR VOLUME (GMV)*

$$GMV = \frac{GRAM\ MOLAR\ MASS}{DENSITY\ OF\ GAS\ AT\ STP}$$

To find the value of

$$\text{GMV OF OXYGEN} = \frac{\text{GMM of } O_2}{\text{DENSITY OF } O_2}$$

$$= 32/1.429$$

$$= 22.4 \text{ lit}$$

Therefore GMV = 22.4 litre at STP

MORE TO KNOW

Gay-Lussac's law of Combining volumes of gases

Whenever gases react, they do so in volumes which bear a simple ratio to one another, and to the volumes of the gaseous products, provided all the volumes are measured under the same conditions of temperature and pressure.

Applications of Avogadro's law

1. It is used to determine the atomicity of gases.

2. It is helpful in determining the molecular formula of gaseous compound.
3. It establishes the relationship between the vapour density and molecular mass of a gas.
4. It gives the value of molar volume of gases at STP. Molar Volume of a gas at STP=22.4 lit (or) 22400 cm^3.
5. It explains Gay Lussac's law effectively.

10.3. ATOMS AND MOLECULES

Atoms and molecules are the building blocks of the matter.

10.3.1. Atom: It is the ultimate particle of an element which may or may not have independent existence. The atoms of certain elements such as hydrogen, oxygen, nitrogen, etc.do not have independent existence whereas atoms of helium,neon,argon,etc. do have independent existence. All elements are composed of atoms.

10.3.2. Molecule: A molecule is the simplest structural unit of an element (or) a compound which contains one (or) more atoms. It retains the characteristics of an element.

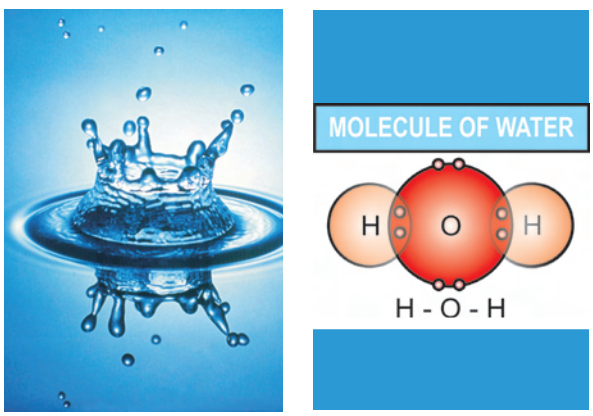


Fig 10.2 Molecule of water

POINT TO EXPLORE

Name the elements and find their number of atoms in one molecule of a) Nitrogen b) Water c) Ammonia d) Sulphuric acid.

A molecule can exist freely and it is a combined form of bonded units whereas an atom is a singular smallest form of non bonded unit.

10.3.3. Differences between atom and molecule:

Atom	Molecule
The smallest particle of an element that can take part in a chemical reaction.	The smallest particle of an element or a compound that can exist freely.
An atom is a non bonded entity	A molecule is a bonded entity
An atom may or may not exist freely	A molecule can exist freely

Molecules are of two types, namely homo atomic molecules and hetero atomic molecules.

1. Homo atomic molecules

These are the molecules which are made up of atoms of the same element.

Most of the elementary gases consist of homo atomic molecules. For example hydrogen gas consists of two atoms of hydrogen (H_2).Similarly oxygen gas consists of two atoms of oxygen (O_2). In accordance with the number of atoms present in these molecules they are classified as monoatomic, diatomic, triatomic or poly atomic molecules showing that they contain one, two, three, or more than three atoms respectively.

2. HETRO ATOMIC MOLECULES

The hetro atomic molecules are made up of atoms of different elements. They are also classified as diatomic, triatomic, or polyatomic molecules depending upon the number of atoms present. H_2O, NH_3, CH_4, etc., are the examples for hetero atomic molecules.

10.4. RELATIVE ATOMIC MASS (RAM)

$$\text{RAM} = \frac{\text{Mass of 1 atom of an element}}{\text{Mass of 1 atom of hydrogen}}$$

10.4.1. Definition (based on hydrogen scale)

The relative atomic mass of an element is the ratio of mass of one atom of the element to the mass of one atom of hydrogen taken as standard.

10.4.2. Definition (based on carbon scale)

$$\text{RAM} = \frac{\text{Mass of 1 atom of an element}}{\frac{1}{12}\text{ th part of the mass of one atom of carbon}}$$

Relative atomic mass of an element is the ratio of mass of one atom of element to the **1/12**th part of mass of one atom of carbon.

Relative atomic mass is a pure ratio and has no unit. If the atomic mass of an element is expressed in grams, it is known as **gram atomic mass.**

e.g.,

Gram atomic mass of hydrogen = 1g

Gram atomic mass of carbon = 12g

Gram atomic mass of nitrogen = 14g

Gram atomic mass of oxygen = 16g

Gram atomic mass of sodium = 23g

Atomic mass is expressed in atomic mass unit (**amu**). **One atomic mass unit is defined as 1/12th part of the mass of one atom of carbon.**

10.5. RELATIVE MOLECULAR MASS(RMM)

Definition (based on hydrogen scale)

$$\text{RMM} = \frac{\text{Mass of 1 molecule of an element / compound}}{\text{Mass of 1 atom of hydrogen}}$$

The relative molecular mass of an element or a compound is the ratio of mass of one molecule of the element or a compound to the mass of one atom of hydrogen.

Definition (based on carbon scale)

$$\text{RMM} = \frac{\text{Mass of 1 molecule of an element / compound}}{\frac{1}{12}\text{ th part of the mass of one atom of carbon}}$$

The relative molecular mass of an element or a compound is the ratio of mass of one molecule of the element or a compound to the mass of 1/12 th part of mass of one atom of carbon.

Relative Molecular mass is a pure ratio and has no unit. If the molecular mass of a given substance is expressed in gram, it is known as **gram molecular mass** of that substance.

Molecular mass is the sum of the masses of all the atoms present in one molecule of the compound or an element.

Gram molecular mass calculations to test your numerical skill

1. Find the gram molecular mass of water (H_2O)

calculation

$2(H) = 2 \times 1 = 2$

$1(O) = 1 \times 16 = 16$

18

∴ **Gram molecular mass of H_2O = 18g**

2. Find the gram molecular mass of carbon dioxide (CO_2)

$1(C) = 1 \times 12 = 12$

$2(O) = 2 \times 16 = 32$

44

Gram molecular mass of CO_2 = 44 g

10.6. MOLE CONCEPT

While performing a reaction, to know the number. of atoms (or) molecules involved, the **concept of mole** was introduced. The quantity of a substance is expressed in terms of mole.

Shown here in Fig.10.3 are one mole quantities of each of the following materials: (clockwise from top left) 180g of acetylsalicylic acid (aspirin), 18.0g of water, 342g of sucrose (table sugar), 201g

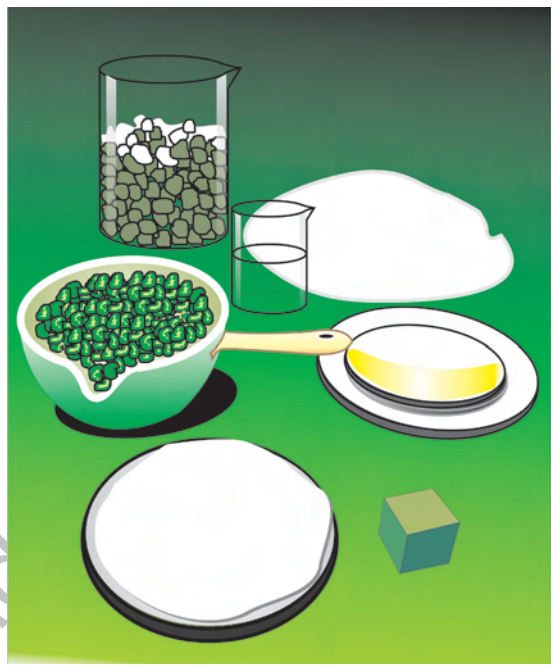


Fig. 10.3 Mole in various forms

of mercury, 55.9g of iron, 58.5g of sodium chloride (table salt), and 254g of iodine.

10.6.1. Definition of mole

Mole is defined as the amount of substance that contains as many specified elementary particles as the number of atoms in 12g of carbon-12 isotope.

One mole is also defined as the amount of substance which contains Avogadro number (6.023×10^{23}) of particles.

Avogadro number: Number of atoms or molecules or ions present in one mole of a substance is called Avogadro number. Its value is 6.023×10^{23}.

CHAPTER10

Therefore, one mole of any substance contains Avogadro number of particles. The particles may be atoms, molecules, ions etc.,

For eg. one mole of oxygen atoms represents 6.023×10^{23} atoms of oxygen and 5 moles of oxygen atoms contain $5 \times 6.023 \times 10^{23}$ atoms of oxygen.

To find the number of moles, the following formulae are useful

$$\text{Number of moles} = \frac{\text{Mass}}{\text{atomic mass}}$$

$$\text{Number of moles} = \frac{\text{Mass}}{\text{molecular mass}}$$

$$\text{Number of moles} = \frac{\text{No. of atoms}}{6.023 \times 10^{23}}$$

$$\text{Number of moles} = \frac{\text{No. of molecules}}{6.023 \times 10^{23}}$$

WATCH OUT !

It may be noted that while using the term mole it is essential to specify the kind of particles involved.

10.6.2. Problems (based on mole concept)

1. *When the mass of the substance is given:*

$$\text{Number of moles} = \frac{\text{given mass}}{\text{atomic mass}}$$

a. Calculate the number of moles in

i) 81g of aluminium ii) 4.6g sodium iii) 5.1g of Ammonia iv) 90g of water v) 2g of NaOH

$$\text{Number of moles} = \frac{\text{given mass}}{\text{atomic mass}} = \frac{81}{27}$$

= 3 moles of aluminium

FOLLOW UP: Find the number of moles for remaining problems given above.

b. Calculate the mass of 0.5 mole of iron

Solution: mass = atomic mass x number of moles

= 55.9 x 0.5 = 27.95 g

FOLLOW UP: Find the mass of 2.5 mole of oxygen atoms

Mass = molecular mass x number of moles

2. *Calculation of number of particles when the mass of the substance is given:*

$$\text{Number of particles} = \frac{\text{Avogadro number x given mass}}{\text{gram molecular mass}}$$

a. Calculate the number. of molecules in 11g of CO_2

Solution: gram molecular mass of CO_2 = 44g

$$\text{Number. of molecules} = \frac{6.023 \times 10^{23} \times 11}{44}$$

= **1.51×10^{23} molecules**

FOLLOW UP: Calculate the number of molecules in 360g of glucose.

3. *Calculation of mass when number of particles of a substance is given:*

$$\text{Mass of a substance} = \frac{\text{gram molecular mass x number of particles}}{6.023 \times 10^{23}}$$

a. Calculate the mass of 18.069×10^{23} molecules of SO_2

Sol: Gram molecular mass SO_2 = 64g

Mass of SO_2

$$= \frac{64 \times 18.069 \times 10^{23}}{6.023 \times 10^{23}} = 192 \text{ g}$$

b. Calculate the mass of glucose in 2×10^{24} molecules

Gram molecular mass of glucose = 180g

Mass of glucose

$$= \frac{180 \times 2 \times 10^{24}}{6.023 \times 10^{23}} = 597.7\text{g}$$

FOLLOW UP: Calculate the mass of 12.046×10^{23} molecules in CaO.

4. *Calculation of number of moles when you are given number of molecules:*

a. Calculate the number moles for a substance containing 3.0115×10^{23} molecules in it.

$$\text{Number of moles} = \frac{\text{Number of molecules}}{\text{Avogadro Number}}$$

$$= \frac{3.0115 \times 10^{23}}{6.023 \times 10^{23}} = 0.5 \text{ moles}$$

b. Calculate number of moles in 12.046×10^{22} atoms of copper

Number of moles of atoms

$$= \frac{\text{Number of atoms}}{\text{Avogadro Number}}$$

$$= \frac{12.046 \times 10^{22}}{6.023 \times 10^{23}} = 0.2 \text{ moles}$$

FOLLOW UP: Calculate the number of moles in 24.092×10^{22} molecules of water.

MORE TO KNOW

Molar volume: Volume occupied by one mole of any gas at STP is called molar volume. Its value is 22.4 litres

22.4 litres of any gas contains 6.023×10^{23} molecules.

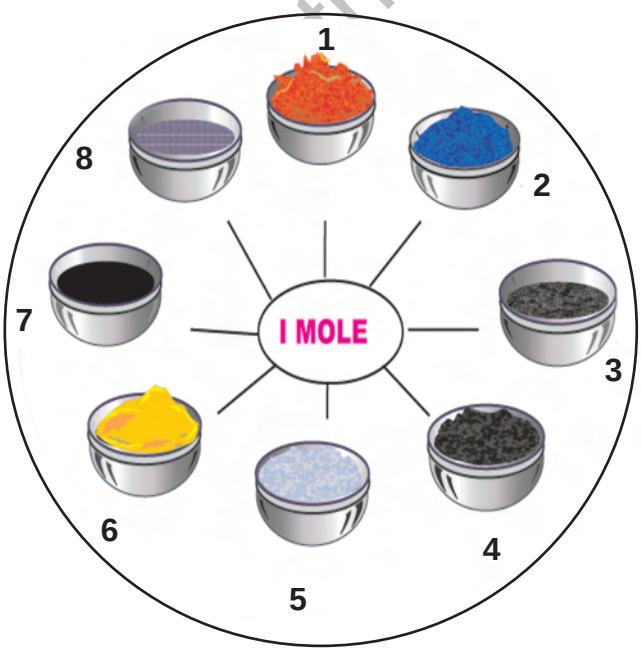


Fig. 10.4 More illustrations for mole in various forms

Answers :

1. 162.4 g of $FeCl_3$

2. 159.6g of $CuSO_4$

3. 27g of Al

4. 56g of Fe

5. 58.5 g of NaCl

6. 32g of S

7. 12g of C

8. 200.6g of Hg

CHAPTER10

EVALUATION

PART - A

1. From the given examples, form the pair of isotopes and the pair of isobars

   $_{18}Ar^{40}$, $_{17}Cl^{35}$, $_{20}Ca^{40}$, $_{17}Cl^{37}$

2. Molecular mass of nitrogen is 28. Its atomic mass is 14. Find the atomicity of nitrogen.
3. Gram molecular mass of oxygen is 32g. Density of oxygen is 1.429g/cc. Find the gram molecular volume of oxygen.
4. 'Cl' represents chlorine atom, 'Cl_2' represents chlorine molecule.

   List out any two differences between atoms and molecules.
5. Calculate the gram molecular mass of water from the values of gram atomic mass of hydrogen and of oxygen.

   Gram atomic mass of hydrogen = 1g

   Gram atomic mass of oxygen = 16g
6. One mole of any substance contains 6.023×10^{23} particles.

   If 3.0115×10^{23} particles are present in CO_2. Find the number of moles.

PART - B

1. Modern atomic theory takes up the wave concept, principle of uncertainty and other latest discoveries to give a clear cut picture about an atom. State the findings of modern atomic theory.
2. You are given the values of mass of one volume of oxygen gas and the mass of one volume of hydrogen. By applying Avagadro's law how will you establish the relation between vapour density and molecular mass of a gas?
3. Calculate the number of moles in
   a. 12.046×10^{23} atoms of copper
   b. 27.95g of iron
   c. 1.51×10^{23} molecules of CO_2

FURTHER REFERENCE :

Books: 1. Physical Chemistry : **Puri and sharma - Vishal publications**

2. Inorganic Chemistry : **P.L. Soni - S.Chand publication**

Website : www.ehow.com/atomsandmolecules

www.chem4kids.com/tag/atomsandmolecules

11. Chemical Reactions

All living beings born in this beautiful world have their own life styles. Have you observed and analyzed your daily life from the view point of a chemist? Chemical reactions happen around us all the time and even in our body.

Any change can be classified as physical change and chemical change. Physical changes can be easily reversed but, it is not easy to reverse a chemical change. What is the reason? In chemical changes, new substances are formed and it is difficult to regenerate the original substances. Chemical changes are more permanent than physical changes. All chemical changes are accompanied by chemical reactions.

How do we come to know that a chemical reaction has taken place? Let us perform some activities to find out the answer to this question.

ACTIVITY 11.1

- Look at the new silver anklet of your mother or sister
- Note the colour of the anklet
- Observe the colour of an old anklet
- What change do you observe?

The lustrous white colour of the silver anklet slowly changes into slightly black colour. That is, silver anklet has got

Fig. 11.1 Silver Anklet

tarnished. Can you guess the reason behind it?

It is due to the formation of silver sulphide (Ag_2S), as a result of the reaction between silver and hydrogen sulphide in the air.

ACTIVITY 11.2

- Take lead nitrate solution in a beaker
- Take potassium iodide solution in a test tube.(Both solutions are colourless)
- Add potassium iodide solution slowly to the lead nitrate solution
- What do you observe?

You observe a deep yellow precipitate, don't you?

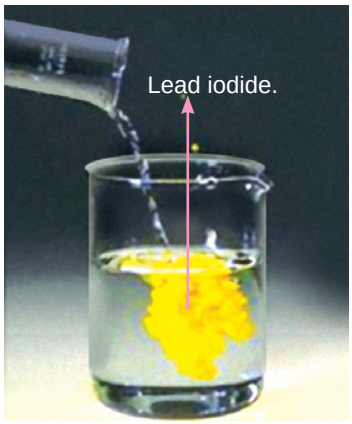


Fig. 11.2 Yellow precipitate of lead iodide.

It is lead iodide (pbI_2).

ACTIVITY 11.3

- Take 5g of calcium oxide (quick lime) in a beaker
- Add water to it slowly
- Touch the beaker
- What do you feel?

Do you feel hot? Let us see what happens

Calcium oxide reacts with water to produce slaked lime (calcium hydroxide). This reaction is exothermic and will be accompanied by hissing sound and bubbles leading to the release of considerable amount of heat.

ACTIVITY 11.4

- Take a pinch of calcium carbonate powder in a test tube
- Add dilute hydrochloric acid
- Note the changes in the test tube carefully

Do you observe any brisk effervescence? It is due to the evolution of carbon dioxide gas.

Fig. 11.3 Reaction of calcium carbonate with dil.HCl

These are some of the common observations in a chemical reaction. From the activities that we have discussed, it is clear that chemical reactions will bring about a permanent change resulting in the formation of new product(s).

The substances taking part in the reaction are known as reactants and those formed as a result of the reaction are called products.

MORE TO KNOW

A solution of slaked lime produced in the Activity 11.3 is used for white washing. Calcium hydroxide reacts slowly with carbon dioxide in air to form a thin layer of calcium carbonate on the walls. Calcium carbonate is formed after two to three days of white washing and gives a shiny finish to the walls. It is interesting to note that the chemical formula for marble is also $CaCO_3$.

11.1.TYPES OF CHEMICAL REACTIONS

Since there are numerous chemical reactions, the study of these reactions can be made easier by classifying them. All the chemical reactions are classified into six broad categories depending on the way the product formed.

Let us see the different types of classifications of chemical reactions.

1. COMBINATION REACTION

A combines with **B** to form a new product **AB**. It is the simple representation of combination reaction.

ACTIVITY 11.5

- Take a clean piece of magnesium ribbon
- Hold the ribbon with a pair of tongs
- Burn it in air using a burner (keeping Mg ribbon as far as possible from your eyes)
- Collect the ash

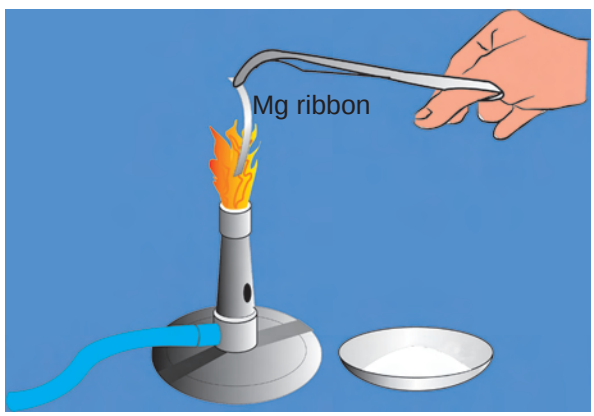


Fig. 11.4 Burning of Mg ribbon

In the above activity, magnesium combines with oxygen to form a single product, magnesium oxide. **Such a reaction in which a single product formed from two or more reactants is known as combination reaction.**

$$2Mg + O_2 \rightarrow 2MgO$$

Repeat "**Activity 11.3**". This reaction is also an example for COMBINATION REACTION. Attempt to write the equation yourself.

Let us discuss some more examples of combination reactions.

- Combustion of coal

$$C + O_2 \rightarrow CO_2\uparrow$$

- Combustion of hydrogen

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

2 DECOMPOSITION REACTION

AB splits into **A** and **B.** It is the representation of decomposition reaction.

ACTIVITY 11.6

- Take about 2 g of copper carbonate powder in a dry test tube
- Note the colour of copper carbonate
- Heat the test tube over the flame
- Observe the change after heating

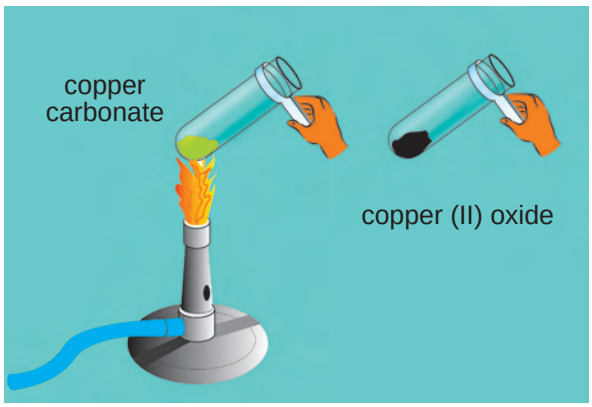


Fig. 11.5 Heating the test tube containing copper carbonate

Change of colour from green to black is observed. This is due to the decomposition of copper carbonate to copper (II) oxide.

$$CuCO_3 \xrightarrow{\Delta} CuO + CO_2\uparrow$$

ACTIVITY 11.7

- Take lead nitrate in a test tube
- Heat it over the flame
- Observe the changes

Liberation of a reddish brown gas (NO_2) is observed. This is because of the decomposition of lead nitrate into lead oxide, nitrogen dioxide and oxygen.

$$2Pb(NO_3)_2 \xrightarrow{\Delta} 2PbO + 4NO_2\uparrow + O_2\uparrow$$

From the above two activities (11.6 and 11.7), It can be noted that a **single compound breaks down to produce two or more substances. Such type of reaction is called decomposition reaction.**

Some other examples for decomposition reaction:

1. Decomposition of lime stone

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2\uparrow$$

2. Decomposition of ammonium dichromate

$$(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} Cr_2O_3\uparrow + N_2\uparrow + 4H_2O\uparrow$$

MORE TO KNOW

At very high temperature,ammonium dichromate decomposes immediately to green vapours which gets released along with the steam. It seems as if a volcano erupts and is termed as chemical volcano.

3. DISPLACEMENT REACTION

In the reaction between **A** and **BC, A** displaces **B** from **BC** to form **AC**. This shows that A is more reactive than **B**.

ACTIVITY 11.8

- Take 20 ml of copper sulphate solution in a beaker
- Drop an iron nail into the beaker
- Leave it for few days
- Observe the colour of the copper sulphate solution and the iron nail

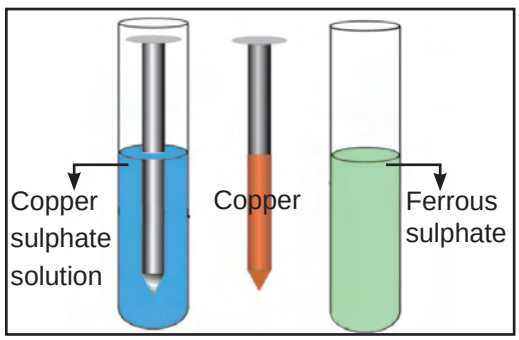


Fig. 11.6 Iron displaces copper from copper sulphate solution

Blue colour of the copper sulphate solution changes into green colour and the iron nail acquires a brownish look. It is a noticeable change. Is it not? This change confirms that iron is more reactive than copper. The following chemical reaction takes place in this activity.

$$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$$

In this reaction, iron displaces copper from $CuSO_4$ solution.

Repeat "**Activity 11.8**" but use zinc rod instead of an iron nail. What colour changes do you observe on the rod and in the solution? Write the chemical equation.

Other example:

$$Pb + CuCl_2 \rightarrow PbCl_2 + Cu$$

Lead can displace copper from its salt solutions. Can copper displace zinc or lead from their salt solutions? No, because copper is less reactive than zinc and lead.

The reaction in which, a more reactive element displaces a less reactive element from its compound is called displacement reaction.

4. DOUBLE DECOMPOSITION REACTION (DOUBLE DISPLACEMENT REACTION)

In the reaction between **AB** and **CD**, both the reactants decompose to form **AD** and **CB** through the rearrangement of ions.

ACTIVITY 11.9

- Take 5ml of sodium sulphate solution in a test tube
- In another test tube, take 5ml of barium chloride
- Mix both the solutions
- What do you observe?

barium sulphate

Fig. 11.7 Formation of barium sulphate

You will observe formation of a white substance, which is insoluble in water. The insoluble substance formed is known as *precipitate*. Any reaction that produces a precipitate is called a **precipitation reaction.** The formed white precipitate of barium sulphate, is due to the reaction of SO_4^{2-} and Ba^{2+} ions. The other product formed is sodium chloride.

$$Na_2SO_4 + BaCl_2 \rightarrow BaSO_4\downarrow + 2NaCl$$

Repeat **"Activity 11.2"** for double decomposition reaction. Attempt to write the equation by yourself.

Double decomposition reaction is any reaction in which exchange of ions between two reactants occur, leading to the formation of two different products.

Other example :

$$CuSO_4 + H_2S \rightarrow CuS\downarrow + H_2SO_4$$

5. OXIDATION AND REDUCTION

We are all aware of the fact that oxygen is the most essential element for sustaining life. One can live without food or even water for a number of days, but not without oxygen. In our daily life we come across phenomena like fading of the colours of the clothes, burning of combustible substances like cooking gas, wood and coal, and also rusting of iron articles. All such processes fall in the category of a specific type of chemical reaction called oxidation – reduction reaction (redox reaction). A large number of industrial processes like electroplating, extraction of metals like aluminium, are based upon the redox reaction.

Oxidation:

A chemical reaction which involves addition of oxygen or removal of hydrogen or loss of electron(s) is called as oxidation.

$2Mg + O_2 \rightarrow 2MgO$ (addition of oxygen)

$H_2S + Br_2 \rightarrow 2HBr + S$ (removal of hydrogen)

$Fe^{2+} \rightarrow Fe^{3+} + e^-$ (loss of electron)

Reduction:

A chemical reaction which involves addition of hydrogen or removal of oxygen or gain of electron(s) is called as reduction.

$2Na + H_2 \rightarrow 2NaH$ (addition of hydrogen)

$CuO + H_2 \rightarrow Cu + H_2O$ (removal of oxygen)

$Fe^{3+} + e^- \rightarrow Fe^{2+}$ (gain of electron)

Redox reaction:

A chemical reaction in which oxidation and reduction take place simultaneously is called redox reaction.

$$Zn + CuSO_4 \rightarrow Cu + ZnSO_4$$

Attempt to write any other redox reaction

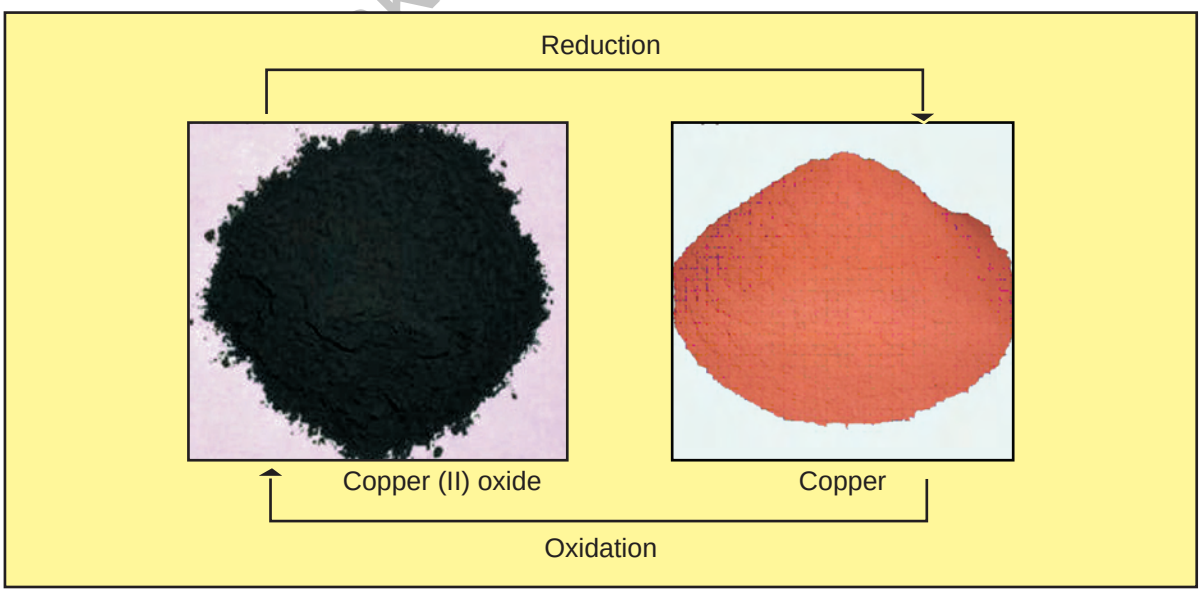


Fig. 11.8 Redox reaction

During the conversion of copper(II) oxide to copper, the copper(II) oxide is losing oxygen and is being reduced. The hydrogen is gaining oxygen and is being oxidised. In other words, one reactant gets oxidised while the other gets reduced during the reaction. Such reactions are called oxidation – reduction reactions or redox reactions.

Oxidation is	**Reduction is**
Gain of oxygen	Loss of oxygen
Loss of hydrogen	Gain of hydrogen
Loss of electron(s)	Gain of electron(s)
Oxidation and reduction always takes place together, so the reaction is called redox reaction.	

DON'T FORGET

Loss of electron is oxidation.

Gain of electron is reduction.

The term LEO, GER will help you to remember.

MORE TO KNOW

Oxidation also has damaging effects on food and eatables. When food containing fat and oil is left as such for a long time, it becomes stale. The stale food develops bad taste and smell. This is very common in curd or chees particularly in summer. Oils and fats are slowly oxidised to certain bad smelling compounds.

6. EXOTHERMIC AND ENDOTHERMIC REACTIONS

During chemical reactions one of the most common change is a change in temperature. When detergent is dissolved in water to wash clothes, heat is given out. When glucose is kept on our tongue, a chilling effect is felt. During these processes, heat is either given out or absorbed from the surroundings. In the same way, in most of the chemical reactions, energy is either taken up or given out.

a. Exothermic reactions

The chemical reactions which proceed with the evolution of heat energy are called exothermic reactions.

$$N_2 + 3H_2 \rightarrow 2NH_3 + Heat$$

All combustion reactions are exothermic. Heat energy is liberated as the reaction proceeds.

b. Endothermic reactions

The chemical reactions which proceed with the absorption of heat energy are called endothermic reactions.

$$2NH_3 + Heat \rightarrow N_2 + 3H_2$$

11.2 RATE OF THE CHEMICAL REACTION

Rate of the chemical reaction is defined as change in concentration of any one of the reactants or product per unit time.

Consider the reaction

$$A \rightarrow B$$

Rate of the reaction is given by

$$\text{Rate} = -\frac{d[A]}{dt} = +\frac{d[B]}{dt}$$

[A] - concentration of reactant A

[B] - concentration of product B

- ve sign indicates decrease in con centration of A with time.

+ ve sign indicates increase in concentration of B with time.

11.2.1 FACTORS INFLUENCING THE RATE OF THE CHEMICAL REACTION

1. NATURE OF THE REACTANTS

ACTIVITY 11.10

- Take magnesium ribbon in two test tubes A and B
- Add hydrochloric acid to test tube A
- Add acetic acid to test tube B
- Observe the changes in two test tubes

Magnesium ribbon reacts with both hydrochloric acid and acetic acid but reaction is faster in hydrochloric acid than in acetic acid. Do you know why? Hydrochloric acid is more reactive than acetic acid. It shows that **nature of the reactant influences the rate of the reaction**.

2. CONCENTRATION OF THE REACTANTS

ACTIVITY 11.11

- Take 3g of granulated zinc in the test tube A and B
- Add 5 ml of 1 M hydrochloric acid in test tube A
- Add 5 ml of 2 M hydrochloric acid in test tube B
- Observe the changes

Granulated zinc reacts with both 1M hydrochloric acid and 2M hydrochloric acid, the rate of evolution of hydrogen gas is more from the test tube B than from the test tube A. This is because, 2M hydrochloric acid is more concentrated than 1M hydrochloric acid. That is, **greater the concentration of the reactant, greater will be the rate of the reaction.**

3. SURFACE AREA OF THE REACTANTS

ACTIVITY 11.12

- Take powdered calcium carbonate in beaker A
- Take marble chips (calcium carbonate) in beaker B
- Add hydrochloric acid in both beakers A and B
- Observe the changes

Powdered calcium carbonate reacts more quickly with hydrochloric acid than marble chips. What is the reason?.

Powdered calcium carbonate offers large surface area for the reaction to occur at a faster rate. **This shows that greater the surface area, greater is the rate of the reaction.**

4. TEMPERATURE

ACTIVITY 11.13

- Take 3g of marble chips in a beaker
- Add 5 ml of 1M hydrochloric acid
- Observe the changes
- Heat the beaker
- Observe the changes

Calcium carbonate present in marble chips react slowly with hydrochloric acid at room temperature and evolves carbon dioxide at slower rate, whereas on heating, the evolution of carbon dioxide is made faster.**This shows that increase in temperature increases the rate of the reaction.**

5. CATALYST

ACTIVITY 11.14

- Take potassium chlorate in a test tube
- Heat the test tube
- Observe what happens
- Add manganese dioxide as a catalyst
- Observe the changes

When potassium chlorate is heated, oxygen is evolved very slowly whereas after the addition of manganese dioxide to the reactant, oxygen is liberated at a faster rate. **This shows that manganese dioxide acts as a catalyst and influences the rate of the reaction.**

GROUP ACTIVITY

- From dawn to dusk observe any 10 chemical changes taking place around you and classify them
- Prepare volcano using ammonium dichromate (vigorous)
- Prepare volcano using baking soda (silent).

MORE TO KNOW

A substance which alters the rate of the reaction without undergoing any change in mass and composition is known as catalyst.

ACIDS, BASES AND SALTS

Nivi : Hai Vini, you look tired. Take this fresh lime juice.

Vini : No, it has sour taste.

Nivi : Do you know why is it sour?

Vini : Sorry, I have no idea at all.

Nivi : It is due to the presence of acid. Ok let's get set to learn about this.

Acids, bases and salts are used in everyday life. Let it be a fruit juice or a detergent or a medicine. They play a key role in our day-to-day activities. Our body metabolism is carried out by means of hydrochloric acid secreted in our stomach.

11.3. ACIDS

Acid is a substance which furnishes H^+ ions or H_3O^+ ions when dissolved in water. Acids have one or more replaceable hydrogen atoms. The word acid is derived from the Latin name 'acidus' which means sour taste. Substances with 'sour taste' are acids. Lemon juice, vinegar and grape juice have sour taste, so they are acidic. They change blue litmus to red. They are

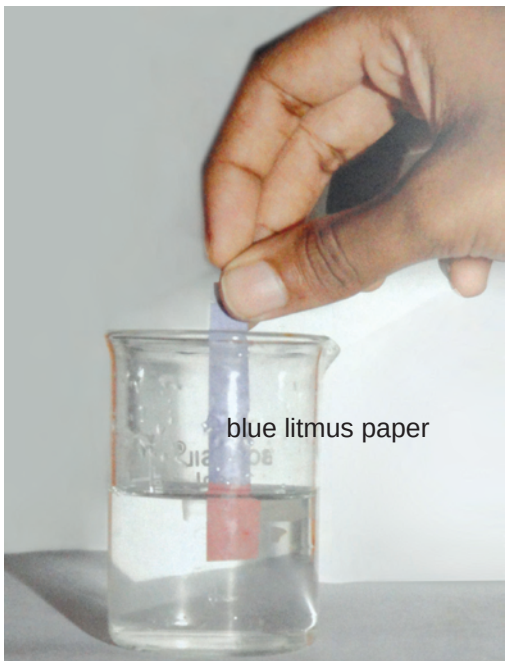


Fig. 11.9 Acid solution turns blue litmus paper red

colourless with phenolphthalein and pink with methyl orange. Many organic acids are naturally present in food items.

11.3.1 CLASSIFICATION OF ACIDS

1. **Based on their sources :** Acids are classified into two types namely organic acids and inorganic acids.

   Organic acids:- Acids present in plants and animals (living beings) are **organic acids** eg. HCOOH, CH_3COOH (Weak acids).

   Inorganic acids:- Acids from rocks and minerals are **inorganic acids** or mineral acids eg. HCl, HNO_3, H_2SO_4 (Strong acids).

2. **Based on their basicity**

   Monobasic acid: - It is an acid which gives one hydrogen ion per molecule of the acid in solution eg. HCl, HNO_3.

   Dibasic acid:- It is an acid which gives two hydrogen ions per molecule of the acid in solution eg. H_2SO_4, H_2CO_3.

   Tribasic acid:- It is an acid which gives three hydrogen ions per molecule of the acid in solution. eg. H_3PO_4

Source	Acid present
Apple	Malic acid
Lemon	Citric acid
Grape	Tartaric acid
Tomato	Oxalic acid
Vinegar (food preservative)	Acetic acid
Curd	Lactic acid

What is the acid present in it?

MORE TO KNOW

For acids, we use the term basicity which means the number of replaceable hydrogen atoms present in one molecule of an acid. For example acetic acid has four hydrogen atoms but only one can be replaced. Hence it is monobasic.

3. Based on ionisation

Acids are classified into two types based on ionisation.

Strong acids:- These are acids which ionise completely in water eg.HCl

Weak acids:-These are acids which ionise partially in water eg. CH_3COOH

4. Based on concentration:- Depending on the percentage or amount of acid dissolved in water acids are classified into concentrated acid and dilute acid.

Concentrated acid:- It is an acid having a relatively high percentage of acid in its aqueous solution.

Dilute acid:- It is an acid having a relatively low percentage of acid in aqueous solution.

MORE TO KNOW

Care must be taken while mixing any concentrated mineral acid with water. The acid must always be added slowly to water with constant stirring. If water is added to a concentrated acid the large amount of heat is generated which may cause burns. The mixture splashes out of the container.

11.3.2 CHEMICAL PROPERTIES OF ACIDS

1. REACTION OF METALS WITH ACID

Note that zinc reacts with dilute hydrochloric acid to form zinc chloride and hydrogen gas.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2\uparrow$$

When a burning candle is brought near the bubble containing hydrogen gas, the flame goes off with a '**pop**'ing sound. This confirms that metal displaces hydrogen from the dilute acid. (Hydrogen gas burns with a '**pop**'ing s und)

Metal + Acid → Salt + Hydrogen

Another example

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2\uparrow$$

ACTIVITY 11.15

- Take 5 g of zinc granules in a test tube
- Add 10 ml of dilute hydrochloric acid through thistle funnel
- During the course of addition, what do you observe?

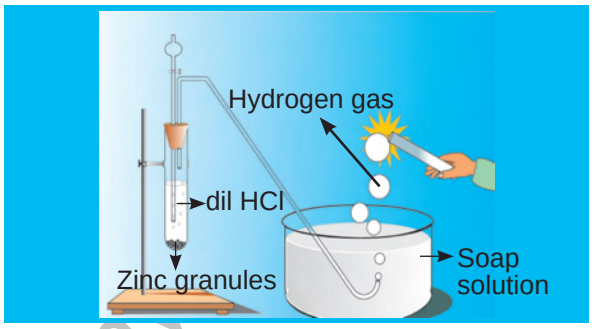


Fig. 11.10 Reaction of Zn granules with dilute HCl

MORE TO KNOW

- All metals do not liberate hydrogen gas on reaction with acids. eg., Ag,Cu.
- Lime stone, chalk and marble are different physical forms of calcium carbonate. They react with acids giving corresponding salt, carbon dioxide and water.

CHEMISTRY

2. REACTION OF METAL CARBONATE AND METAL BICARBONATE WITH ACIDS

ACTIVITY 11.16

- Take two test tubes, label them as I and II
- Take small amount of washing soda (Na_2CO_3) in test tube I and small amount of baking soda ($NaHCO_3$) in test tube II
- Add dilute hydrochloric acid to both the test tubes
- What do you observe?
- Pass the gas produced in each case, through lime water [$Ca(OH)_2$] solution and record your observations

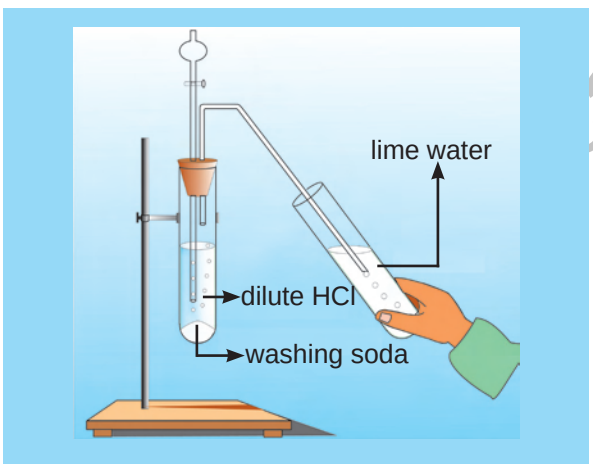


Fig. 11.11 Testing of carbon dioxide

Test tube I

$Na_2CO_3 + 2\ HCl \rightarrow 2\ NaCl + H_2O + CO_2\uparrow$

Test tube II

$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2\uparrow$

When carbon dioxide is passed through lime water, it turns milky.

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

(milky)

From the above activity the reaction can be summarized as

Metal carbonate or Metal bicarbonate + Acid ⟶ Salt + Water + Carbon dioxide

Other examples

$MgCO_3 + 2\ HCl \rightarrow MgCl_2 + H_2O + CO_2\uparrow$

$Mg(HCO_3)_2 + 2\ HCl \rightarrow MgCl_2 + 2H_2O + 2CO_2\uparrow$

MORE TO KNOW

Since metal carbonates and metal bicarbonates are basic they react with acids to give salt and water with the liberation of carbon dioxide.

3. REACTION OF METALLIC OXIDES WITH ACIDS

ACTIVITY 11.17

- Take about 2g copper (II) oxide in a watch glass and add dilute hydrochloric acid slowly
- Note the colour of the salt
- What has happened to the copper (II) oxide?

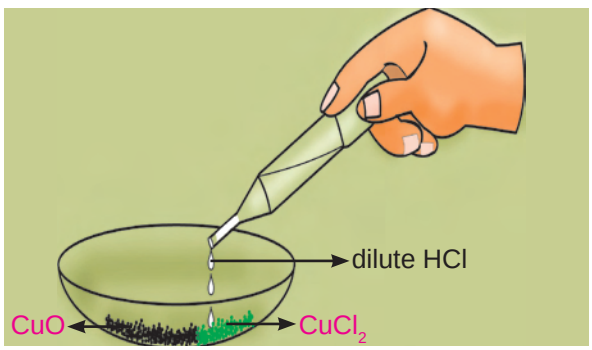


Fig. 11.12 Reaction of copper(II) oxide with dilute hydrochloric acid

CHAPTER 11

The colour changes from **black to green.** This is due to the formation of copper (II) chloride in the reaction. Since metal oxides are basic, they react with acid to form salt and water.

$$CuO + 2HCl \rightarrow CuCl_2 + H_2O$$

From the above activity we conclude that

Metallic oxide + Acid → Salt + Water

Another example

$$CaO + 2HCl \rightarrow CaCl_2 + H_2O$$

4 . ACTION OF ACIDS WITH WATER.

An acid produces hydrogen ions in water.

$$HCl + H_2O \rightarrow H_3O^+ + Cl^-$$

Hydrogen ions cannot exist alone, but they exist in the form of hydronium (H_3O^+) ions. When water is absent, the separation of hydrogen ions from an acid does not occur.

11.3.3. USES OF ACIDS

1. Sulphuric acid (King of chemicals) is used in car battery and in the preparation of many other compounds.
2. Nitric acid is used in the production of ammonium nitrate which is used as fertilizer in agriculture.
3. Hydrochloric acid is used as cleansing agent in toilet.
4. Tartaric acid is a constituent of baking powder.
5. Salt of benzoic acid (sodium benzoate) is used in food preservation.
6. Carbonic acid is used in aerated drinks.

MORE TO KNOW

The atmosphere of Venus is made up of thick white and yellowish clouds of sulphuric acid. Do you think life can exist on this planet?

11.4. BASES

Base is a substance which releases hydroxide ions when dissolved in water. It is a substance which is bitter in taste and soapy to touch (e.g. Washing soda, caustic soda and caustic potash). They change red litmus to blue. They are pink with phenolphthalein and yellow with methyl orange.

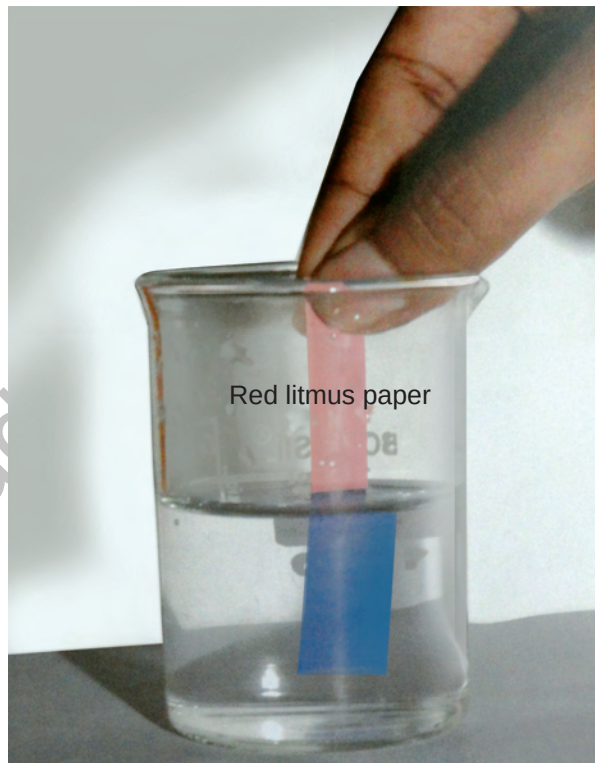


Fig. 11.13 Bases turns red litmus paper blue

11.4.1. Classification of bases

1. **Based on ionisation**

   Strong bases:- These are bases which ionise completely in aqueous solution eg.NaOH, KOH.

   Weak bases:- These are bases which ionise partially in aqueous solution eg. NH_4OH, $Ca(OH)_2$.

2. **Based on their acidity**

   Monoacidic base:- It is a base which ionises in water to give

one hydroxide ion per molecule eg.NaOH, KOH.

Diacidic base:- It is a base which ionises in water to give two hydroxide ions per molecule eg. $Ca(OH)_2$, $Mg(OH)_2$.

Triacidic base:- It is a base which ionises in water to give three hydroxide ions per molecule eg. $Al(OH)_3$, $Fe(OH)_3$.

MORE TO KNOW

The term acidity is used for base which means the number replaceable hydroxyl groups present in one molecule of a base.

3. Based on the concentration:

Depending on the percentage or amount of base dissolved in water, bases are classified as concentrated alkali and dilute alkali.

Concentrated alkali:- It is an alkali having a relatively high percentage of alkali in its aqueous solution.

Dilute alkali:- It is an alkali having a relatively low percentage of alkali in its aqueous solution.

MORE TO KNOW

Bases which dissolve in water are called alkalies. All alkalies are bases, but not all bases are alkalis. NaOH and KOH are alkalies whereas $Al(OH)_3$ and $Zn(OH)_2$ are bases.

11.4.2. Chemical Properties Of Bases

1. REACTION OF BASE WITH METALS

Zinc reacts with sodium hydroxide to form sodium zincate with the liberation of hydrogen gas.

$$Zn + 2\ NaOH \rightarrow Na_2ZnO_2 + H_2\uparrow$$

Metal + Base → Salt + Hydrogen

Another example

$$2\ Al + 2\ NaOH + 2\ H_2O \rightarrow 2\ NaAlO_2 + 3\ H_2\uparrow$$

MORE TO KNOW

All metals do not react with sodium hydroxide eg. Cu, Ag, Cr

2. REACTION OF NON METALLIC OXIDES WITH BASES

Sodium hydroxide reacts with carbon dioxide gives sodium carbonate and water.

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

The above reaction confirms that

Non metallic oxide + Base → Salt + Water

Another example

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

3. ACTION OF BASES WITH WATER

Bases generate hydroxide (OH^-) ions when dissolved in water.

$$NaOH \rightarrow Na^+ + OH^-$$

4. REACTION OF ACIDS WITH BASES

ACTIVITY 11.18

- Indira takes 20 ml of 0.1N sodium hydroxide solution in a conical flask and adds few drops of phenolphthalein.
- What colour does she observe?
- She is adding 20 ml of 0.1N hydrochloric acid solution to the above conical flask drop by drop.
- Does she observe any colour change in the reaction mixture?

In the above activity, Indira observed that the effect of a base is nullified by an acid.

$NaOH + HCl \rightarrow NaCl + H_2O$

The above reaction between an acid and a base is known as neutralisation reaction.

Acid + Base → Salt + Water

Fig. 11.14 Reaction of sodium hydroxide with hydrochloric acid

11.4.3 USES OF BASES

1. Sodium hydroxide is used in the manufacture of soap.
2. Calcium hydroxide is used in white washing the buildings.
3. Magnesium hydroxide is used as a medicine for stomach troubles.
4. Ammonium hydroxide is used to remove grease stains from clothes.

11.5 IDENTIFICATION OF ACIDS AND BASES

ACTIVITY 11.19

- Collect lemon juice, washing soda solution, soap solution and soft drinks.
- Take 2 ml of each solution in a test tube and test with a litmus paper or indicator.
- What change in colour do you observe with red litmus, blue litmus, phenolphthalein and methyl orange?
- Tabulate your observations.

Sample solution	Red litmus	Blue litmus	Phenolphthalein	Methyl orange
Lemon Juice				
Washing soda Solution				
Soap solution				
Soft drinks				

Same activity can be repeated for dilute hydrochloric acid, dilute sulphuric acid, sodium hydroxide solution and potassium hydroxide solution with the help of your teacher.

INDICATOR	COLOUR IN ACID	COLOUR IN BASE
Litmus	Red	
Phenolphthalein		
Methyl orange	Red	Yellow

11.6 p^H SCALE

p^H stands for the power of hydrogen ion concentration in a solution. p^H values decide whether a solution is acidic or basic or neutral. p^H scale was introduced by S.P.L. Sorenson. It is mathematically expressed as

$$p^H = -\log_{10}[H^+]$$

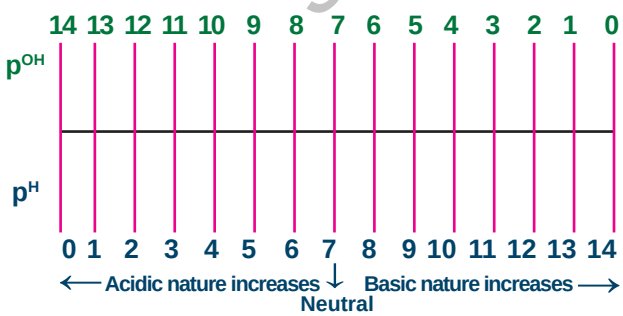
For neutral solution $[H^+] = 10^{-7}M$; $p^H = 7$

For acidic solution $[H^+] > 10^{-7}M$; $p^H < 7$

For basic solution $[H^+] < 10^{-7}M$; $p^H > 7$

When OH^- ions are taken into account the p^H expression is replaced by p^{OH}

$$p^{OH} = -\log_{10}[OH^-]$$



Problems

1. The hydrogen ion concentration of a solution is 0.001M. What is the p^H of the solution?

Solution

$p^H = -\log_{10}[H^+]$

$p^H = -\log_{10}(0.001)$

$p^H = -\log_{10}(10^{-3})$

$= -(-3)\log_{10} 10$ [$\log 10 = 1$]

$p^H = 3$

2. The hydrogen ion concentration of a solution is 1.0×10^{-9} M. What is the p^H of the solution? Predict whether the given solution is acidic, basic or neutral.

Solution

$p^H = -\log_{10}[H^+]$

$p^H = -\log_{10}(1.0 \times 10^{-9})$

$p^H = -(\log_{10}1.0 + \log_{10}10^{-9})$ [$\log_{10} 1 = 0$]

$= -(0 - 9\log_{10} 10)$

$p^H = -(0 - 9) = 9$

$p^H = 9$ ie $p^H > 7$

Therefore the given solution is basic.

3. The hydroxyl ion concentration of a solution is 0.001M. What is the p^H of the solution?

Solution

$p^{OH} = -\log_{10}[OH^-]$

$p^{OH} = -\log_{10}(10^{-3})$

$p^{OH} = 3$

$p^H = 14 - p^{OH}$

$p^H = 14 - 3 = 11$

$p^H + p^{OH} = 14$

$p^H = 14 - p^{OH}$

4. The hydroxyl ion concentration of a solution is 1.0×10^{-9} M. What is the p^H of the solution?

Solution

$p^{OH} = -\log_{10}[OH^-]$

$p^{OH} = -\log_{10}(1.0 \times 10^{-9})$

$p^{OH} = 9$

$p^{H} = 14 - p^{OH}$

$p^{H} = 14 - 9 = 5$

11. 6.1 p^{H} paper

A more common method of measuring p^{H} in a school laboratory is by using p^{H} paper. p^{H} paper contains a mixture of indicators, which gives different colours across the entire p^{H} range. p^{H} value of the various solutions are given in the table.

$$p^{H} = -\log_{10}[H^{+}]$$

$$p^{H} = -\log_{10}\left[\frac{1}{H^{+}}\right]$$

$$[H^{+}] = 10^{-pH}$$

$[H^{+}] = 1 \times 10^{-7}$; $p^{H} = 7$

$[H^{+}] = 1 \times 10^{-2}$; $p^{H} = 2$

$[H^{+}] = 1 \times 10^{-14}$; $p^{H} = 14$

Solution	Approximate p^{H}
Lemon juice	2.2 – 2.4
Tomato juice	4.1
Coffee	4.4 - 5.5
Human saliva	6.5 - 7.5
House hold ammonia	12.0

Fig. 11.15 p^{H} paper

ACTIVITY 11.20

- Take lemon juice, orange juice, 1M NaOH, 1M HCl, pure water and vinegar
- Dip p^{H} paper into these solutions
- Observe the changes

Sl. No.	Sample	Colour of p^{H} paper	Approximate p^{H}	Nature of substance
1.	Lemon juice			
2.	Orange juice			
3.	1M NaOH			
4.	1M HCl			
5.	Pure H_2O			
6.	Vinegar			

CHEMISTRY

11.6.2 Importance of p^H in everyday life

1. p^H in human body

(i) Using p^H factor the healthiness of our body is predicted. At p^H level 6.9, the body becomes prone to viral infections like colds, cough and flu. Cancer cells thrive inside the body at a p^H of 5.5.

(ii) The p^H of a normal, healthy human skin is 4.5 to 6. Proper skin p^H is essential for a healthy complexion.

(iii) p^H of stomach fluid is approximately 2.0. This fluid is essential for the digestion of food.

(iv) Human blood p^H range is 7.35 to 7.45. Any increase or decrease in this value, leads to diseases. The ideal pH for blood is 7.4.

(v) p^H of normal saliva ranges between 6.5 to 7.5.

(vi) White enamel coating in our teeth is calcium phosphate, hardest substance in our body. It does not dissolve in water. If p^H of mouth falls below 5.5, the enamel gets corroded. Toothpastes are generally basic, and is used for cleaning the teeth, can neutralize the excess acid and prevent tooth decay.

2. p^H in soil

In agriculture, the p^H of soil is very important. Citrus fruits require slightly alkaline soil, while rice requires acidic soil and sugar cane requires neutral soil.

3. p^H in rain water

p^H of rain water is approximately 7 showing high level of its purity and neutrality. If rain water is polluted by SO_2 and NO_2, acid rain occurs, bringing the p^H value less than 7.

11.7 SALT

When you say salt, you may think of white stuff put on chips. But that is just one salt called common salt. There are many other salts used in other fields. Salts are the products of the reaction between acids and bases (see reaction of acids and bases), which produce positive ions and negative ions when dissolved in water.

11.7.1 Classification of salts

1. Normal salts

A normal salt is obtained by complete neutralization of an acid by a base

$$NaOH + HCl \rightarrow NaCl + H_2O$$

2. Acid salts

Acid salts are derived by the partial replacement of hydrogen ions of an acid by a metal. When a calculated amount of a base is added to a polybasic acid, acid salt is obtained, as follows.

$$NaOH + H_2SO_4 \rightarrow NaHSO_4 + H_2O$$

3. Basic salts

Basic salts are formed by the partial replacement of hydroxide ions of a diacidic or triacidic base by an acid radical.

A basic salt may further reacts with an acid to give a normal salt.

$$Pb(OH)_2 + HCl \rightarrow Pb(OH)Cl + H_2O$$

(Diacidic base) Basic salt

4. Double salts

Double salts are formed by the combination of saturated solution of two simple salts in equimolar ratio followed by crystallization.

e.g. potash alum

11.7.2 USES OF SALTS

Common salt (NaCl)

It is used in our daily food and as preservative.

Washing soda (Na_2CO_3)

1. It is used in softening hard water.
2. It is used as a cleaning agent for domestic purposes.

Baking soda ($NaHCO_3$)

1. It is used in making baking powder, which is the mixture of baking soda and tartaric acid. Baking powder is used to make cake and bread soft and spongy .
2. It is an ingredient in antacid. Being alkaline, it neutralises excess of acid in the stomach.

Bleaching powder ($CaOCl_2$)

1. It is used for disinfecting drinking water to make it free from microorganisms.
2. It is used for bleaching cotton and linen in the textile industry

Plaster of paris($CaSO_4$. ½H_2O)

It is used for plastering fractured bones and in making casts for statues

GROUP ACTIVITY

Prepare the following salt in the laboratory

1. Sodium chloride
2. Potash alum

EVALUATION

PART - A

1. $Zn + 2HCl \rightarrow ZnCl_2 + H_2 \uparrow$

The above reaction is an example of

a. Combinationreaction
b. Double displacement reaction
c. Displacement reaction
d. Decomposition reaction.

2. A reddish brown coloured element 'X' on heating in air becomes black coloured compound 'Y'. X and Y are_____ and _____(Cu, CuO / Pb, PbO).

3. A student tested the p^H of pure water using a p^H paper. It showed green colour. If a p^H paper is used after adding lemon juice into water, what color will he observe? (Green / Red / Yellow)

4. Chemical volcano is an example of (combination reaction / decomposition reaction)

5. When crystals of lead nitrate on heating strongly produces a ____ gas and the colour of the gas is _____.

6. When aqueous solution of silver nitrate and sodium chloride are mixed _____ precipitate is immediately formed (white / yellow / red).

7. aluminium can displace Zinc metal from aqueous solution of Zinc sulphate (zinc is more reactive than aluminium / aluminium is more reactive than zinc).

8. To protect tooth decay, we are advised to brush our teeth regularly. The nature of the tooth paste commonly used is _____ in nature.

9. Vinegar is present in acetic acid. Curd contains _____ acid (Lactic acid / Tartaric acid).

10. $p^H = - \log_{10} [H^+]$. The p^H of a solution containing hydrogen ion concentration of 0.001M solution is _____(3 / 11 / 14)

PART - B

11. What type of chemical reaction takes place when i) limestone is heated ii) a magnesium ribbon is burnt in air

12. The p^H values of certain familiar substances are given below

Substance	pH value
Blood	7.4
Baking soda	8.2
Vinegar	2.5
Household ammonia	12

analyse the data in the table and answer the following questions

a. Which substance is acidic in nature?

b. Which substances are basic in nature?

13. Why does the colour of copper sulphate change when an iron nail is kept in it? Justify your answer.

14. The hydroxyl ion concentration of a solution is 1.0×10^{-8}M. What is the p^H of the solution?

15. Equal lengths of magnesium ribbons are taken in test tubes A and B. Hydrochloric acid is added to test tube A, while acetic acid is added to test tube B. Amount and concentration taken for both the acids are same in which test tube reaction occurs more vigourously and why?

FURTHER REFERENCE

Books:

1. Text book of Inorganic Chemistry–**P.L. Soni - S.Chand & sons** publishers
2. Principles of Physical Chemistry –B.R. Puri, L.R. Sharma Vishal publishers

Website:

www. ask.com

www.chem4kids.com

12. Periodic classification of elements

Have you ever visited a library? There are thousands of books in a large library. If you ask for a book in general it is very difficult to trace. Whereas if you ask for a particular book, the library staff can locate it very easily. How is it possible? In library the books are classified into various categories and sub categories. They are arranged on shelves accordingly. Therefore locating books become very easy.

As on date one hundred and eighteen elements are known. It is difficult to identify each and every element individually and to know its property and uses. Therefore they have been classified on the basis of their similarities in properties. One of the important instincts of mankind is to be systematic. Scientists felt the necessity to group elements of similar characteristics together so that if the properties of one of them are known, those of the others could be guessed and related.

Henry Gwyn-Jeffreys Moseley, an English physicist (1887–1915), used X-rays to determine the atomic numbers of the elements.

When a large number of elements were discovered, several attempts were being made to arrange them on the basis of their properties, nature, character, valency, etc., (Real credit for preparing the periodic table goes to Mendeleev).

12.1. MODERN PERIODIC LAW

A large number of scientists made attempts to eliminate the drawbacks of Mendeleev's periodic table. In 1912, Moseley, an English physicist measured the frequencies of X-rays emitted by a metal, when the metal was bombarded with high speed electrons. He plotted square roots of the frequencies against atomic numbers. The plot obtained was a straight line. He found that the square root of the frequency of the prominent X-rays emitted by a metal was proportional to the atomic number and not to the atomic weight of the atom of that metal.

MORE TO KNOW

Atomic number is number of protons in the nucleus or number of electrons revolving around the nucleus in an atom.

Moseley suggested that atomic number (Z) should be the basis of the classification of the element. Thus, he gave modern periodic law as follows:

Modern periodic law states that **"the physical and chemical properties of elements are the periodic function of their atomic numbers."**

Thus, according to the modern periodic law, if elements are arranged in the increasing order of their atomic numbers, the elements with similar properties are repeated after certain regular intervals.

12.2. MODERN PERIODIC TABLE

Based on the modern periodic law, a number of forms of periodic table have been proposed from time to time but general plan of the table remained the same as proposed by Mendeleev. The table which is most commonly used and which is based upon the **electronic configuration of elements** is called the **long form of the periodic table**. This is called the **modern periodic table.**

12.2.1. Description of modern or long form of the periodic table

Long form of the periodic table is a chart of elements in which the elements have been arranged in the increasing order of their atomic numbers. This table consists of **horizontal rows called periods and vertical columns called groups**.

12.2.3. Study of periods

The **horizontal rows are called periods**. There are **seven** horizontal rows in the periodic table.

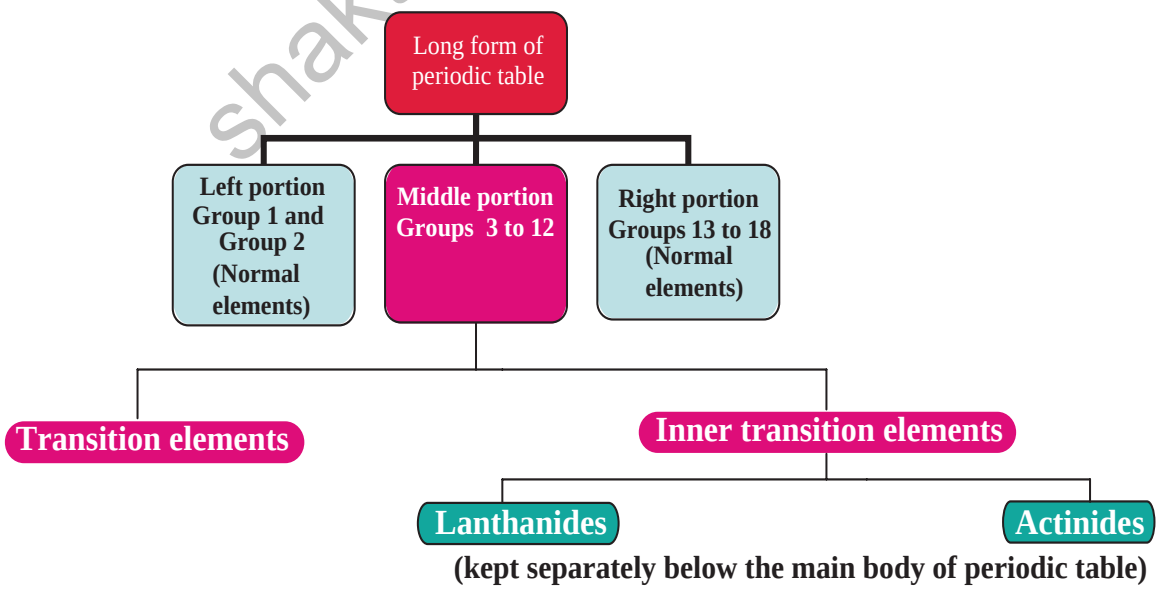
MORE TO KNOW

The modern periodic table has also been divided into four blocks known as s,p,d and f blocks.

- **First period** (Atomic number 1 and 2): This is the shortest period. It contains only two elements (Hydrogen and Helium).
- **Second period** (Atomic number 3 to 10): This is a short period. It contains eight elements (Lithium to Neon).

Third period (Atomic number 11 to 18): This is also a short period. It contains eight elements (Sodium to Argon).

12.2.2. Different portions of long form of periodic table



- **Fourth period** (Atomic number 19 to 36):

  This is a long period. It contains eighteen elements (Potassium to Krypton). This includes 8 normal elements and 10 transition elements.

- **Fifth period** (Atomic number 37 to 54): This is also a long period. It contains 18 elements (Rubidium to Xenon). This includes 8 normal elements and 10 transition elements.

- **Sixth period** (Atomic number 55 to 86): This is the longest period. It contains 32 elements (Ceasium to Radon). This includes 8 normal elements, 10 transition elements and 14 inner transition elements (Lanthanides).

- **Seventh period** (Atomic number 87 to 118): As like the sixth period, this period also can accomodate 32 elements. Till now only 26 elements have been authenticated by IUPAC

12.2.4. Study of groups

- Vertical columns in the periodic table starting from top to bottom are called groups. There are 18 groups in the periodic table.
- First group elements are called alkali metals.
- Second group elements are called alkaline earth metals.
- Groups three to twelve are called transition elements .
- Group 1, 2 and 13 - 18 are called normal elements or main group elements or representative elements .
- Group 13 is Boron family.
- Group 14 is Carbon family.
- Group 15 is Nitrogen family.
- Group 16 elements are called chalcogen family (except polonium).
- Group 17 elements are called halogen family.
- Group 18 elements are called noble gases or inert gases.
- The Lanthanides and actinides which form part of the group 3 are called inner transition elements.

12.3. CHARACTERISTICS OF MODERN PERIODIC TABLE

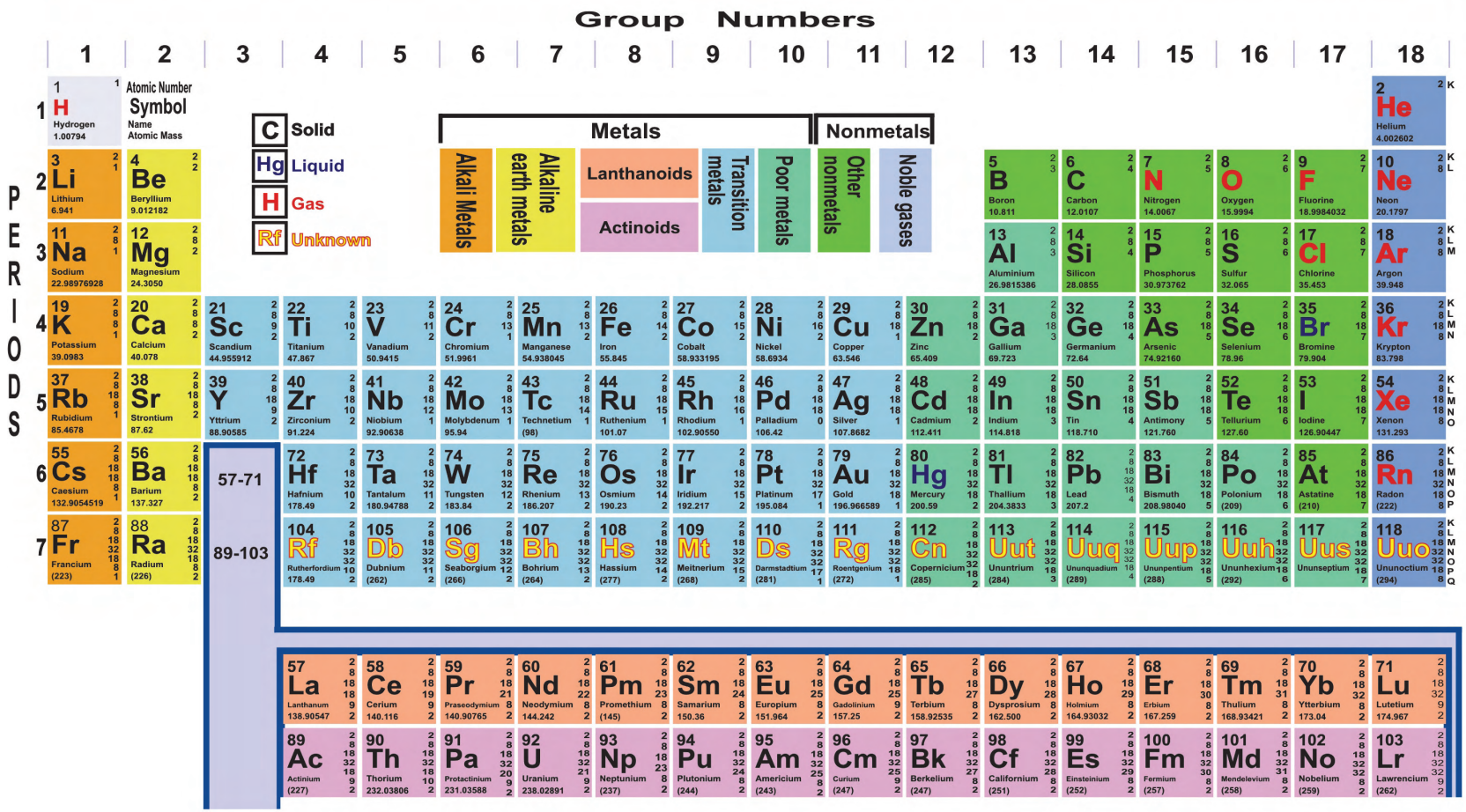
12.3.1. Characteristics Of Periods

- In a period, the electrons are filled in the same valence shell of all elements.
- As the electronic configuration changes along the period, the chemical properties of the elements also change.
- Atomic size of the elements in a period decrease from left to the right.
- In a period, the metallic character of the element decreases while their non-metallic character increases.

12.3.2. Characteristics of Groups

- The elements present in 2 and 18 groups differ in atomic number by 8,8,18,18,32.
- The elements present in 13 – 17 groups differ in atomic number by 8,18,18,32.
- The elements present in 4 - 12 groups differ in atomic number by 18,32,32.

MODERN PERIODIC TABLE



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- The elements present in a group have the same number of electrons in the valence shell of their atoms.
- The elements present in a group have the same valency.
- The elements present in a group have identical chemical properties.
- The physical properties of the elements in group such as melting point, boiling point, density vary gradually.
- Atomic radii of the elements present in a group increases downwards.

12.3.3. Advantages of the Modern Periodic Table

- The table is based on a more fundamental property ie., atomic number.
- It correlates the position of the element with its electronic configuration more clearly.
- The completion of each period is more logical. In a period as the atomic number increases, the energy shells are gradually filled up until an inert gas configuration is reached.
- It is easy to remember and reproduce.
- Each group is an independent group and the idea of sub-groups has been discarded.
- One position for all isotopes of an element is justified, since the isotopes have the same atomic number.
- The position of eighth group (in Mendeleev's table) is also justified in this table. All transition elements have been brought in the middle as the properties of transition elements are intermediate between left portion and right portion elements of the periodic table.
- The table completely separates metals from non-metals. The non-metals are present in upper right corners of the periodic table.
- The positions of certain elements which were earlier misfit (inter-changed) in the Mendeleev's periodic table are now justified because it is based on atomic number of the elements.
- Justification has been offered for placing lanthanides and actinides at the bottom of the periodic table.

12.3.4. Defects in the Modern Periodic Table

- Position of hydrogen is not fixed till now.
- Position of lanthanides and actinides has not been given inside the main body of periodic table.
- It does not reflect the exact distribution of electrons of some of transition and inner transition elements.

MORE TO KNOW

The last element authenticated by IUPAC is Cn112 [Copernicium]. However, the number of elements discovered so far is 118.

12.4. METALLURGY

I (Al) am a light silvery white metal to build aircraft. So, I am great.

I (Fe) am a lustrous steel metal to make machineries and bridges.So, I am great.

I (Cu) am a reddish brown metal to make coins. So, I am great.

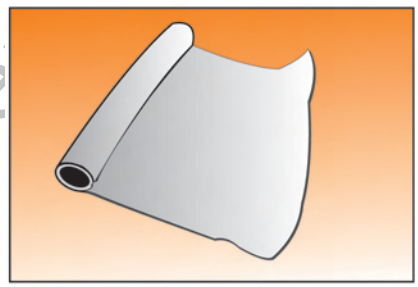
Individually you are great in your aspect.You will become the GREATEST IF YOU ARE ALLOYED TOGETHER.
Unity is strength.

INTRODUCTION

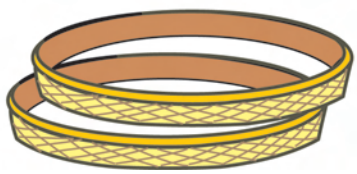
Metallurgy is as old as our civilization. Copper was the first metal to be used for making utensils, weapons and for other works. Metals play a significant role in our life. They constitute the mineral wealth of a country which is the measure of prosperity.

Metals like titanium, chromium, manganese, zirconium etc. find their applications in the manufacture of defence equipments. These are called **strategic metals**. The metal uranium plays, a vital role in nuclear reactions releasing enormous energy called nuclear energy. Copper, silver and gold are called **coinage metals** as they are used in making coins, jewellery etc.

Vietnameses Craft Work in silver



Aluminium foil



Bangles

MORE TO KNOW

Purity of gold is expressed in carat.

24 carat gold = pure gold.

For making ornaments 22 carat gold is used which contains 22 parts of gold by weight and 2 parts of copper by weight. The percentage of purity is $\frac{22}{24}$ x 100=91.6% (**916 Make gold**)

From one gram of gold, nearly 2km of wire can be drawn. Its an amazing fact indeed!

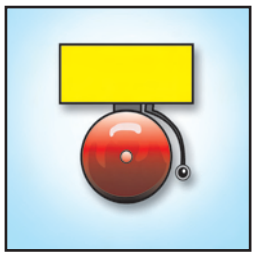
MORE TO KNOW

THE VITALITY OF METALS FOR THE TOTALITY OF LIFE

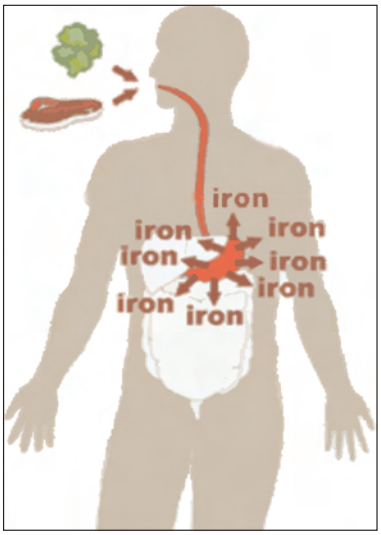
Metals in minute amounts are essential for various biological purposes. **Fe** – a constituent of blood pigment (haemoglobin).

Ca - a constituent of bone and teeth. **Co** - a constituent of vitamin B-12

Mg - constituent of chlorophyll.

METALS AROUND US



12.4.1. TERMINOLOGIES IN METALLURGY

Minerals: A mineral may be a single compound or complex mixture of various compounds of metals which are found in earth.

Ores: The mineral from which a metal can be readily and economically extracted on a large scale is said to be a ore.

For example, clay ($Al_2O_3.2SiO_2.2H_2O$) and bauxite ($Al_2O_3.2H_2O$) are the two minerals of aluminium. But aluminium can be profitably extracted only from bauxite. Hence **bauxite is an ore of aluminium and clay is its mineral**.

Gold *Silver* *Aluminium*

12.4.2. Differences between minerals and ores

- Minerals contain a low percentage of metal while ores contain a large percentage of metal.
- Metals cannot be extracted easily from mineral. On the other hand,ores can be used for the extraction of metals.
- All minerals cannot be called as ores,but all ores are minerals.

Mining: The process of extracting the ores from the earth crust is called mining.

Metallurgy: Various steps involved in the extraction of metals from their ores as well as refining of crude metal are collectively known as metallurgy.

Gangue or Matrix: The rocky impurity, associated with the ore is called gangue or matrix.

Flux: It is the substance added to the ore to reduce the fusion temperature

Slag: It is the fusible product formed when flux reacts with gangue during the extraction of metals.

$$\text{Flux} + \text{Gangue} \rightarrow \text{Slag}$$

Smelting: Smelting is the process of reducing the roasted oxide to metals in the molten condition.

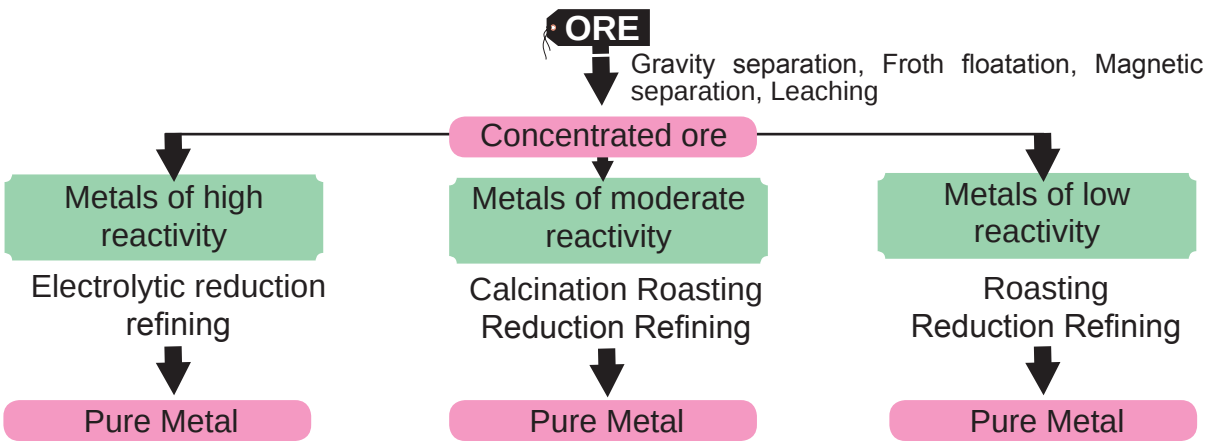
12.5. OCCURRENCE OF METALS

Nearly 80 metallic elements are obtained from mineral deposits on or beneath the surface of the earth.Metals which have low chemical reactivity are found in **free state, or in native state.**

Gold, silver and platinum are examples of metals that are partly found in a free state. Most of the other metals are found in a combined state in the form of their oxide ores, carbonate ores, halide ores, sulphide ores, sulphate ores and so on.

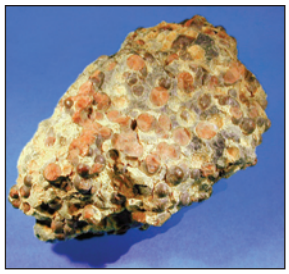
Oxide Ores	Carbonate Ores	Halide Ores	Sulphide Ores
Bauxite ($Al_2O_3.2H_2O$)	Marble ($CaCO_3$)	Cryolite (Na_3AlF_6)	Galena (PbS)
Cuprite (Cu_2O)	Magnesite ($MgCO_3$)	Fluorspar (CaF_2)	Iron pyrite (FeS_2)
Haematite (Fe_2O_3)	Siderite ($FeCO_3$)	Rock salt (NaCl)	Zinc blende (ZnS)

Flow Chart (Extraction of Metal from its ore)



12.6. METALLURGY OF ALUMINIUM, COPPER AND IRON

12.6.1. Metallurgy of aluminium



Symbol : Al
Colour : Silvery white
Atomic number : 13
Electronic configuration:2, 8, 3
Valency : 3
Atomic mass : 27

Position in the periodic table: period=3, group=13 (III A)

Aluminium is the most abundant metal in the earth's crust. Since it is a reactive metal it occurs in the combined state. The important ores of aluminium are as follows:

Name of the ore	Formula
Bauxite	$Al_2O_3.2H_2O$
Cryolite	Na_3AlF_6
Corundum	Al_2O_3

The chief ore of aluminium is bauxite ($Al_2O_3.2H_2O$).

Extraction of aluminium from bauxite involves two stages:

I. Conversion of Bauxite into Alumina by Baeyer's Process

The conversion of Bauxite into Alumina involves the following steps:

i.Bauxite ore is finely grounded and heated under pressure with concentrated caustic soda solution at 150°C to obtain sodium meta aluminate.

$$\underset{\text{Bauxite}}{Al_2O_3.2H_2O} + 2NaOH \xrightarrow{150^\circ C} \underset{\text{Sodium Meta aluminate}}{2NaAlO_2} + 3H_2O$$

ii.On diluting sodium meta aluminate with water, aluminium hydroxide precipitate is obtained.

$$NaAlO_2 + 2H_2O \rightarrow NaOH + Al(OH)_3$$

iii.The precipitate is filtered, washed, dried and ignited at 1000°C to get alumina.

$$2Al(OH)_3 \xrightarrow{1000^\circ C} Al_2O_3 + 3H_2O$$

2.Electrolytic reduction of Alumina by Hall's process

Aluminium is produced by the electrolytic reduction of fused alumina (Al_2O_3) in the electrolytic cell.

Cathode : Iron tank lined with graphite

Anode : A bunch of graphite rods suspended in molten electrolyte

Electrolyte : Pure alumina + molten cryolite + fluorspar (fluorspar lowers the fusion temperature of electrolyte)

Temperature : 900-950°C

Voltage used : 5-6V

The overall equation for aluminium extraction is

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Aluminium deposits at cathode and oxygen gas is liberated at anode

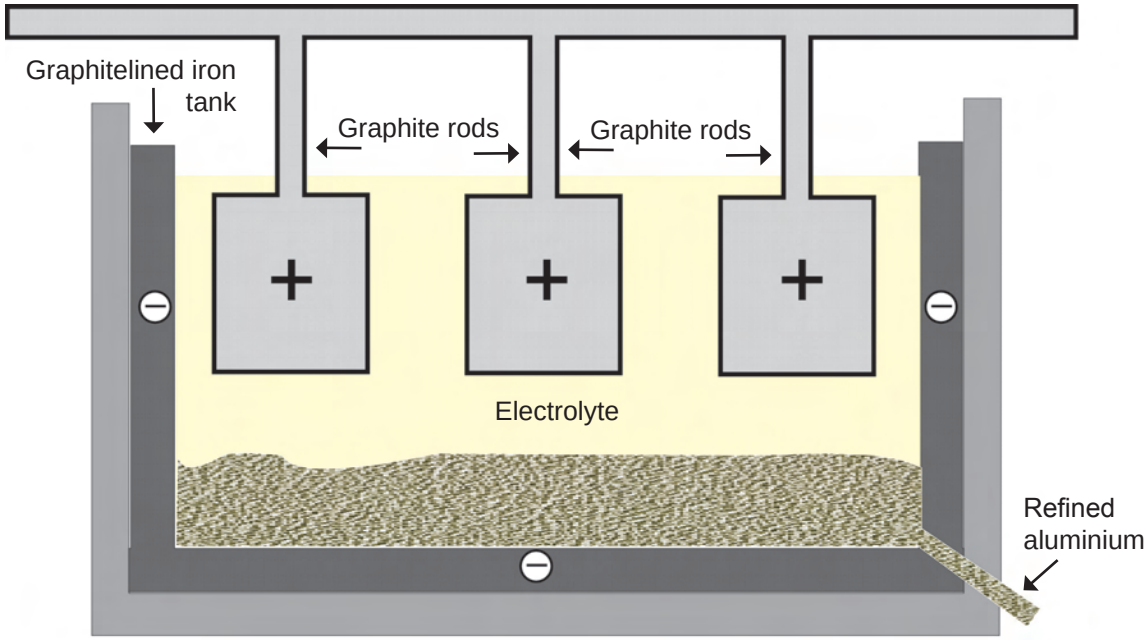


Fig 12.1 Electrolytic refining of aluminium

Properties of Aluminium

Physical properties:

i. It is a silvery white metal.
ii. It has low density and it is light
iii. It is malleable and ductile.
iv. It is a good conductor of heat and electricity.

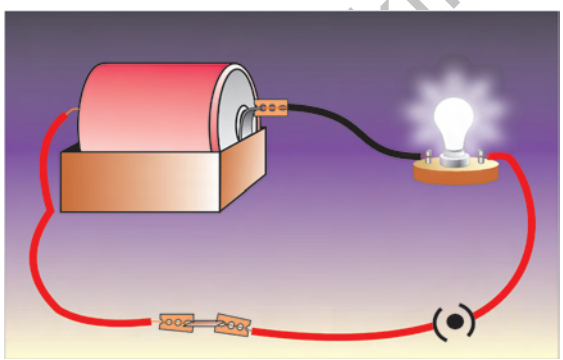


Fig. 12.2 Electric conductivity of metal

v. Melting point: 660°C
vi. It can be well polished to produce attractive shiny appearance.

Chemical properties:

1. Reaction with air: It is not affected by dry air.On heating at 800°C,aluminium burns very brightly forming its oxide and nitride.

$4Al + 3O_2 \rightarrow 2Al_2O_3$ (Aluminium Oxide)
$2Al + N_2 \rightarrow 2AlN$ (Aluminium Nitride)

2. Reaction with water: Water has no reaction on aluminium due to the layer of oxide on it.When steam is passed over red hot aluminium, hydrogen is produced.

$$2Al + \underset{\text{Steam}}{3H_2O} \rightarrow \underset{\substack{\text{Aluminium}\\\text{Oxide}}}{Al_2O_3} + 3H_2\uparrow$$

3. Reaction with alkalis: It reacts with strong caustic alkalis forming aluminates.

$$2Al + 2NaOH + 2H_2O \rightarrow \underset{\substack{\text{Sodium meta}\\\text{aluminate}}}{2NaAlO_2} + 3H_2\uparrow$$

4. Reaction with acids: With dilute and con. HCl it liberates H_2 gas.

$$2Al + 6HCl \rightarrow \underset{\substack{\text{Aluminium}\\\text{Chloride}}}{2AlCl_3} + 3H_2\uparrow$$

Aluminium liberates hydrogen on reaction with dilute sulphuric acid.Sulphur dioxide is liberated with hot concentrated sulphuric acid.

$$2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2\uparrow$$
Dilute

$$2Al + 6H_2SO_4 \rightarrow Al_2(SO_4)_3 + 6H_2O + 3SO_2\uparrow$$
hot & conc. Sulphuric acid — Aluminium Sulphate

MORE TO KNOW

Dilute or concentrated nitric acid does not attack aluminium. But it renders aluminium passive due to the formation of an oxide film on its surface.

5. Reducing action : Aluminium is a powerful reducing agent. When a mixture of aluminium powder and iron oxide is ignited, the latter is reduced to metal. This process is known as aluminothermic process.

$$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$$

Uses of Aluminium

USES	FORM	REASON
1.Household utensils	Aluminium metal	It is light, cheap, corrosion resistant, and good conductor of heat.
2.Electrical cable industry	Aluminium wires	It is a good conductor of electricity.
3.Aeroplanes and other industrial parts	Duralumin Al,Cu,Mg,Mn Magnalium Al,Mg	Its alloys are light, have high tensile strength and are corrosion resistant.
4.Thermite welding	Al powder and Fe_2O_3	Its powder is a strong reducing agent and reduces Fe_2O_3 to iron.

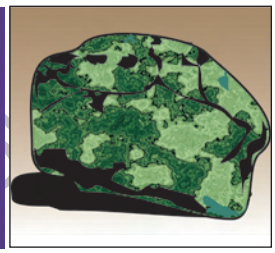
AirCraft - An alloy of aluminium

INDUSTRIAL VISIT

Fig 12.3

Make an industrial visit to the place where **Thermite welding** is actually done and record your observations on joining the gap between the broken pieces of rails.

12.6.2 Metallurgy of Copper



Symbol : Cu
Atomic mass : 63.55
Atomic number : 29
Electronic configuration : 2, 8, 18, 1
Valency : 1 and 2

Occurrence: It was named as cuprum by the Romans because they used to get it from the island of Cyprus. Copper is found in the **native state** as well as in the combined state.

Ores of copper	Formula
i. Copper pyrite	$CuFeS_2$
ii. Cuprite or ruby copper	Cu_2O
iii.Copper glance	Cu_2S

The chief ore of copper is copper pyrite. It yields nearly 76% of the world production of copper.

Extraction from copper pyrites:

Extraction of copper from copper pyrites involves the following steps.

1.**Crushing and concentration:** The ore is crushed and then concentrated by froth-floatation process.

2.**Roasting:** The concentrated ore is roasted in excess of air. During roasting,

i.moisture and volatile impurities are removed.
ii.copper pyrite is partly converted into sulphides of copper and iron.

$2CuFeS_2 + O_2 \rightarrow Cu_2S + 2FeS + SO_2$

3.**Smelting:** The roasted ore is mixed with powdered coke and sand and is heated in a blast furnace to obtain matte and slag. ***(Matte = Cu_2S + FeS)*** The slag is removed as a waste.

4.**Bessemerisation:** The molten matte is transferred to Bessemer converter in order to obtain ***blister copper.*** Ferrous sulphide from matte is oxidised to ferrous oxide which is removed as slag using silica.

$2Cu_2S + 3O_2 \rightarrow 2Cu_2O + 2SO_2$
$2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$
$FeO + SiO_2 \rightarrow FeSiO_3$ (Iron silicate, slag)

5.Refining: Blister copper contains 98% pure copper and 2% impurities and are purified by electrolytic refining.

Electrolytic refining.

This method is used to get metal of high degree of purity. For electrolytic refining of copper, we use

Cathode: A thin plate of pure copper metal.

Anode: A block of impure copper metal.

Electrolyte: Copper sulphate solution acidified with sulphuric acid. When electric current is passed through the electrolytic solution pure copper gets deposited at the cathode, impurities settled at the bottom of the anode in the form of sludge called **anode mud**.

Properties

Physical properties: Copper is a reddish brown metal, with high lustre, high density and high melting point (1356^0C).

Chemical properties:

i.**Action of air and moisture:** Copper gets covered with a green layer of basic copper carbonate in the presence of CO_2 and moisture.

$2Cu + O_2 + CO_2 + H_2O \rightarrow CuCO_3.Cu(OH)_2$

ii. Action of Heat: On heating at different temperatures in the presence of oxygen it forms two types of oxides CuO, Cu_2O.

$2Cu + O_2 \xrightarrow{\text{below 1370K}} 2CuO$ (copper II oxide –black)

$4Cu + O_2 \xrightarrow{\text{above 1370K}} 2Cu_2O$ (copper I oxide-red)

iii. Action of Acids:

a) with dil.HCl and dil.H_2SO_4

Dilute acids such as HCl and H_2SO_4 have no action on these metals in the absence of air. Copper dissolves in these acids in the presence of air.

$2Cu + 4HCl + O_2\ (air) \rightarrow 2CuCl_2 + 2H_2O$
$2Cu + 2H_2SO_4 + O_2\ (air) \rightarrow 2CuSO_4 + 2H_2O$

b) with dil.HNO_3 Copper reacts with dil. HNO_3 with the liberation of Nitric Oxide gas.

$3Cu + 8HNO_3(dil) \rightarrow 3Cu(NO_3)_2 + 2NO\uparrow + 4H_2O$

c) with con.HNO_3 and con.H_2SO_4

Copper reacts with con. HNO_3 and con. H_2SO_4 with the liberation of nitrogen dioxide and sulphur dioxide respectively.

$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2\uparrow + 2H_2O$
(conc.)

$$Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2\uparrow + 2H_2O$$
(conc.)

iv. Action of chlorine: Chlorine reacts with copper, resulting in the formation of copper (II) chloride.

$$Cu + Cl_2 \rightarrow CuCl_2$$

v. Action of alkalis: Copper is not attacked by alkalis.

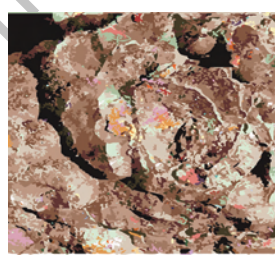
Uses

- It is extensively used for making electric cables and other electric appliances.
- It is used for making utensils, containers, calorimeters, coins.
- It is used in electroplating.
- It is alloyed with gold and silver for making coins and jewels.

PROJECT

Students may be asked to submit a project report on the important applications of copper in everyday life along with the samples.

12.6.3 METALLURGY OF IRON



Symbol	:	Fe
Colour	:	Greyish white
Atomic mass	:	55.9
Atomic number:		26
Valency	:	2 & 3
Electronic configuration	:	2, 8, 14, 2

Occurrence:

Iron is the second most abundant metal after aluminium. It occurs in nature as oxides, sulphides and carbonates. The ores of iron are given in the following table:

Ores of iron	Formula
I.Red haematite	Fe_2O_3
ii.Magnetite	Fe_3O_4
iii.Iron pyrites	FeS_2

Extraction of Iron from haematite ore (Fe_2O_3)

1.Concentration by gravity separation

The powdered ore is washed with stream of water. As a result, the lighter sand particles and other impurities are washed away and heavier ore particles settle down.

2.Roasting and calcination

The concentrated ore is strongly heated in a limited supply of air in a reverberatory furnace. As a result, moisture is driven out and sulphur, arsenic, phosphorus impurities are oxidised off.

3.Smelting (in Blast furnace)

The **charge** consisting of roasted ore, coke and limestone in the ratio **8 : 4 : 1** is smelted in a blast furnace by introducing it through the **cup and cone** arrangement at the top. There are three important regions in the furnance.

i.The lower region(combustion zone)- temperature is at 1500^0C.

In this region, coke burns with oxygen to form CO_2 when the charge comes in contact with the hot blast of air.

$C + O_2 \xrightarrow{1500°C} CO_2 + heat$

It is an exothermic reaction since heat is liberated.

ii.The middle region (fusion zone)-The temperature prevails at 1000^{0}C.In this region CO_2 is reduced to CO.

$CO_2 + C \xrightarrow{1000°C} 2CO$

Limestone decomposes to calcium oxide and CO_2.

$CaCO_3 \xrightarrow{\blacktriangle} CaO + CO_2$

These two reactions are endothermic due to the absorption of heat. Calcium oxide combines with silica to form calcium silicate slag.

$CaO + SiO_2 \rightarrow CaSiO_3$

iii.The upper region (reduction zone)-temperature prevails at 400^{0}C. In this region carbon monoxide reduces ferric oxide to form a fairly pure spongy iron.

$Fe_2O_3 + 3CO \xrightarrow{400°C} 2Fe + 3CO_2$

The molten iron is collected at the bottom of the furnace after removing the slag.

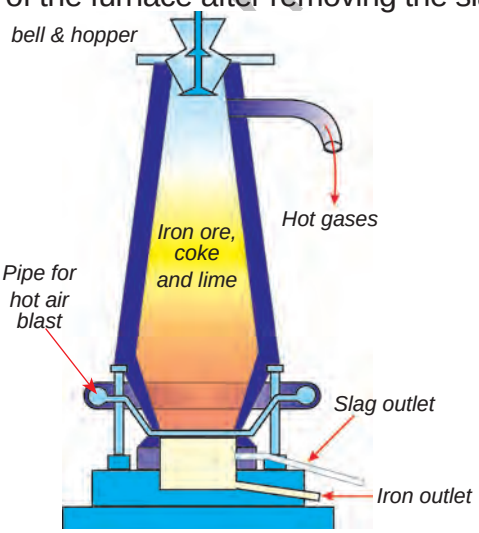


Fig. 12.4 Blast furnace

The iron thus formed is called **pig iron**. It is remelted and cast into different moulds. This iron is called **cast iron.**

MORE TO KNOW

CALCINATION AND ROASTING

CALCINATION: It is a process in which ore is heated in the absence of air. As a result of calcinations the carbonate ore is converted into its oxide.

ROASTING: It is a process in which ore is heated in the **presence of excess of air**. As a result of roasting the sulphide ore is converted into its oxide.

MORE TO KNOW

Depending upon the carbon content iron is classified into 3 types.

Pig iron with carbon content of 2- 4.5%

Wrought iron with carbon content <0.25%

Steel with carbon content of 0.25-2%.

Physical properties

- It is a heavy metal of specific gravity 7.9 g/cc
- It is a lustrous metal and greyish white in colour.
- It has high tensility, malleability and ductility.
- It is a good conductor of heat and electricity.
- It can be magnetised.

CHAPTER 12

Chemical properties

1.Reaction with air or oxygen: Only on heating in air, iron forms magnetic oxide

$3Fe + 2O_2 \rightarrow Fe_3O_4$ (black)

2.Reaction with moist air: When iron is exposed to moist air, it forms a layer of brown hydrated ferric oxide on its surface. This compound is known as rust and the phenomenon of forming this rust is known as rusting.

$4Fe + 3O_2 + \underset{\text{(Moisture)}}{3H_2O} \rightarrow 2Fe_2O_3.3H_2O$(Rust)

3.Reaction with steam: When steam is passed over red hot iron,magnetic oxide of iron is formed.

$3Fe + 4H_2O$(steam) $\rightarrow Fe_3O_4 + 4H_2\uparrow$

4.Reaction with chlorine: Iron combines with chlorine to form ferric chloride.

$2Fe + 3Cl_2 \rightarrow 2FeCl_3$(ferric chloride)

5.Reaction with acids: With dilute HCl and dilute H_2SO_4 it evolves H_2 gas

$Fe + 2HCl \rightarrow FeCl_2 + H_2\uparrow$

$Fe + H_2SO_4 \rightarrow FeSO_4 + H_2\uparrow$

With conc. H_2SO_4 it forms ferric sulphate

$2Fe + 6H_2SO_4 \rightarrow Fe_2(SO_4)_3 + 3SO_2 + 6H_2O$

With dilute HNO_3 in cold condition it gives ferrous nitrate

$4Fe + 10HNO_3 \rightarrow 4Fe(NO_3)_2 + NH_4NO_3 + 3H_2O$

When iron is dipped in conc. HNO_3 it becomes chemically **inert or passive** due to the formation of a layer of iron oxide (Fe_3O_4) on its surface.

Uses of iron

i.**Pig iron** is used in making pipes, stoves, radiators, railings, man hole covers and drain pipes.

ii. **Steel** is used in the construction of buildings, machinery, transmission and T.V towers and in making alloys.

iii.**Wrought iron** is used in making springs, anchors and electromagnets.

12.7 ALLOYS

An alloy is a homogeneous mixture of of a metal with other metals or with non-metals that are fused together.

Alloys are solid solutions. Alloys can be considered as solid solutions in which the metal with high concentration is **solvent** and the metal with low concentration is **solute**. For example, brass is an alloy of zinc(solute) in copper(solvent).

12.7.1 Methods of making alloys:

1.By fusing the metals together.

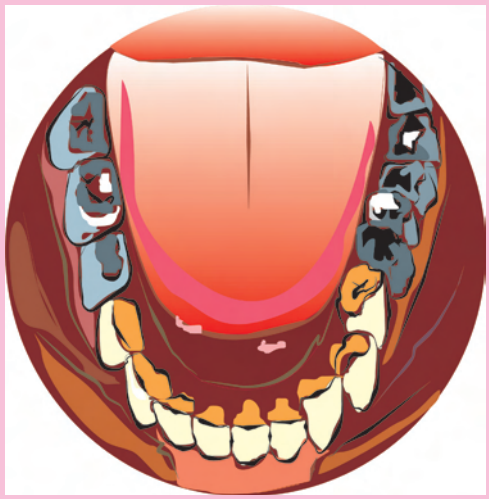
2.By compressing finely divided metals one over the other.

Amalgam: An amalgam is an alloy of mercury with metals such as sodium, gold, silver, etc.,

MORE TO KNOW

DENTAL AMALGAMS

It is an alloy of mercury with silver and tin metals. It is used in dental filling.



Dental amalgam

CHEMISTRY

12.7.2 Copper Alloys

Name of the alloy	Reason for alloying	Uses
i.Brass(Cu,Zn)	Lusturous,easily cast,malleable, ductile,harder than Cu.	Electrical fittings, medals, hard ware, decorative items.
ii.Bronze(Cu,Sn,Zn)	Hard,brittle,takes up polish.	Statues, coins, bells, gongs.

12.7.3 Aluminium Alloys

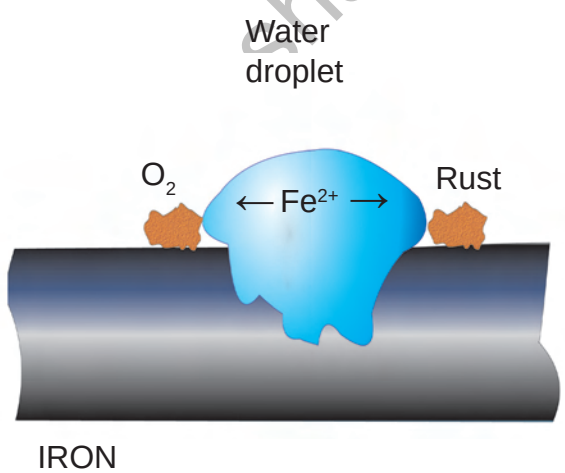
Name of the alloy	Reason for alloying	Uses
i.Duralumin(Al,Mg,Mn,Cu)	Light,strong,resistant to corrosion stronger than aluminium.	Aircraft,tools,pressure cookers
ii.Magnalium(Al,Mg)	Light,hard,tough,corrosion resistant.	Aircraft,scientific instrument

12.7.4 Iron Alloys

Name of the alloy	Reason for alloying	Uses
i.Stainless steel (Fe,C,Ni,Cr)	Lusturous,corrosion resistant,high tensile strength.	Utensils,cutlery,automobile parts.
ii.Nickel steel (Fe,C,Ni)	Hard, corrosion resistant,elastic.	Cables,aircraft parts,propeller.

12.8 CORROSION

Corrosion is defined as the slow and steady destruction of a metal by the environment. It results in the deterioration of the metal to form metal compounds by means of chemical reactions with the environment.



Rusting of iron

MORE TO KNOW

MECHANISM OF CORROSION

Corrosion is a simple electro chemical reaction.

When the surface of iron is in contact with a piece of carbon and water, iron acts as the anode and the carbon acts as a cathode.CO_2 from air dissolves in water to form carbonic acid(H_2CO_3).This acid acts as an electrolyte.

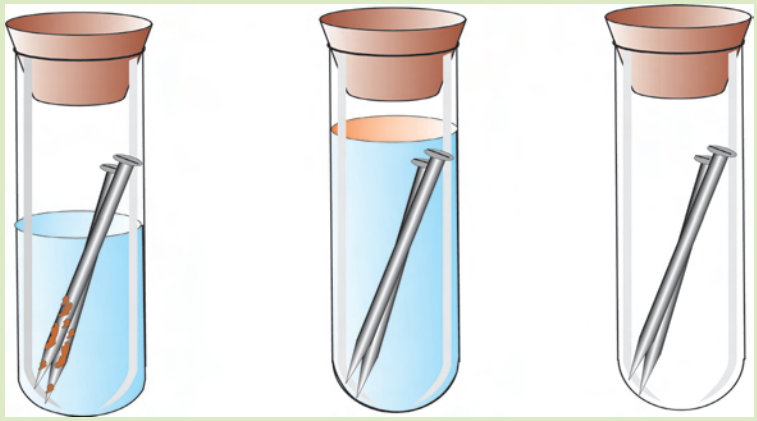
The electrochemical reactions are as follows:

$Fe \rightarrow Fe^{2+} + 2e^-$

$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$

The Fe^{2+} ions are oxidised to Fe^{3+} ions. The Fe^{3+} ions combine with OH^- ions to form $Fe(OH)_3$.This becomes **rust ($Fe_2O_3.xH_2O$) which is hydrated ferric oxide.**

ACTIVITY 12.1



The conditions for rusting

Take three test tubes provided with rubber corks and label them as A, B and C. Place few iron nails of same size in these tubes. Pour some water in test tube A, some boiled water along with turpentine oil in test tube B and anhydrous $CaCl_2$ in test tube C.Keep them under observation for few days. Notice the changes.

The nails in A are rusted while the nails in B and C are unaffected.

The rusting of nails in A is due to air and water. In B, the oily layer above water does not allow air to come in contact with nails. In C, the substance anhydrous $CaCl_2$ has absorbed moisture completely. This activity shows that rusting of iron requires air and water.

Methods of preventing corrosion:

Corrosion of metals is prevented by not allowing them to come in contact with moisture,CO_2 and O_2.This is achieved by the following methods:

- **By coating with paints:** Paint coated metal surfaces keep out air and moisture.
- **By coating with oil and grease:** Application of oil and grease on the surface of iron tools prevents them from moisture and air.
- **By alloying with other metals:** Alloyed metal is more resistant to corrosion.
- **Example:** stainless steel.
- **By the process of galvanization:** This is a process of coating zinc on iron sheets by using electric current. In this zinc forms a protective layer of zinc carbonate on the surface of iron. This prevents corrosion.
- **Electroplating:** It is a method of coating one metal with another by passing electric current. Example: silver plating, nickel plating. This method not only lends protection but also enhances the metallic appearance.
- **Sacrificial protection:** Magnesium is more reactive than iron. When it is coated on the articles made of steel it sacrifices itself to protect the steel.

EVALUATION

PART - A

1. In the modern periodic table periods and groups are given. Periods and groups indicate_____
   a) Rows and Columns b) Columns and rows
2. Third period contains 8 elements, out of these elements how many elements are non-metals?.
3. An element which is an essential constituent of all organic compounds belongs to _____ group. (14^{th} group / 15^{th} group)
4. Ore is used for the extraction of metals profitably. Bauxite is used to extract aluminium, it can be termed as _____. (ore / mineral)
5. Gold does not occur in the combined form. It does not react with air (or) water. It is in _____. (native state / combined state)

PART - B

6. Assertion: Greenish layer appears on copper vessels if left uncleaned.
   Reason: It is due to the formation of layer of basic copper carbonate
   Give your correct option
   a) assertion and reason are correct and relevant to each other
   b) assertion is true but reason is not relevant to the assertion
7. A process employed for the concentration of sulphide ore is _____. (froth floation / gravity separation)
8. Coating the surface of iron with other metal prevents it from rusting. If it is coated with thin layer of zinc it is called _____ (galvanization / painting / cathodic protection)
9. Any metal mixed with mercury is called amalgam. The amalgam used for dental filling Is _____. (Ag – Sn amalgam / Cu – Sn amalgam)
10. Assertion: In thermite welding, aluminium powder and Fe_2O_3 are used. Reason: Aluminium powder is a strong reducing agent. Does the reason satisfy the assertion?

PART - C

11. Can rusting of iron nail occur in distilled water. Justify your answer.
12. Why cannot aluminium metal be obtained by the reduction of aluminium oxide with coke?
13. Iron reacts with con. HCl and con. H_2SO_4. But it does not react with con. HNO_3. Suggest your answer with proper reason.
14. To design the body of the aircraft aluminium alloys are used. Give your reason.
15. X is a silvery white metal. X reacts with oxygen to form Y. The same compound is obtained from the metal on reaction with steam with the liberation of hydrogen gas. Identify X and Y.

FURTHER REFERENCE:
Books: Text Book of Inorganic chemistry – P.L. Soni S.Chand Publishers
Website: www.tutorvista.com. www.sciencebyjones.com

13. Carbon and its compounds

Symbol	:	C
Atomic Number	:	6
Atomic Mass	:	12
Valency	:	4

The electronic configuration of carbon is K=2, L=4. It has four electrons in the valence shell and belongs to group IV A (group 14) of the periodic table.

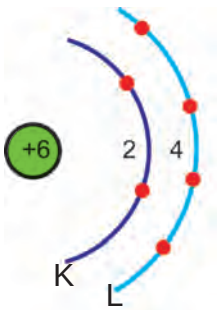


Fig. 13. 1 electronic configuration of carbon

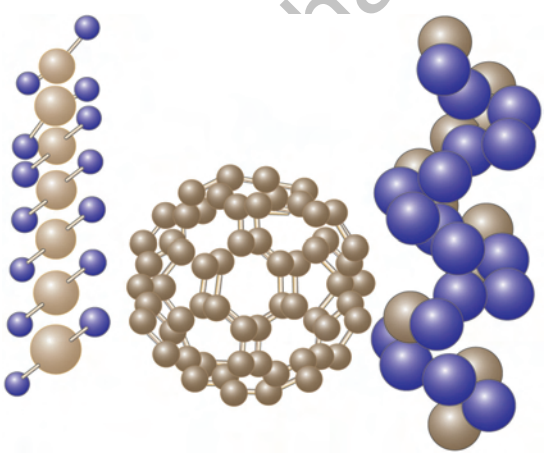


Fig. 13.2 An arrangement depicting carbon and its compounds.

INTRODUCTION

Without carbon, no living thing could survive. Human beings are made up of carbon compounds. Carbon is a non metal. In nature, it occurs in its pure form as **diamond and graphite.** When fuels burn, the carbon in them reacts with oxygen to form carbon dioxide.

Carbon compounds hold the key to plant and animal life on earth. Hence, carbon chemistry is called **Living Chemistry.** Carbon circulates through air, plants, animals and soil by means of complex reactions. This is called **carbon cycle**.

13.1. COMPOUNDS OF CARBON

In the beginning of 19th century scientists classified the compounds of carbon into two types, based on their source of occurence:

i) Inorganic compounds (obtained from non living matter)

ii) Organic compounds (obtained from living matter, such as plant and animal sources) however the basis of classification was subjected to alteration after wohler synthesis.

LIVING CHEMISTRY

All living organisms are made of carbon atoms. This means that, carbon atoms form the building blocks for living organisms. These carbon atoms, in combination with other atoms decide life on earth. Hence **carbon chemistry** is also called as **living chemistry**.

Fig. 13.3

Fig. 13.4

FRIEDRICH WOHLER

A creator of revolution in **ORGANIC CHEMISTRY**

MORE TO KNOW

ORGANIC CHEMISTRY:

The word organic signifies life. The term organic chemistry was used by the Swedish chemist Berzelius. This refers to the chemistry of living things. However, the German chemist Wohler succeeded in creating an organic compound (urea) from an inorganic compound (ammonium cyanate) in his laboratory. This has dealt a severe blow to the Vital force theory (a theory of life process).

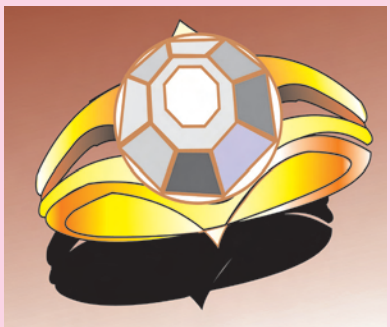
FRIEDRICH WOHLER
A German Chemist

CHEMISTRY

13.2. MODERN DEFINITION OF ORGANIC CHEMISTRY

Organic chemistry is defined as the branch of chemistry that deals with organic compounds which are made up of the hydrocarbons and their derivatives. It gives a thorough insight into the nature of bonding, synthesis, characteristics and their usefulness in various fields.

MORE TO KNOW



A polished diamond

The most precious diamond is a crystalline allotrope of carbon. KOHINOOR DIAMOND is a 105 carat diamond (21.68g) It was seized by the EAST INDIA COMPANY and became the part of British Crown Jewels. May it be an ordinary coal or the most precious Kohinoor diamond,it is an allotropic modification of carbon indeed!

13.3. BONDING IN CARBON AND ITS COMPOUNDS

The atomic number of carbon is 6 and its ground state electronic configuration is $1s^2\ 2s^2\ 2p^2$. Since it has four electrons in its outermost shell, its valency is four. To achieve noble gas configuration, carbon atom has to lose or gain four electrons to form C^{4+} and C^{4-} ions.

1. It could gain four electrons forming C^{4-} anion, but it would be difficult for the nucleus with six protons to hold on to ten electrons i.e.four extra electrons.
2. It could lose four electrons to form C^{4+} cations, but it would require a large amount of energy to remove four electrons leaving behind the carbon cations with six protons in its nucleus holding on to just two electrons.

Carbon overcomes this problem by sharing its valence electrons with other atoms of carbon or with atoms of other elements. *This characteristic of carbon atom by virtue of which it forms four covalent bonds is generally referred as* **tetra valency of carbon.**

A molecule of methane (CH_4) is formed when four electrons of carbon are shared with four hydrogen atoms.

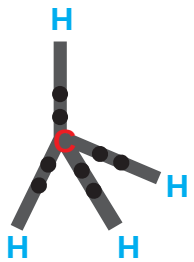


Fig. 13.5 Structure of methane

•• ***Represents shared pair of electrons***

CHAPTER 13

13.4 ALLOTROPY

Allotropy is defined as the property by which an element can exist in more than one form that are physically different but chemically similar.

Allotropes of carbon

- Carbon exists in three allotropic forms. They are crystalline form (diamond and graphite), amorphous form (coke,charcoal) and fullerene.

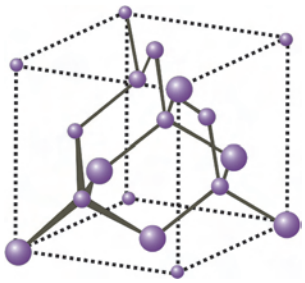


Fig. 13.6
Structure of diamond

- In diamond each carbon atom is bonded to four other carbon atoms forming a rigid three dimensional structure, accounting for it's hardness and rigidity.
- In graphite each carbon atom is bonded to three other carbon atoms in the same plane giving hexagonal layers held together by weak **vander Waals forces** accounting for softness.
- Graphite is a good conductor of electricity unlike other non-metals since it has free electrons in it.

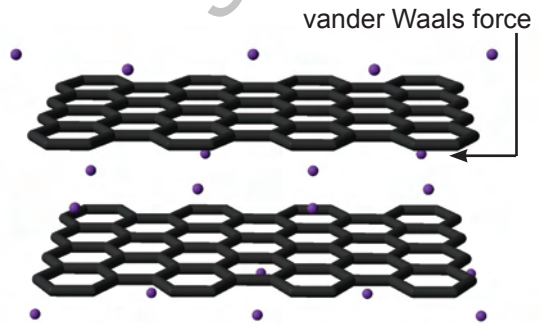


Fig. 13.7 Structure of graphite

- Fullerenes form another type of carbon allotropes. The first one was identified to contain 60 carbon atoms in the shape of a football. (C-60). Since this looks like the geodesic dome designed by the US architect Buck Minster Fuller, it is named as Buck Minster Fullerene.

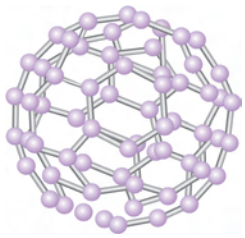


Fig. 13.8 Fullerene

Fig. 13.9 Foot ball

13.5 Physical nature of carbonand its compounds :

- Carbon has the ability to form covalent bonds with other atoms of carbon giving rise to large number of molecules through self linking property This property is called ***catenation***. Since the valency of carbon is four, it is capable of bonding with four other atoms.
- Carbon combines with oxygen, hydrogen, nitrogen, sulphur, chlorine and many other elements to form various stable compounds.
- The stability of carbon compounds is due to the small size of carbon which enables the nucleus to hold on to the shared pair of electrons strongly.
- Carbon compounds show ***isomerism***, the phenomenon by which two or more compounds to have same molecular formula but different structural formula with difference in properties. i.e the formula C_2H_6O represents two different compounds namely ethyl alcohol (C_2H_5OH) and dimethyl ether (CH_3OCH_3).
- Carbon compounds have low melting and boiling points because of their covalent nature.

- The reactions shown by carbon compounds involve breaking of old bonds in the reacting molecules and the formation of new bonds in the product molecules.
- Carbon compounds are easily combustible.

13.6 CHEMICAL PROPERTIES

- Carbon and its compounds burn in oxygen to give carbon dioxide along with heat and light.

e.g.,

$C + O_2 \rightarrow CO_2 + \text{heat} + \text{light}$

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{heat} + \text{light}$

$C_2H_5OH + 2O_2 \rightarrow 2CO_2 + 3H_2O + \text{heat} + \text{light}$

- Carbon compounds can be easily oxidized using suitable oxidizing agent Alkaline potassium permanganate to form carboxylic acids.
- Unsaturated carbon compounds undergo addition reactions with hydrogen in the presence of palladium or nickel catalyst.

e.g.,

$$CH_2 = CH_2 \xrightarrow[\text{Ni-catalyst}]{\text{Addition of hydrogen}} CH_3 - CH_3$$

Ethene Ethane

- Carbon compounds undergo substitution reactions in the presence of either sunlight or any other reagents. e.g., methane undergoes substitution reaction to form different types of products.
- Carbon compounds such as alcohols react with sodium to liberate hydrogen gas.

e.g., $2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2ONa + H_2$

13.7 HOMOLOGOUS SERIES

A homologous series is a group or a class of organic compounds having similar structure and similar chemical properties in which the successive compounds differ by a CH_2 group.

13.7.1 Characteristics of homologous series

- Each member of the series differs from the preceeding or succeeding member by a common difference of CH_2 and by a molecular mass of 14 amu (amu = atomic mass unit).
- All members of homologous series contain same elements and the same functional groups.
- All members of homologous series have same general molecular formula.

e.g **Alkane = C_nH_{2n+2}**

Alkene = C_nH_{2n}

Alkyne = C_nH_{2n-2}

- The members in homologous series show a regular gradation in their physical properties with respect to increase in molecular mass.
- The chemical properties of the members of the homologous series are similar.
- All members of homologous series can be prepared by using same general method.

13.8 IMPORTANCE OF HOMOLOGOUS SERIES

1. It helps to predict the properties of the members of the series that are yet to be prepared.
2. Knowledge of homologous series gives a systematic study of the members.
3. The nature of any member of the family can be ascertained if the properties of the first member are known.

13.9 HYDROCARBONS

The simplest organic compounds containing only carbon and hydrogen are called ***Hydrocarbons.*** These are regarded as the **parent organic compounds** and all other compounds are considered to be derived from them by the replacement of one or more hydrogen atoms by other atoms or groups of atoms.

Hydro carbons are classified into two types: *saturated and unsaturated hydrocarbons*.

13.9.1 Saturated hydrocarbons – Alkanes

General formula = C_nH_{2n+2} Suffix : ane

These are the organic compounds which contain carbon – carbon single bond.These were earlier named as **paraffins**(Latin : meaning little affinity) due to their least chemical reactivity. According to IUPAC system, these are named as ***alkanes*** (ane is suffix with root word).

Formula	Common name	IUPAC name
CH_4	Methane	Methane
CH_3CH_3	Ethane	Ethane
$CH_3CH_2CH_3$	Propane	Propane
$CH_3CH_2CH_2CH_3$	n-Butane	Butane

13.9.2 Unsaturated hydrocarbons

These are hydrocarbons which contain carbon to carbon double bonds $\left(-\overset{|}{C}=\overset{|}{C}-\right)$ or carbon to carbon triple bonds **-C≡C-** in their molecules.These are further classified into two types: ***alkenes and alkynes.***

i)***Alkenes***: ***General formula:*** **C_nH_{2n}** ***Suffix:*** **ene**

The hydrocarbons containing atleast one carbon to carbon double bond are called ***alkenes.***They have the general formula C_nH_{2n} .These were previously called ***olefins*** (Greek : olefiant – oil forming) because the lower gaseous members of the family form oily products when treated with chlorine.

In IUPAC system, the name of alkene is derived by replacing suffix **ane** of the correspding alkane by **ene**.For example,

$CH_3 - CH_3$ ethane $H_2C = CH_2$ ethene

Fig. 14.0 Bromine Test

(Left) No change in colour - saturated, (Right) Decolouration occurs - unsaturated

In higher alkenes, the position of the double bond, can be indicated by assigning numbers 1, 2, 3, 4, ……to the carbon atoms present in the molecule.

Alkene	Common name	IUPAC name
$CH_2 = CH_2$	Ethylene	Ethene
$CH_3CH = CH_2$	Propylene	Propene
$CH_3CH_2–CH=CH_2$	α-Butylene	But–1–ene
$CH_3CH = CHCH_3$	β-Butylene	But–2–ene

ii) ***Alkynes***: ***General formula:*** C_nH_{2n-2} ***Suffix :*** **yne**

The hydrocarbons containing carbon to carbon triple bond are called ***alkynes***. Alkynes are named in the same way as alkenes i.e., by replacing suffix **ane** of alkane by **yne.** In higher members, the position of triple bond is indicated by giving numbers 1, 2, 3, 4, ….to the carbon atom in the molecule.

Alkyne	Common name	IUPAC name
HC ≡ CH	Acetylene	Ethyne
H_3C – C ≡CH	Methyl acetylene	Propyne
H_3C – C ≡C – CH_3	Dimethyl acetylene	But–2-yne
H_3C - CH_2 –C ≡ CH	Ethyl acetylene	But–1–yne

13.10. FUNCTIONAL GROUP

Functional group may be defined as an atom or group of atoms or reactive part which is responsible for the characteristic properties of the compounds. The chemical properties of organic compounds are determined by the functional groups while their physical properties are determined by the remaining part of the molecule.

Example: -OH => Alcohol | >C=O => Ketone

–CHO => Aldehyde | –COOH => Carboxylic acid

13.10.1. Classification of organic compounds based on functional group

1. Alcohols

Alcohols are carbon compounds containing **–OH** group attached to alkyl group. The general formula of alcohol is **R-OH** where '**R**' is an **alkyl group** and **–OH** is the **functional group**. The IUPAC name of alcohol is derived by replacing **–e**, in the word **alkane,** by the suffix **–ol**. Hence we get the name **alkanol**.

Molecular formula	Common name	IUPAC name
CH_3OH	Methyl alcohol	Methanol
CH_3-CH_2-OH	Ethyl alcohol	Ethanol
CH_3- CH_2-CH_2-OH	n-Propyl alcohol	1-Propanol
CH_3-CH-CH_3 I OH	Isopropyl alcohol or secondary propyl alcohol	2-Propanol
CH_3- CH_2-CH_2-CH_2-OH	n-Butyl alcohol	1-Butanol
CH_3-CH-CH_2-OH I CH_3	Isobutyl alcohol	2-Methyl-1-propanol

2. Aldehydes

Aldehydes are carbon compounds containing -**CHO** group attached to alkyl group or hydrogen atom. The general formula of aldehydes is **R – CHO** where **'R'** is an **alkyl group** or **hydrogen atom** and – **CHO** is the **functional group**. The IUPAC name of aldehyde is derived by replacing –**e**, in the word alkane, by the suffix –**al**. Hence we get the name **"alkanal"**.

Molecular formula	Common name	IUPAC name
HCHO	Formaldehyde	Methanal
CH_3- CHO	Acetaldehyde	Ethanal
CH_3- CH_2- CHO	Propionaldehyde	Propanal
CH_3- CH_2-CH_2- CHO	Butyraldehyde	Butanal

3. Ketones

Ketones are carbon compounds containing carbonyl – **CO** – group attached to two alkyl groups. The general formula of ketone is **R-CO-R'** where **R** and **R'** are **alkyl groups** and – **CO** – is the **functional group**. The IUPAC name of ketone is derived by replacing –**e**, in the word alkane, by the suffix -**one**. Hence we get the name **"alkanone"**.

Molecular formula	Common name	IUPAC name
CH_3COCH_3	Dimethyl ketone (Acetone)	Propanone
$CH_3COCH_2CH_3$	Ethyl methyl ketone	2-Butanone
$CH_3CH_2COCH_2CH_3$	Diethyl ketone	3-Pentanone

4. Carboxylic Acids

Carboxylic acids are carbon compounds containing **–COOH** group attached to a hydrogen atom or alkyl group. The general formula of acid is **R-COOH** where **'R'** is a **hydrogen atom** or **alkyl group** and **–COOH** is the **functional group**. The IUPAC name of acid is derived by replacing – e, in the word alkane, by the suffix –oic acid. Hence we get the name **"alkanoic acid"**.

Molecular formula	Common name	IUPAC name
HCOOH	Formic acid	Methanoic acid
CH_3-COOH	Acetic acid	Ethanoic acid
CH_3- CH_2-COOH	Propionic acid	Propanoic acid
CH_3- CH_2-CH_2-COOH	n-Butyric acid	Butanoic acid

SOME IMPORTANT ORGANIC COMPOUNDS

Almost all the compounds are useful to us in a number of ways. Most of the fuels, medicines, paints, explosives, synthetic polymers, perfumes and detergents are basically organic compounds. In fact, organic chemistry has made our life colourful and also comfortable. Two commercially important compounds, ethanol and ethanoic acid are briefly discussed here.

13.11 ETHANOL (C_2H_5OH)

Ethanol or ethyl alcohol or simply alcohol is one of the most important members of the family of alcohols.

(1) Manufacture of ethanol from molasses

Molasses is a dark coloured syrupy liquid left after the crystallization of sugar from the concentrated sugar cane juice. Molasses still contain about 30% of sucrose which cannot be separated by crystallization. It is converted into ethanol by the following steps:

(i) Dilution

Molasses is first diluted with water to bring down the concentration of sugar to about 8 to 10 percent.

(ii) Addition of ammonium salts

Molasses usually contains enough nitrogenous matter to act as food for yeast during fermentation. If the nitrogen content of the molasses is poor, it may be fortified by the addition of ammonium sulphate or ammonium phosphate.

(iii) Addition of yeast

The solution from step (ii) is collected in large 'fermentation tanks' and yeast is added to it. The mixture is kept at about 303K for a few days.During this period, the enzymes invertase and zymase present in yeast, bring about the conversion of sucrose into ethanol.

$$C_{12}H_{22}O_{11} + H_2O \xrightarrow{\text{invertase}} C_6H_{12}O_6 + C_6H_{12}O_6$$

Sucrose — Glucose — Fructose

$$C_6H_{12}O_6 \xrightarrow{\text{zymase}} 2C_2H_5OH + 2CO_2\uparrow$$

Glucose — Ethanol

The fermented liquid is technically called wash.

(iv) Distillation of wash

The fermented liquid containing 15 to 18 percent alcohol and the rest of the water, is now subjected to fractional distillation. The main fraction drawn, is an aqueous solution of ethanol which contains 95.5% of ethanol and 4.5% of water. This is called rectified spirit. This mixture is then heated under reflux over quicklime for about 5 to 6 hours and then allowed to stand for 12 hours. On distillation of this mixture, pure alcohol (100%) is obtained. This is called absolute alcohol.

MORE TO KNOW

FERMENTATION :

The slow chemical change taking place in an organic compound by the action of enzymes leading to the formation of smaller molecules is called fermentation.

2. Physical properties

(i) Ethanol is a clear liquid with burning taste.

(ii) Its boiling point is 351.5 K which is higher than corresponding alkane.

(iii) It is completely miscible with water in all proportions.

3. Chemical properties

(i) Dehydration

(a) Intra molecular dehydration : Ethanol, when heated with excess conc. H_2SO_4 at 443 K undergoes intra molecular dehydration (i.e. removal of water within a molecule of ethanol).

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[443K]{\text{Conc.}H_2SO_4} \underset{\text{Ethene}}{CH_2=CH_2} + H_2O$$

(b) Intermoleculardehydration: When excess of alcohol is heated with conc. H_2SO_4 at 413K two molecules condense by losing a molecule of water to form ether (i.e. removal of water from two molecules of ethanol).

$$C_2H_5\text{-}OH + HO\text{-}C_2H_5 \xrightarrow[413K]{\text{Conc.}H_2SO_4} \underset{\text{Diethyl ether}}{C_2H_5\text{-}O\text{-}C_2H_5} + H_2O$$

(ii) Reaction with sodium : Ethanol reacts with sodium metal to form sodium ethoxide and hydrogen gas.

$$2C_2H_5OH + 2Na \longrightarrow \underset{\text{sodium ethoxide}}{2C_2H_5ONa} + H_2\uparrow$$

(iii) Oxidation : Ethanol is oxidized to ethanoic acid with alkaline $KMnO_4$ or acidified $K_2Cr_2O_7$

$$CH_3CH_2OH \xrightarrow{\text{Oxidation}} \underset{\text{Ethanoic acid}}{CH_3COOH} + H_2O$$

During this reaction, orange colour of $K_2Cr_2O_7$ changes to green. Therefore, this reaction can be used for the **identification of alcohols**.

(iv) Esterificaiton : Ethanol reacts with ethanoic acid in the presence of conc.H_2SO_4 (catalyst) to form ethyl ethanoate and water. The compound formed by the reaction of an alcohol with carboxylic acid is known as ester (fruity smelling compound) and the reaction is called esterification.

$$\underset{\text{Ethanol}}{C_2H_5OH} + \underset{\text{Ethanoic acid}}{CH_3COOH} \xrightarrow{\text{conc.}H_2SO_4} \underset{\text{Ethyl ethanoate}}{CH_3COOC_2H_5} + H_2O$$

(v). Dehydrogenation : When the vapour of ethanol is passed over reduced copper catalyst at 573 K, it is dehydrogenated to acetaldehyde.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[573\ K]{Cu} \underset{\text{Acetadehyde}}{CH_3CHO} + H_2$$

4. Uses

Ethanol is used

1. as an anti-freeze in automobile radiators.
2. as a preservative for biological specimen.
3. as an antiseptic to sterilize wounds in hospitals.
4. as a solvent for drugs, oils, fats, perfumes, dyes, etc.
5. in the preparation of methylated spirit (mixture of 95% of ethanol and 5% of methanol), rectified spirit (mixture of 95.5% of ethanol and 4.5% of water), power alcohol (mixture of petrol and ethanol) and denatured spirit (ethanol mixed with pyridine).
6. in cough and digestive syrups.

Evil effects of consuming alcohol

- If ethanol is consumed, it tends to slow down metabolism of our body and depresses the central nervous system.
- It causes mental depression and emotional disorder.
- It affects our health by causing ulcer, high blood pressure, cancer,
- brain and liver damage.
- Nearly 40% accidents are due to drunken drive.

- Unlike ethanol, intake of methanol in very small quantities can cause death.
- Methanol is oxidized to methanal (formaldehyde) in the liver and methanal reacts rapidly with the components of cells.
- Methanal causes the protoplasm to get coagulated, in the same way an egg is coagulated by cooking. Methanol also affects the optic nerve, causing blindness.

13.12. ETHANOIC ACID (CH_3COOH)

Ethanoic acid is most commonly known as acetic acid and belongs to a group of acids called carboxylic acids. Acetic acid is present in many fruits and sour taste of fruits is because of this acid.

1. Preparation of Ethanoic acid

Ethanol on oxidation in the presence of alkaline potassium permanganate or acidified potassium dichromate gives ethanoic acid.

2. Physical properties

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow{\text{Oxidation}} \underset{\text{Ethanoic acid}}{CH_3COOH} + H_2O$$

(i) Ethanoic acid is a colourless liquid and has a sour taste.

(ii) It is miscible with water in all proportions.

(iii) Boiling point (391 K) is higher than corresponding alcohols, aldehydes and ketones.

(iv) On cooling, pure ethanoic acid is frozen to form ice like flakes. They look like glaciers, so it is called glacial acetic acid.

3. Chemical properties

(i) Ethanoic acid is a weak acid but it turns blue litmus to red.

(ii) Reaction with metal

Ethanoic acid reacts with metals like Na, K, Zn, etc to form metal ethanoate and hydrogen gas.

$$2CH_3COOH + Zn \longrightarrow (CH_3COO)_2Zn + H_2\uparrow$$

$$2CH_3COOH + 2Na \longrightarrow 2CH_3COONa + H_2\uparrow$$

(iii) Reaction with carbonates and bicarbonates.

Ethanoic acid reacts with carbonates and bicarbonates and produces brisk effervescence due to the evolution of carbon dioxide.

$$2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + CO_2\uparrow + H_2O$$

$$CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + CO_2\uparrow + H_2O$$

(iv) Reaction with base

Ethanoic acid reacts with sodium hydroxide to form sodium ethanoate and water.

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

(v) Decarboxylation (Removal of CO_2)

When sodium salt of ethanoic acid is heated with soda lime (Solid mixure of 3 parts of NaOH and 1 part of CaO) methane gas is formed.

$$CH_3COONa \xrightarrow{NaOH\ /\ CaO} CH_4\uparrow + Na_2CO_3$$

4. USES

Ethanoic acid is used

1. for making vinegar which is used as a preservative in food and fruit juices.
2. as a laboratory reagent.
3. for coagulating rubber from latex.
4. in the preparation of dyes, perfumes and medicine.

EVALUATION

PART - A

1. Assertion: Chemical bonds in organic compounds are covalent in nature.
   Reason: Covalent bond is formed by the sharing of electrons in the bonding atoms.
   Does the reason satisfy the given assertion.

2. Assertion: Diamond is the hardest crystalline form of carbon
   Reason: Carbon atoms in diamond are tetrahedral in nature (Verify the suitability of reason to the given Assertion mentioned above)

3. Assertion: Due to catenation a large number of carbon compounds are formed.
Reason: Carbon compounds show the property of allotropy.
(Is the reason holding good for the given Assertion)

4. Buckminster fullerene is the allotropic form of (Nitrogen / Carbon / Sulphur)

5. Eventhough it is a non metal, graphite conducts electricity. It is due to the presence of _____(free electrons / bonded electrons)

6. Formula of methane is CH_4 and its succeeding member ethane is expressed in C_2H_6. The common difference of succession between them is (CH_2 / C_2 H_2)

7. IUPAC name of first member of alkyne is _____ (ethene / ethyne)

8. Out of ketonic and aldehydic group which is the terminal functional group?

9. Acetic acid is heated with a solid 'X' kept in a test tube. A colourless and odourless gas (Y) is evolved. The gas turns lime water milky when passed through it. Identify X and Y.

10. Assertion: Denaturation of ethyl alcohol makes it unfit for drinking purposes.
Reason: Denaturation of ethyl alcohol is carried out by methyl alcohol.
Check whether the reason is correct for assertion.

PART - B

11. Write down the possible isomers and give their IUPAC names using the formula C_4H_{10}.

12. Diamond is the hardest allotrope of Carbon. Give reason for its hardness.

13. An organic compound (A) is widely used as a preservatives in pickles and has a molecular formula $C_2H_4O_2$. This compound reacts with ethanol to form a sweet smelling compound (B).

    (i) Identify the compound A and B.

    (ii) Name the process and write corresponding chemical equation.

14. An organic compound (A) of molecular formula C_2H_6O on oxidation with alkaline $KMnO_4$ solution gives an acid (B) with the same number of carbon atoms. Compound A is used as an antiseptic to sterilize wounds in hospitals. Identify A and B. Write the chemical equation involved in the formation of B from A.

PART - C

15. Fill in the blanks using suitable formula in the given table

No.	Alkane	Alkene	Alkyne
1.	C_2H_6 ethane	_____ethene	C_2H_2 ethyne
2.	_____Propane	C_3H_6 Propene	_____propyne
3.	C_4H_{10} Butane	_____Butene	_____Butyne

16. Homologous series predict the properties of the members of hydrocarbon. Justify this statement through its characteristics.

17. Write the common name and IUPAC name of the following.

a) CH_3CH_2CHO

b) CH_3COCH_3

c) $CH_3 - \underset{\underset{OH}{|}}{CH} - CH_3$

d) CH_3COOH

e) HCHO

FURTHER REFERENCE

Books: 1.Oraganic chemistry - **B.S. Bahl & Arun Bahl** S.Chand Publishers

2.Organic chemistry - **R.T. Morrision & R.N. Boyd** - Practice Hall Publishers.

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