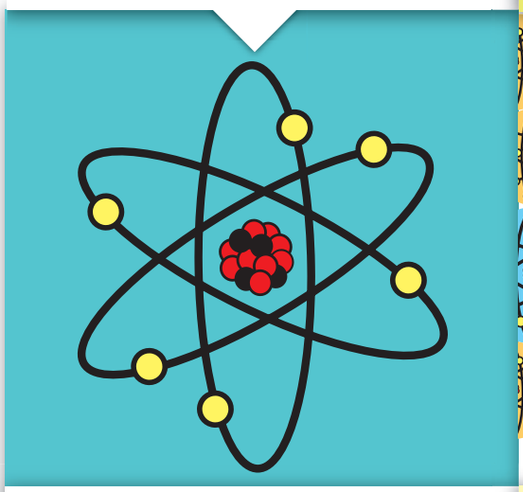
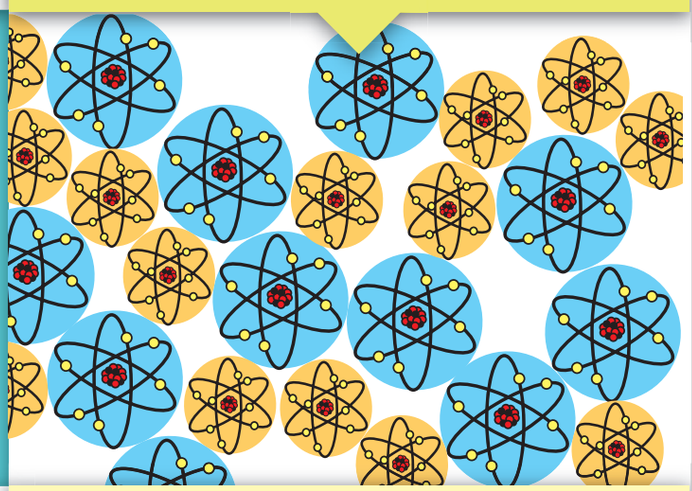
Configuration of Matter

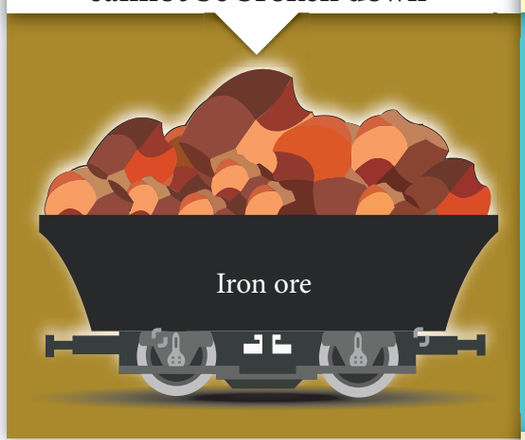
ATOM
Smallest particle of an Element



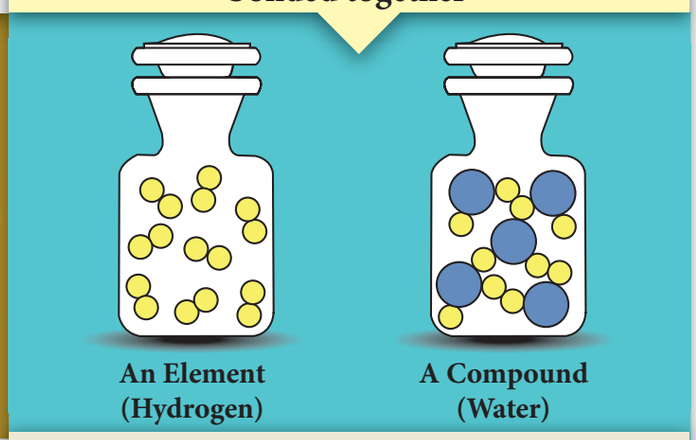
MOLECULE
Molecules are made up of atoms



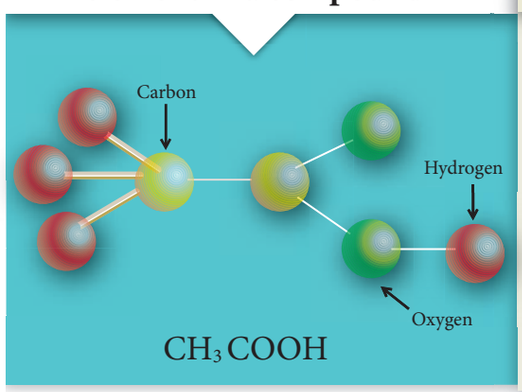
ELEMENT
Chemically simplest substance cannot be broken down



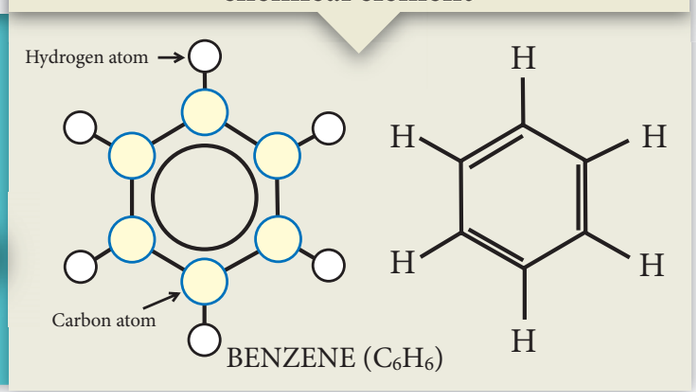
COMPOUND
Two or more elements are chemically bonded together



CHEMICAL FORMULA
Tells the number of atoms of element in a compound



CHEMICAL SYMBOL
Short representating of chemical element



Classification of Matter

Matter is classified into two broad categories, namely, pure substances and mixtures. Pure substances are further divided into categories as elements and compounds.

DJ5LGU

3.3 Elements

Matter in its simplest form is called an element. We are using many elements in our daily life. The common salt is consisting of elements of Sodium and Chlorine. Water consists of Hydrogen and Oxygen. Magnesium and Phosphorus used for making crackers. Sulphur is used as manure in agriculture. Gallium is used for making mobile phones and silicon is used for making computer chips.

There are 118 known elements till date. 94 of these elements occur naturally while 24 elements have been created artificially in the laboratory.

Classification of Elements

We can classify the elements broadly into metals, non-metals and metalloids based upon their chemical properties.

DO YOU KNOW?

The Robert Boyle is the first scientist used the term element. An early proponent of the elemental nature of matter and the nature of vacuum. He was known best for Boyle's Law.

Metals

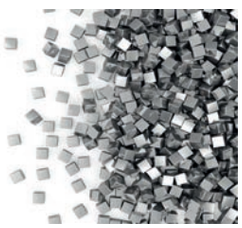
We have tools, utensils and jewelry made from silver, copper, iron, gold, Aluminum. Using pressure like hammering or rolling we can deform these materials into various shapes. Such elements that are malleable (a material may be flattened into thin sheets or various shapes) is called as metals.

Metals are generally hard and shiny elements. Sodium is one of the exceptions as it is soft. All metals, except mercury are solids at

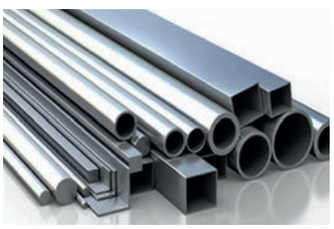
Copper

Lead

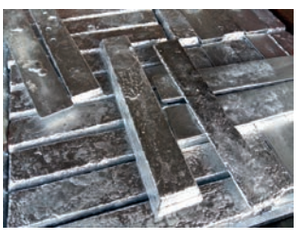
Iron



Nickel



Steel



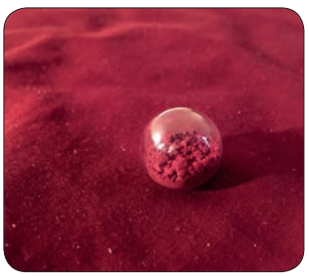
Zinc

room temperature. Mercury is the only metal that is liquid at room temperature . Metals are malleable, can be bent or beaten into sheets. They can be drawn into wires. They are good conductors of heat and electricity. Copper, Lead, tin, nickel, iron, zinc, gold, magnesium and calcium are examples of metals.

Non-Metals

Non-metals are generally dull and soft. However, diamond is shiny and also the hardest natural substance on earth. Non-metals can be gases, solids, liquids. Non metals such as oxygen, hydrogen and chlorine are gases at room temperature. Non metals such as carbon, iodine, sulphur and phosphorus are solids at room temperature. Bromine is the only non-metal that is liquid at room temperature. Non-metals are poor conductors of heat and electricity. However, graphite (a form of the non-metal carbon) is a good conductor of electricity.

Carbon



Phosphorus

Sulfur

The difference between metals and non-metals

Metals	Non-Metals
Metals are lustrous. They have a shiny surface	Non metals are non lustrous. They have non- shiny surface
Metals are generally hard	Non-metals are generally soft
Most metals are bendable	Non-metals are non bendable
Most metals can be bent, beaten into sheets and they can drawn into wires	Non-metals are non ductile
Most metals are good conductors of electricity	Non-metals are bad conductors of electricity
Most metals are good conductors of heat	Non-metals are bad conductors of heat
Most metals are making ringing sound when struck. Hence, they are used to make objects like bells	Non-metals does not make any sound when they struck

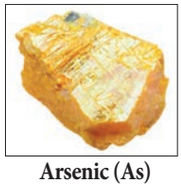
Metalloids

Metalloids exhibit the properties of both metals and non metals. Silicon, arsenic, antimony, and boron are some examples of metalloids.

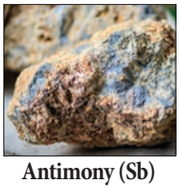
Boron (B)

Silicon (Si)

Germanium (Ge)



Arsenic (As)



Antimony (Sb)

Tellurium (Te)

3.4 Compounds

A compound is a pure substance that is formed when the atoms of two or more elements combine chemically in definite proportions.

Compounds exhibit properties entirely different from the properties of their constituent elements. For example, the atoms of the elements hydrogen and oxygen combine chemically in a fixed ratio to form the compound water. However, water does not have the exact same properties as hydrogen and oxygen. For example, at room temperature water exist as liquid while hydrogen and oxygen exist as gases. Also, oxygen supports fire whereas water is used as a fire extinguisher.

Similarly, common salt (sodium chloride) is a compound made up of elements sodium and chlorine. It is used in our food, whereas sodium and chlorine are poison, are both unsafe for consumption.

Sodium is a highly reactive solid at room temperature . It burns vigorously when in contact with water

+

Chlorine is yellowish green poisonous gas at room

→

Sodium Chloride (Used for cooking)

Elements in the compound:

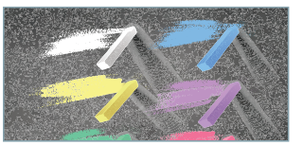
Table Salt

Sodium and Chlorine

Sugar

Carbon, Hydrogen and Oxygen

Chalk



Calcium, Carbon and Oxygen

ACTIVITY 1

Complete the following table by writing compounds of its constituents

Compound	Constituent Elements
Water	
Salt (Sodium chloride)	
Sodium carbonate	
Baking soda (sodium bicarbonate)	
Sugar	
Calcium oxide	
Calcium hydroxide	
Sodium hydroxide	
Potassium hydroxide	

Properties of Compounds

- A compound is formed only when the constituent elements combine in a fixed proportion.
- The properties of a compound are different from those of its constituent elements
- A compound cannot be broken down by physical methods. This is because a

compound is made up of different elements that are chemically combined. Sodium chloride cannot be separated by physical methods such as filtration.

- A compound can be separated into its constituent elements by chemical methods only.

Difference between an element and a compound

Elements	Compounds
An element is the simplest substance	A compound is a chemical substance formed by the combination of two or more elements
Elements combine to form compounds	Compounds can be split into elements
Atoms are the fundamental particle of an element	Molecules are the fundamental particles of a compound

ACTIVITY 2

Complete the following table by counting the number of different elements in a compounds and give appropriate name.

Formula	No. of different elements	Name of Elements
H_2O		
NaCl		
$C_6H_{12}O_6$		
NaOH		

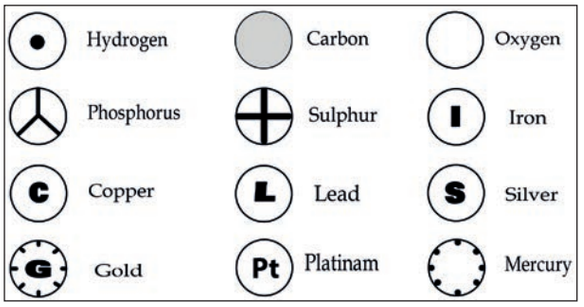
Symbol of an element

A symbol is an abbreviation or short representation of a chemical element. There is a unique symbol for each element. It represents one atom of the element. The symbol is usually derived from the name of the element, which is either in English or Latin. These symbols are allocated by the International Union of Pure and Applied Chemistry (IUPAC).

ETGAJ6

Dalton was the first scientist to use the symbols for elements in a very specific sense. When he used a symbol for an element he also meant a definite quantity of that element, that is, one atom of that element. Berzelius suggested that the symbols of elements be made from one or two letters of the name of the element.

Symbols for some elements as proposed by Dalton



The following rules are followed while assigning symbol to an elements:

- Chemical symbols usually consist of one or two letters
- The symbols of most elements correspond to the first letter (which is capitalized) of their English name. For example, the symbol for oxygen is "O" and that for hydrogen is "H".

Elements represented by single letter symbols

Element	Symbol	Element	Symbol
Hydrogen	H	Phosphorus	P
Fluorine	F	Sulphur	S
Oxygen	O	Potassium	K
Carbon	C	Uranium	U

When there is more than one element that begins with the same letter, their symbols take two letters. ***The first letter is capitalised while the second letter has a lower case.*** For example, the names of both hydrogen and helium begin with H. So, hydrogen is represented by the symbol H and Helium by He. Similarly, the symbol for carbon is C while the symbols for calcium, chlorine and chromium are Ca, Cl and Cr, respectively.

Elements represented by symbols of two letters

Element	Symbol	Element	Symbol
Aluminium	Al	Chromium	Cr
Argon	Ar	Cobalt	Co
Arsenic	As	Helium	He
Barium	Ba	Magnesium	Mg
Nickel	Ni	Calcium	Ca
Bromine	Br	Chlorine	Cl

The symbols for some elements are derived from their Latin names. For example, the symbol for gold is Au after its Latin name Aurum. Similarly, the symbols for copper is Cu after its Latin name Cuprum.

Element	Latin Name	Symbol
Copper	Cuprum	Cu
Lead	Plumbum	Pb
Potassium	Kalium	K
Iron	Ferrum	Fe
Mercury	Hydrargyrum	Hg
Sodium	Natrium	Na

ACTIVITY 3

Write down the symbols of the following elements

Elements	Symbol	Elements	Symbol
Gold		Aluminium	
Silver		Calcium	
Copper		Phosphorus	
Iron		Magnesium	
Nitrogen		Potassium	
Oxygen		Sodium	

DO YOU KNOW?

In the beginning, the names of elements were derived from the name of the place where they were found for the first time. For example, the name copper was taken from Cyprus. Some names were taken from specific colours. For example, gold was taken from the English word meaning yellow. Now-a-days, IUPAC approves names of elements. Many of the symbols are the first one or two letters of the element's name in English. The first letter of a symbol is always written as a capital letter (uppercase) and the second letter as a small letter (lowercase).

Chemical Formulae

Often we hear that water is H_2O. This is the chemical formula for water molecule. This means that each molecule of water has two hydrogen atoms combined with one oxygen atom. A chemical formula is a symbolic representation of one molecule of an element or a compound. It provides information about the elements present in the molecule and the number of atoms of each element. Can you guess the types of atoms and number of each of the atoms in NaCl, which is the chemical formula for cooking salt?

The chemical formula tells us the types of atoms and the number of each type of atom in one molecule of substance

Water
H_2O

The small number beside the H symbol is called subscript. It tells us the number of atoms that element present in the molecule. Hence, there are 2 hydrogen atoms in water molecule.

When there is no number of besides O symbol, it means that there is only one atom of that element present in the molecule. Hence, there us 1 oxygen atom in an water molecule.

Here are some examples of chemical formula

Sodium Chloride

Nacl

1 atom of Sodium and 1 atom of chlorine

Ammonia

NH_3

1atom of Nitrogen and 3 atoms of Hydrogen

Glucose

$C_6H_{12}O_6$

6 carbon atoms, 12 Hydrogen atoms 6 oxygen atoms

Common compounds and their chemical formula

Examples of Compounds	
Examples of Formulas for compounds	Examples of names of common compounds
H_2O	Water
$C_6H_{12}O_6$	Glucose
NaCl	Salt (Sodium Chloride)
C_2H_6O	Ethanol
NH_3	Ammonia
H_2SO_4	Sulphuric Acid
CH_4	Methane
$C_{12}H_{22}O_{11}$	Sucrose

Atomicity

In chemistry we usually understand atomicity to imply the total number of atoms present in one molecule of an element, compound or a substance.

Let we see how to calculate the atomicity of elements. For example, Oxygen exists as a diatomic molecule which means that a molecule of oxygen contains two atoms hence its atomicity is 2.

$$O + O \longrightarrow O_2$$

(Oxygen atom + Oxygen atom) $\longrightarrow$ Oxygen Molecule)

Similarly a phosphorus (P_4) molecule contains 4 atoms; a sulphur (S_8) molecule contains 8 sulphur atoms. Hence their atomicity is 4 and 8 respectively.

For molecule containing more than one types of atoms, simply count the number of each atom and that would be its atomicity. For example, a molecule of sulphuric acid (H_2SO_4) consists of 2 hydrogen atom, 1 sulphur atom and 4 oxygen atoms. Hence e its atomicity is 2+1+4=7.

One molecule of water (H_2O) contains two atoms of hydrogen and one atom of oxygen, the atomicity of water is three.

Atomicity of some elements

Element	Atomicity	Elements	Atomicity
H	2	F	2
He	1	Ne	1
Li	1	Na	1
N	2	P	4
O	2	S	8

Elements in human Body

Nearly 99% of the mass of our human body consists of just 6 chemical elements: oxygen, carbon, hydrogen, nitrogen, calcium, and phosphorus. Another 5 elements make up most of the least percentage point: potassium, sulphur, sodium, chlorine, and magnesium.

ACTIVITY 4

Write down atomicity of the following elements and compounds

Elements	Atomicity
Cl	
Na	
K	
Ca	
Compounds	
H2O	
Nacl	

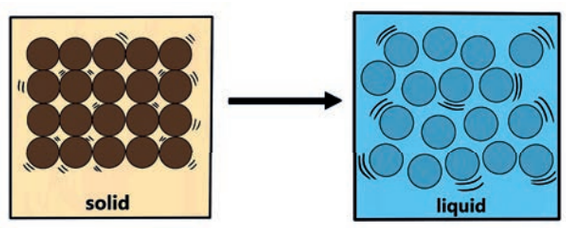
Elements in air

Air is a mixture of gases. The molecules of two different elements, nitrogen and oxygen, make up about 99% of the air. The rest includes small amounts of argon and carbon dioxide. (Other gases such as neon, helium, and methane are present in trace amounts.) Oxygen is the life-giving element in the air.

Effect of temperature on Solid, Liquid and Gas

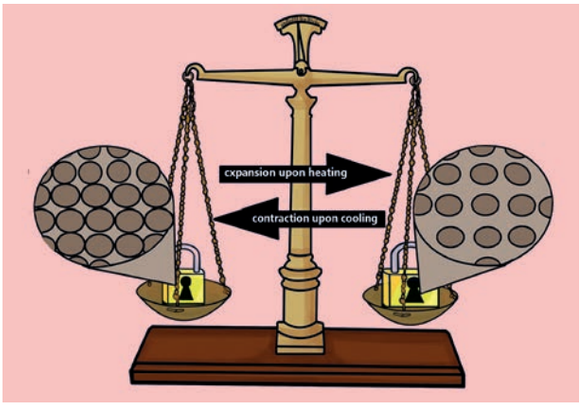
What happens to matter during heating?

The following are models of particles in solids during heating. These models can be modified to represent heating in Solids, Liquids and Gas.



When solid is heated, the particles gain energy and vibrate vigorously. The particles move slightly further apart from one another.

This causes the volume of matter to increase. This process is called expansion. How it is happens? The matter begun to expand when heated. The volume increases due to the greater distance between the particles. But the size of the particles remains in same size.



DO YOU KNOW?

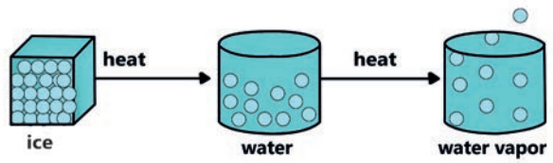
How do hot-air balloons float? When air inside the hot air balloon is heated with a burner, it expands. The expansion causes the density of the air inside the balloon to decrease. Hence, the air inside the balloon has a lower density that the air outside of the balloon. This difference is density allows the hot-air balloon to float.

During heating or expansion, the mass of matter does not change. This is explained in the following way. During heating, the distance between the particles of the iron locks change. Mass is conserved when matter expands.

Although the volume of the matter changes, the size and number of the particles of matter do not change. Hence, during heating, the mass of a matter is conserved. For example, in an iron lock the distance between the iron particles increases when they gain enough heat. However, the number of iron particles does not change. Hence the mass of the iron lock is conserved.

The melting of ice is an example of a change in the states of matter. The change in the states of matter occurs during melting, boiling and freezing and condensation.

When the particles possess enough energy, they overcome the strong forces of attraction between one another. The particles break free from one another and move randomly. For example, when solid ice is heated to 0^0C, it melts to become liquids water. In the same way, liquid water is heated to 100^0C, it boils to become steam.



1. Solid
When solid is heated, the particles gain energy and vibrate more vigorously
2. Liquid
Melting occurs when the melting point is reached. The solid changes to its liquid state.
When a liquid is heated the particles gain energy and vibrate more vigorously
3. Gas
Boiling occurs when the boiling point is reached. The liquid changes to its gaseous State.

Points to remember

- An atoms is the smallest particle of an element
- Elements are the simplest forms of pure substances
- Molecules of an element consist of a fixed number of one type of atom
- Molecules of a compound consist of a fixed number of different types of atom
- The molecules of the different element nitrogen and oxygen make up 99 percent of the air
- The particulate nature of matter can be used to explain heating effect of Solid, Liquid and Gas
- The mass of the matter remains same during expansion
- A molecule is made up of two or more atoms chemically combined
- We can represent a molecule using the chemical formula.

Evaluation

I. Choose the appropriate answer.

1. Which of the following is an example of a metal?
   a. Iron
   b. Oxygen
   c. Helium
   d. Water

G3RYLH

2. Oxygen, hydrogen, and sulphur are examples of which of the following?
   a. Metals b. Non-metals
   c. Metalloids d. Inert gases
3. Which of the following is a short and scientific way of representing one molecule of an element or compound?
   a. Mathematical formula
   b. Chemical formula
   c. Mathematical symbol
   d. Chemical symbol
4. The metals which is a liquid at room temperature
   a. Chlorine
   b. Sulphur
   c. Mercury
   d. Silver
5. An element which is always lustrous, malleable and ductile
   a. non-metal b. metal
   c. metalloid d. gas

II. Fill in the blanks.

1. The smallest particle of matter that can exist by itself _____.
2. A compound containing one atom of carbon and two atoms of oxygen is _____.
3. _____ is the only non-metal conducts electricity.
4. Elements are made up of _____ kinds of atoms.
5. _____ of some elements are derived from Latin or Greek names of the elements.
6. There are _____ number of known elements.
7. Elements are the _____ form of pure substances .
8. The first letter of an element always written in _____ letter
9. Molecule containing more than three atoms are known as_____.
10. _____ is the most abundant gas in the atmosphere.

III. Fill in the Blanks.

1. Mercury: liquid at room temperature:: Oxygen: _____.

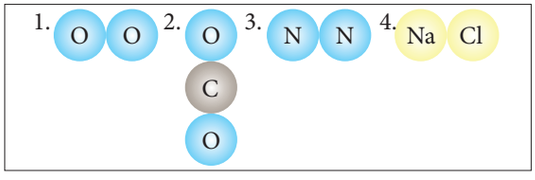
2. Non metal conducting electricity: _____:: Metal conducting electricity: Copper
3. Elements: combine to form compounds::Compounds:_____.
4. Atoms: fundamental particle of an element:: _____: fundamental particles of a compound.

IV. True of False. If False, give the correct statement.

1. Two different elements may have similar atoms.
2. Compounds and elements are pure substance.
3. Atoms cannot exist alone; they can only exist as groups called molecules.
4. NaCl represents one molecule of sodium chloride.
5. Argon is mono atomic gas.

V. Answer in brief.

1. Write the chemical formula and name the elements present in the following compounds:
   a. Sodium chloride
   b. Potassium hydroxide
   c. Carbon-di-oxide
   d. Calcium oxide
   e. Sulphur dioxide
2. Classify the following molecules as the molecules of element or compound



3. What do you understand by chemical formula of a compound? What is its significance?
4. Define the following terms with an example of each:
   a. Element
   b. Compound
   c. Metal
   d. Non-metal
   e. Metalloid
5. Write the symbols for the following elements and classify them as solid, liquid and gas
   Aluminum, carbon, chlorine, mercury, hydrogen and helium
6. Classify the following as metals, non-metals and metalloids
   Sodium, Bismuth, Silver, Nitrogen, Silicon, carbon, chlorine, Iron, copper
7. Classify the following as elements and compounds
   Water, common salt, sugar, carbon dioxide, iodine and lithium
8. Write the chemical formula for the following elements
   a. Hydrogen b. Nitrogen
   c. Ozone d. Sulphur
9. What are elements? What are they made of? Give two examples.
10. Define molecule.
11. What are compounds? Give two examples.
12. Give an example for the elements derived from their Latin names.
13. What is atomicity of elements?
14. Calculate the atomicity of H_2SO_4.

VI. Answer in detail.

1. Differentiate metals and non metals.
2. Explain the characteristics of compounds
3. Describe the different ways in which we can write the symbols of elements. Give appropriate examples.
4. Differentiate between elements and compounds.
5. Write any five characteristics of compound.

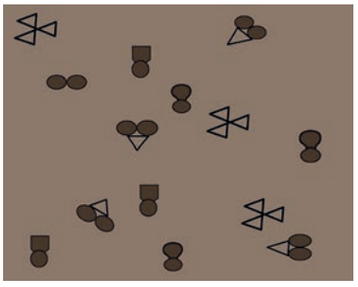
6. List comparative properties of metals and non-metals. Give three examples of each.
7. Write down the properties of metalloids.

VII. Rewrite the sentence in correct form

1. Elements contains two or more kinds of atoms and compounds contains only one kinds of atoms.

VIII. Higher Order Thinking questions

1. Lists the metals, non-metals and metalloids which you used in your house, schools. Compare their properties.
2. Aakash noticed that the metal latch on gate was difficult to open during hot sunny days. However, this same latch was not difficult to open at night. Aakash observed that the latch and the gate are exposed to the sun during the day.
   a. Formulate a hypothesis based on the information provided.
   b. Briefly state how you would test the hypothesis stated in (a).
3. What changes take place in the movement and arrangement of particles during heating process?
4. In the diagram below, the circle, square and triangle represent the atoms of different elements.



5. In the diagram above, identify all combinations that represent
   a. A molecule of a compound
   b. A molecule of an element consisting of two atoms
   c. A molecule of an element consisting of three atoms

IX. Assertion-reason questions

Directions: Please refer to the following instructions:

1st Statement	2nd Statement
Oxygen is a compound	Oxygen cannot be broken down into anything simpler
Hydrogen is an element	Hydrogen cannot be broken down into anything simpler
Air is a compound	Air consists of carbon dioxide
Air is a mixture of elements only	Only nitrogen, oxygen and neon gases exist in air
Mercury is solid in room temperature	Mercury is a non-metal

A. Both statements are true and the 2nd statement is a correct explanation of the 1st statement.

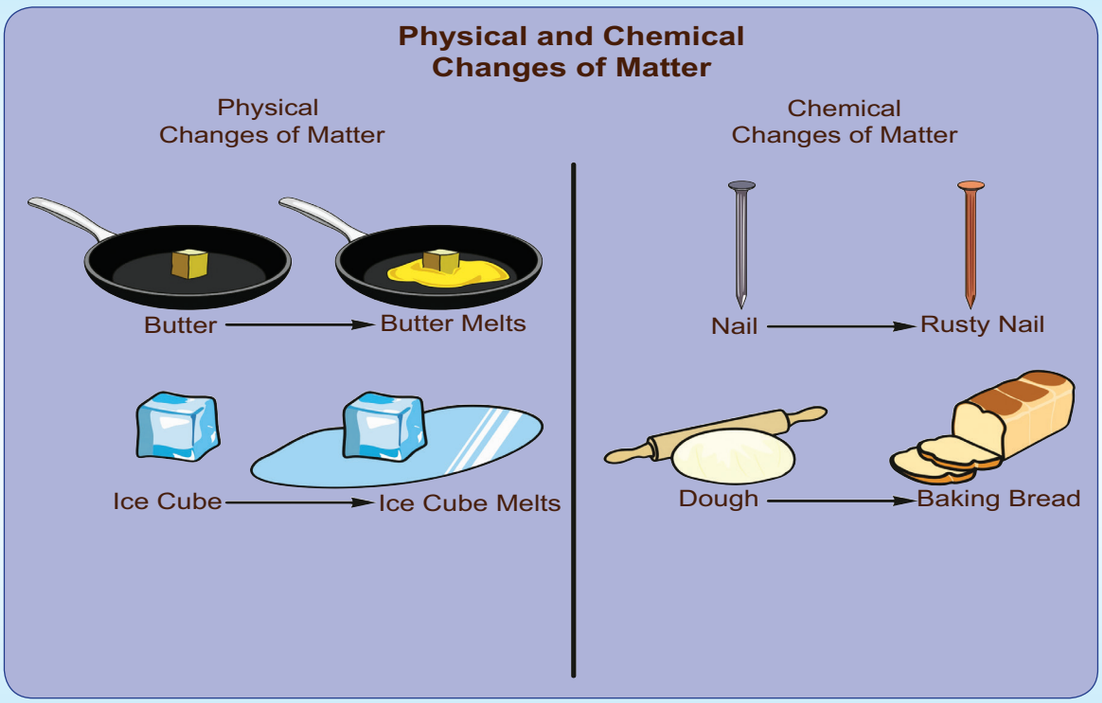
B. Both statements are true but the 2nd statement is NOT a correct explanation of the 1st statement.

C. The 1st statement is false while the 2nd statement is true.

D. Both statements are false.

Unit 3

Changes Around Us



Learning Objectives

- To state the effect of heat on solid, liquid and gas and the associated changes in the arrangement of particles upon heating
- To differentiate physical change and chemical change on the basis of particle theory
- To involve in experiments crystallizing copper sulphate, melting ice, freezing water, sublimating camphor.
- To identify the process as a physical change or chemical change based on its characteristics
- To clarify the process of rusting, burning of paper, curdling of milk, reaction of baking soda with lemon juice
- To distinguish periodic and non-periodic changes
- To experience the endothermic and exothermic changes through simple activities

S5A5Q1

Introduction

Changes take place around us all the time. A change refers to an alteration in physical properties or alteration in the composition of matter. For example, ice melts on heating, that is, it changes from a solid to liquid. On further heating, water starts evaporating; it changes from a liquid to gas. Here, there is a change in the physical state of the substance. Let us look at another change, that is, when objects made of iron are exposed to moist conditions, a reddish-brown new substance called rust forms on the surface of these objects. In this instance of rusting, there is change in the composition of the substance. Thus, the change involves an alteration in the properties such as colour, texture and the state of the substance since there is formation of a new substance.

Let us go for another set of example. Heat a cup of water and a paper. The water upon heating become just hotter and hotter and at some point will become water vapour. It remains water at all times; that is, water remains the same, only its volume changes and hence it is called as physical change. Whereas in case of burning of paper, changes to carbon dioxide and other substances. Now we cannot get back the paper after burning. As there is a change in the chemical nature, it is called as chemical change.

When you mix sugar in water, is it a chemical change or physical change?

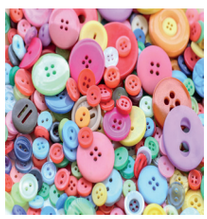
Look at the following list. Identify the physical and chemical changes and fill in the given table.

(rusting of iron, digestion of food, boiling egg, rotting banana, mixing sand and water, chopping wood, crushing a can, mixtures of different coloured buttons, burning of wood)








Physical Changes	Chemical Changes

In class six, we read that matter is classified as solid, liquid and gas based on the physical state. We know that matter is made up of tiny particles, atoms and molecules; particles are in constant and random movement. Let us have a look at the summary of the characteristics of solid, liquid and gas.

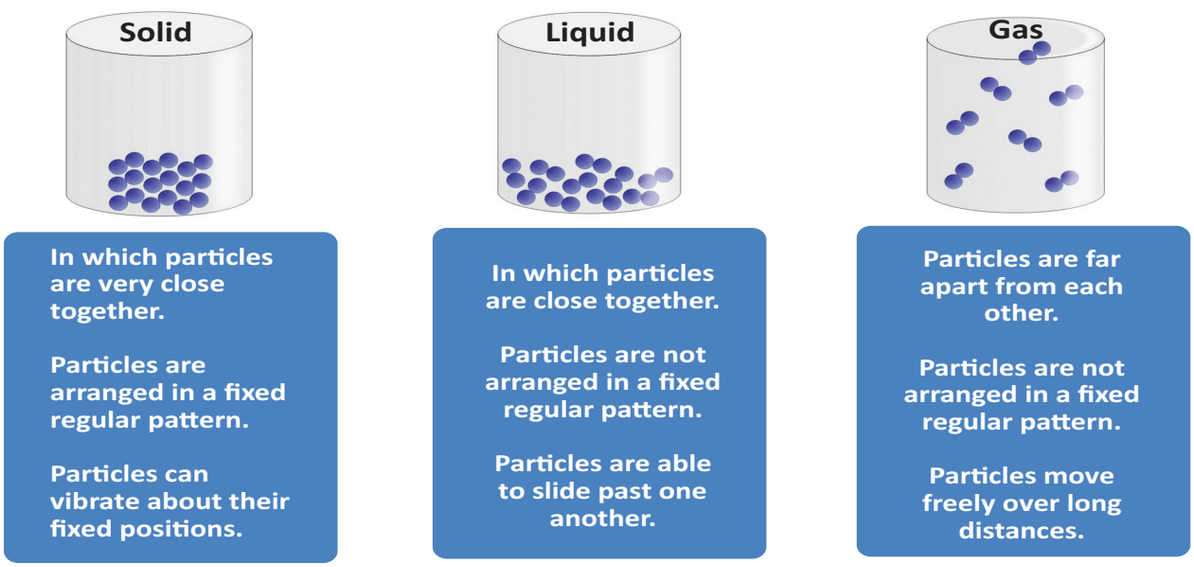
When the arrangement of the particles in a substance change for any reason (applying pressure, altering temperature and other different reasons) the physical state of the substance gets changed.

Let us see what happens when we apply heat to the substances.

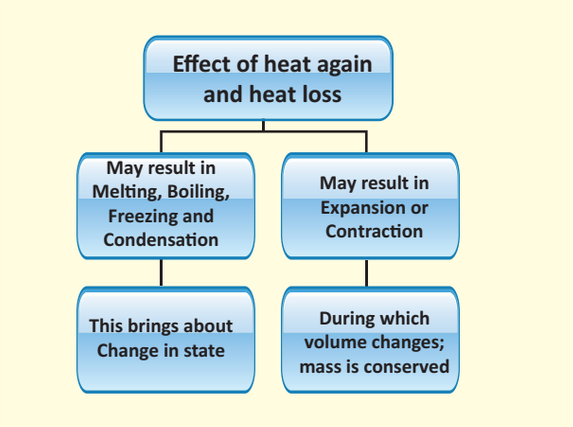
3.1 Effect of heat on solid, liquid and gases

Z5P5G3

Upon heating, particle arrangement within the state of matter gets disturbed. The disturbance is seen either as expansion or contraction. When heated or cooled, the object may expand or contract, but the mass remains the same. That is, the number of particles that was inside the object does not undergo any change, only the arrangement of the particle changes. When a glass of water is heated, its volume increases and if a glass of water is cooled its volume decreases.



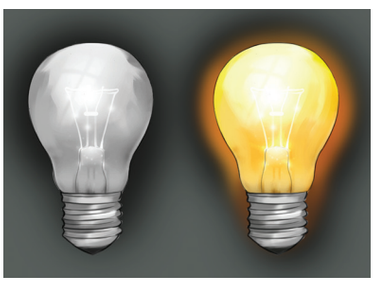
Such changes where there is change in volume but mass remaining the same are called physical changes and they can be pictorially depicted as follows:



There are other possibilities that can occur upon heating the solids, liquids and gases. The possible changes are due to melting, boiling, freezing and condensation during which there is change in the physical state of the particles of the matter. Let us discuss about them in detail in a short while.

Let us now see some physical changes and the underlying reasons as why they are simply physical changes.

3.2 Physical changes



Physical changes are the changes in which only physical properties of a substance undergo a change and there is no change in its chemical composition. There is no new substance formed in a physical change. Physical properties include lustre, malleability (flexibility), and ductility (ability to be drawn into a thin wire), density, viscosity, solubility, mass, volume and so on. Any change in these physical properties is referred to as a physical change. For example, when a rubber band is stretched, it elongates. However, when then stretching is stopped, the rubber band comes back to its original state and shape. In this example, there is no new substance formed but the rubber band remains the same before and after elongation.

3.2.1 Characteristics of a physical change

A physical change has following characteristics:

- During a physical change, no new substances are formed. In a physical change, the chemical properties of a substance do not change. For example, when ice cube melts, water is formed. In this change, there is no new substance, but water is same both in ice and in water.
- A physical change is usually temporary and reversible in nature. For example, when water is heated, water vapours are formed, once water vapours are cooled, water can be obtained again.
- In a physical change, the chemical properties of a substance do not change. For example, when a piece of gold is melted, its chemical composition remains the same in the solid form and also in the liquid form.
- In a physical change, the physical properties such as colour, shape and size of a substance may undergo a change . For example, cutting of vegetables and inflating a balloon are some examples of physical changes in which size and shape of a substance undergoes a change. we know it is not

3.3 Changes of state

Change of state of a substance is one of the major physical changes we encounter in daily lives. We have read about simple changes of physical state such as melting of ice in our previous classes.

The following are some of the changes of state:

from Solid → to Liquid is Melting

from Liquid → to Gas is Vaporization

from Liquid → to Solid is Freezing

from Gas → to Liquid is Condensation

from Solid → to Gas is Sublimation

Melting, vaporization, and sublimation occur when heated and hence it is called as endothermic process. In an endothermic process, the speed of the molecules is increased hence they move faster.

In contrast, such as in freezing and condensation, heat is removed, resulting in the decreasing the speed of the molecules causing them move slower. Such processes are called as exothermic process.

In the next section we will look at each of these physical changes.

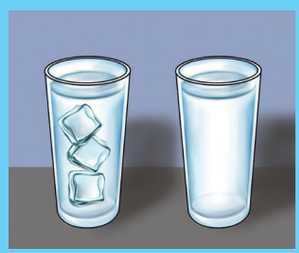
3.3.1 Melting

You have seen a puddle of water getting pooled around the glass of ice-cream or a glass of ice cubes when it is kept in room temperature. The ice cubes / ice-cream melt. Right! Can you give reason for that? The ice kept in the beaker receives heat from the surrounding air, to melt and form water.

ACTIVITY 1

Melting of ice and freezing of water

Though ice and water look different, they are both made of water molecules. This means that no new substance is formed during the melting of ice, only a change of state from solid to liquid takes place during the melting of ice. So, the melting of ice to form water is a physical change.



The change which occurs during the melting of ice to form water can be reversed easily by freezing the water to form ice again by keeping a beaker of water in the freezer zone of a refrigerator.

Thus we can find that

$$\text{Solid} \xrightarrow{\text{heating}} \text{Liquid}$$

$$\text{Liquid} \xrightarrow{\text{cooling}} \text{Solid}$$

Melting is the changing of a solid into its liquid state and it happens by heating, whereas Freezing is the changing of a liquid into its solid state and it happens by cooling.

3.3.2 Vapourization

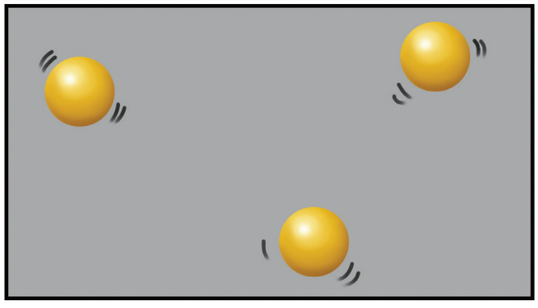
Look at a kettle kept on the fire. The bubbles form and the liquid water becomes

water vapour, if you heat it sufficiently.

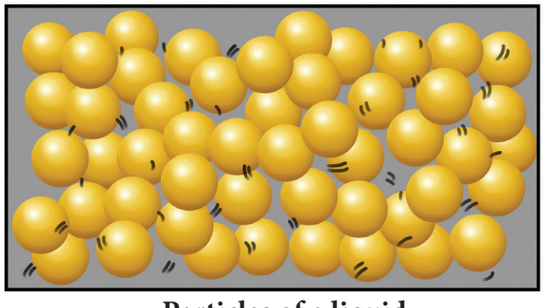
However, when you put a wet cloth to dry, the water evaporates into air, leaving the clothes dry.

That is there are two types of vaporization: boiling and evaporation, the first one is by heating and the second type of vapourization is natural.

Boiling is the process of conversion of a liquid into vapours on heating. In gaseous state, only the arrangement of molecules changes, there is no change in their chemical composition. So, boiling is a physical change.

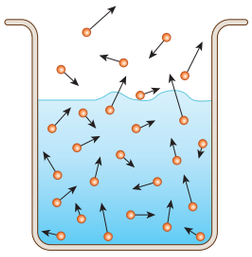


Particles of a gas



Particles of a liquid

Upon heating a liquid, the particles gain energy and vibrate more vigorously. When the particles possess enough energy, they overcome the strong forces of attraction between one another. The particles break free from one another and move randomly. For example, when liquid water is heated to 100°C, it boils to become steam. Boiling occurs when the boiling point is reached. The liquid changes to its gaseous state.

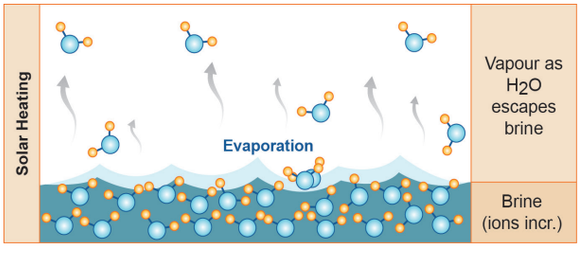


Evaporation

Take a glass of water. All the water molecules are moving here and there at different velocities (shown as arrows of different lengths). Some of the molecules, especially at the surface, could be moving in a direction away from the liquid, and have adequate energy to overcome the attractive force (surface tension) of the liquid, then that molecule will escape into the air. Thus slowly and steadily the water molecules escape, or said to evaporate, and the water level in the glass decreases as the time passes. Note that the temperature of the water did not rise to the level of boiling point of water. Nor were there any bubbles formed like boiling.

Evaporation is the technique used to separate dissolved solids from a solid-liquid mixture. This is the technique used to extract salt from sea water in salt pans. Shallow level of sea water is impounded. Slowly the water evaporates due to action of Sun. Ultimately salt deposits over the ground we can understand. Evaporation makes use of the fact that the solvent in a solution can vapourise at any temperature, leaving behind a residue of the solid that was dissolved in the liquid.

From drying clothes to drying fish, evaporation is used.



Factors affecting the rate of evaporation

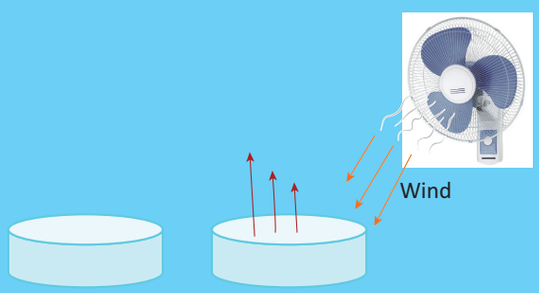
ACTIVITY

Activity 2

You must be remembering an activity done in Class six, in which we have taken two same shaped glasses and fill them with equal amount of water from same tap. We kept one under the hot sun and other under the shadow. After three to four hours, we saw that there is difference in water levels. The one kept in the hot place witness more evaporation compared to the one in shade. From this we can conclude that higher the temperature, the rate of evaporation will be more. As the temperature increases, more molecules are able to break free from the surface. Thus the rate of evaporation increases with rising temperature.

Activity 3

Take two pans, one wide and another narrow. Fill hot water in both to the same depth. Keep them in open. Observe after one to two hours. The pan that is wide has cooled more than the narrow one. That is more the surface area; the rate of evaporation is more.



From this, can you guess why we unfurl the clothes while putting them to dry, rather than just drape them over the cloth line?

Greater the surface of conversion of a liquid, more molecules are available for evaporation.

Activity 4

Take sugar solution in a shallow, broad bowl. Place the bowl in hot sun for a few hours. See that the bowl does not get any disturbance for the whole day. You can see that the solvent in the sugar solution evaporates leaving the sugar crystals in the bowl.

Evaporation is a slow process and occurs only at the surface of the liquid.

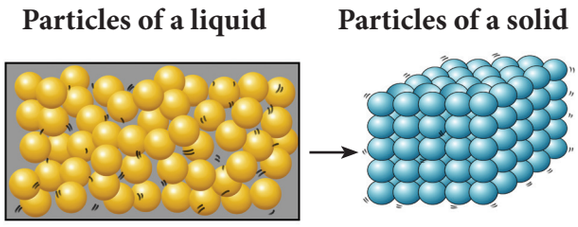
3.3.3 Freezing

Water in the freezer compartment of a refrigerator gets cooled and solidifies to form ice. In this case, the liquid water changes into solid water called ice.

Only a change in state (from liquid to solid) takes place during the freezing of water to form ice, but no new substance is formed. So, the freezing of water is a physical change.

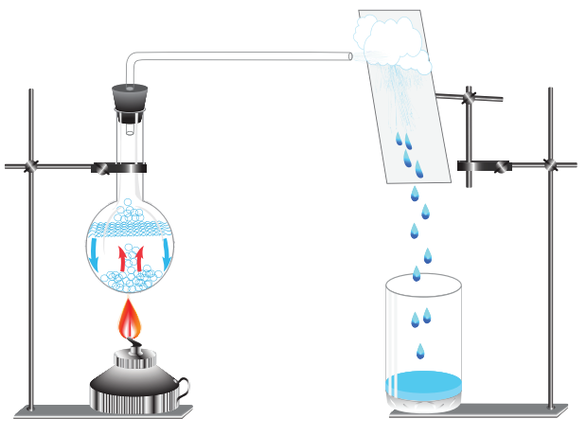
Upon cooling a liquid, the particles loose energy and vibrate less vigorously. When the particles possess less energy, they can experience strong forces of attraction between one another. The particles move closer to each other and movement of particles is also restricted. For example, when liquid water is cooled to 0° C, it freezes to become ice. Freezing occurs when the freezing point is reached. The liquid changes to its solid state.

The arrangement of particles in liquid and solid are diagrammatically represented as follows:



3.3.4 Condensation

We would have observed that the plate that covers the cooked food items have water droplets inside. Why?



The water vapour emerges from the hot food and goes up. The plate covering the food item is in relative less temperature than the hot food. Thus the more energetic molecules loose energy once they touch the cooler plate. As the molecules lose heat, they lose energy and slow down. They move closer to other gas molecules. Finally these molecules collect together to form a liquid. Condensation happens when molecules in a gas cool down.

In class six, you learnt about water cycle in which you already know how the clouds are formed from water vapour. Water vapour condenses to form clouds.

Condensation is the conversion of gas into its liquid state. The liquid obtained after condensation can be converted back into gas on heating. So, condensation is also a physical process. During this process, only the arrangement of molecules changes from the gaseous state to liquid state. So, condensation is a physical change.

$$\text{Gas} \xrightarrow{\text{cooling}} \text{Liquid}$$

$$\text{Liquid} \xrightarrow{\text{heating}} \text{Gas}$$

Condensation is the changing of a gas into its liquid state and it happens by cooling, whereas **Evaporation** is the changing of a liquid into its gas state and it happens by heating.

3.3.5 Sublimation

We have seen camphor being burnt at home, kept in rooms to prevent entry of mosquitoes. Have you ever noticed camphor becoming liquid at any point of time? ..... It will not.

There are certain solid substances like camphor, naphthalene that get converted into gas directly upon heating without becoming liquid. **This process in which a solid is converted directly into gas is called sublimation**.

In each of the above said processes, there is a change of state due to change in temperature. But there is no change in chemical composition. By changing the temperature all these changes can be reversed. We know that change of a physical state is only a physical change. So,

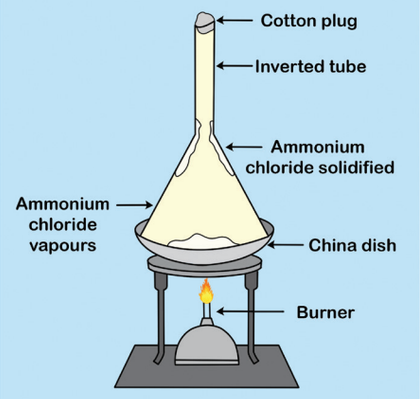
evaporation, boiling, condensation, melting and freezing are all physical processes

ACTIVITY 5

Sublimation

Take some camphor in a porcelain dish and cover it with a clean glass funnel. Close the mouth of the funnel with small amount of cotton wool. Heat the contents in the dish. can you see that camphor changes into vapour state without becoming liquid.

Ammonium chloride is another substance that undergoes sublimation.



3.3.6 Crystallization

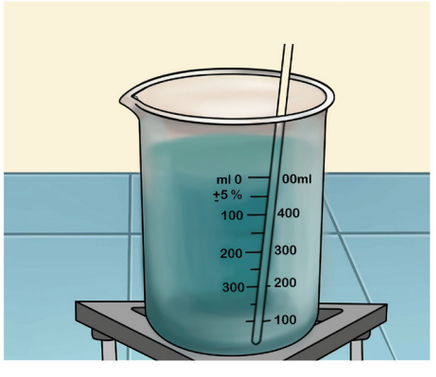
Though not mentioned earlier, crystallization is also a special form of physical change. The soluble impurities get removed from certain solids by crystallization. The process of cooling a hot, concentrated solution of a substance to obtain crystals is called crystallization.

We also know that sea-water contains salts dissolved in it and the salt can be separated from sea-water by the process of evaporation. The process of evaporation is not a good technique because the soluble impurities do not get removed in the process of evaporation.

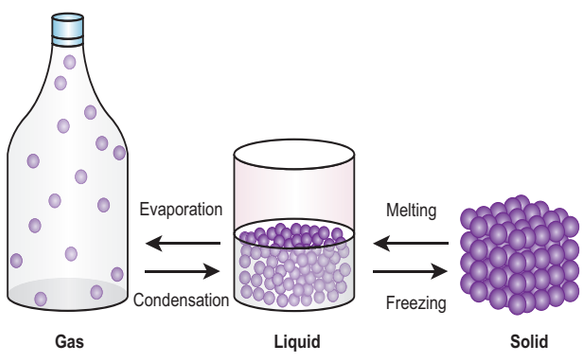
ACTIVITY 6

Crystallizing copper sulphate

Take about 100ml of water in a beaker. Heat the water over a burner till it boils. Add impure copper sulphate to the hot water with constant stirring. Continue to add copper sulphate till the solution takes up the added copper sulphate, that is, the added copper sulphate will not dissolve anymore. Filter the contents on a glass plate and allow it to cool. You could see crystals of copper sulphate in a few hours.



Further the crystals of salts obtained by the process of evaporation are small. The shape of crystals cannot be seen clearly. So the solid substances are usually purified by the process of crystallization. Large crystals of pure substances can be obtained from their solutions by the process of crystallization. **Crystallization is a method of separation as well as a method of purification.**



3.4 Chemical changes

Changes that occur with the formation of new substance with different chemical composition or transformation of a substance into another substance with the evolution or absorption of heat or light energy are termed as chemical changes. Rusting of iron, burning, curdling of milk, reaction of baking soda with lemon juice, fermentation are some examples of chemical changes.

Chemical changes are very important in our lives. All the new substances which we use in various fields of our life are produced as a result of chemical reactions. Some of the examples of the importance of chemical changes are given below:

i. Metals are extracted from their naturally occurring compounds called 'ores' by a series of chemical changes.
ii. Medicines are prepared by carrying out a chain of chemical changes.
iii. The materials such as plastics, soaps, detergents, perfumes, acids, bases, salts etc are all made by carrying out various types of chemical changes.
iv. Every new material is discovered by studying different types of chemical changes.

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

- Heat, light or any other radiation may be given off or absorbed.
- Sound may be produced
- A change in smell may take place (or) a new smell may be given off.
- A colour change may take place.
- A gas may be formed.

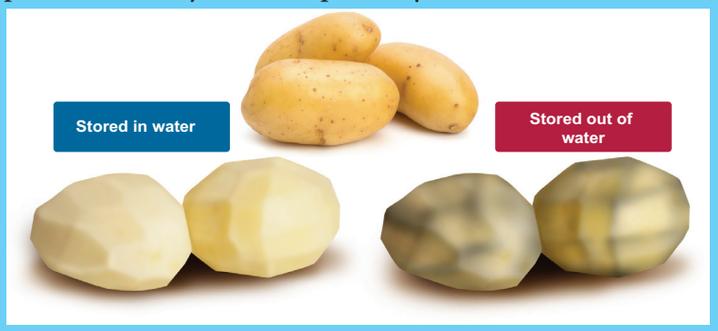
Explosion of a firework is a chemical change. We know that such an explosion produces heat, light, sound and unpleasant gases that pollute the atmosphere. That is why we are advised not to play with fireworks.

When food gets spoiled, it produces a foul smell. Shall we call this change as a chemical change? ..... Discuss in the class. Give your reflections.

You must have noticed that a slice of an apple acquires a brown colour if it is not consumed immediately. Colour of the potato remains the same when stored in water but there is change in colour with the piece kept in air. Look at the cut brinjal kept in air. The change of colour in these cases is due to the formation of some new substances which you will learn in higher classes. Are these not chemical changes?

Try yourself

Cut a fresh slice of potato and brinjal and keep it away for sometime.



Discuss and give your answer
You know that plant produce their food by a process called photosynthesis.
Can we call photosynthesis a chemical change?

3.4.1 Rusting of iron

In class six, we have already studied that rusting is an example of a chemical change. Now, shall we read why the process of rusting is called a chemical change.

DO YOU KNOW?

The Iron Pillar at Delhi

Amazingly there is an iron that did not rust!

There is an iron pillar at the Qutub complex in Delhi which is more than 1600 years age. Even after such a long period, the iron pillar kept in open spaces has not rusted at all. This shows that Indian scientists made great advances in metal making technology even at 16th century which enabled them to make this iron pillar having the quality of great rust resistance.

Rusting is one change that affects iron articles and slowly destroys them. Since iron is used in making bridges, ships, cars, truck bodies and many other articles, the monetary loss due to rusting is huge. The process of forming rust is represented as follows:

iron + oxygen + water→rust

$2Fe + 2O_2$ from air + $2H_2O \longrightarrow 2Fe_2O_3 . H_2O$

For rusting to take place both oxygen and water (or even water vapour) is essential. In fact, if the content of moisture in air is high, the air is said to be more humid and eventually rusting is faster.

How can we prevent rusting?

Iron articles can be prevented from making contact with oxygen, water/water vapour. A simple way is to apply a coat of paint or grease. These coats should be applied regularly to prevent rusting.

DO YOU KNOW?

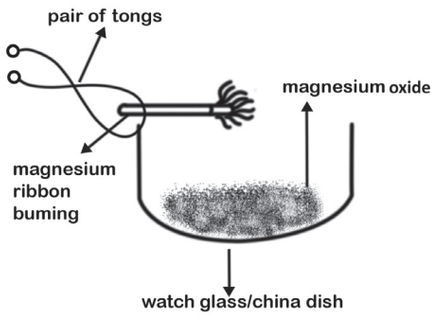
Another way of preventing rusting is to deposit a layer of a metal like chromium or zinc on iron. This is called galvanization and you will learn about this detail in higher classes.

3.4.2 Burning

we have already studied that burning of paper is a fast change. Burning a piece of paper gives entirely new substances such as carbon-di-oxide, water, water vapour, smoke and ash. Heat and light are also given out during the burning of

ACTIVITY 7

Take a small piece of magnesium ribbon and clean it by rubbing its surface with a sand paper. Hold the magnesium ribbon at one end with a pair of tongs and bring its other end over the flame of a burner.



paper. We cannot combine the products of burning of paper to form the original paper again. So, it is a permanent change. Now, shall we perform an activity of burning a piece of magnesium ribbon and find what type of change is it?

What do you observe?

You can see that the magnesium ribbon starts burning with a dazzling white light. Hold the burning magnesium ribbon over a watch glass so that the powdery ash being formed by the burning of magnesium collects in the watch glass.

When magnesium ribbon burns in air, then the magnesium metal combines with the oxygen of air to form a new substance called magnesium oxide.

Magnesium + Oxygen ⟶ Magnesium oxide

$2Mg + O_2 \longrightarrow 2MgO$

Magnesium oxide compound appears as a white powdery ash.

The burning of magnesium ribbon is a chemical change, because a new substance, magnesium oxide, is formed during this change.

3.4.3 Curdling of milk

We know that curdling of milk is an example of irreversible change since we cannot get back the milk after curdling occurs. It is also called as a chemical change. Shall we clarify the process of curdling?

Curdling is a process in which liquid gradually turns into solid, forming clumps along the way. Take hot milk in a pan and add few drops of curd, in few minutes milk curdles forming lumpy solid masses. We can even add lemon extract to the hot milk to effect curdling immediately, but the taste and texture of the curd will not be the same as that of the curdling occurring in a few hours. You can try to taste the curd formed by immediate curdling and gradual curdling.

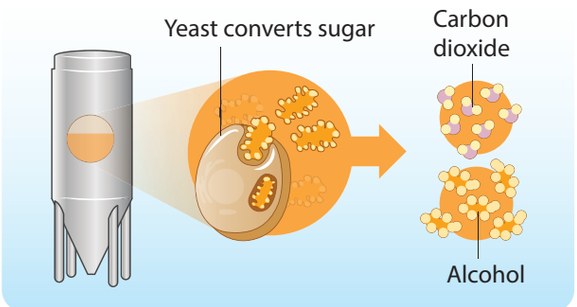
L5I2R4

3.4.4 Fermentation

In class six, we saw an example that preparation of batter to produce idly is an example for irreversible change.

Fermentation is the process in which microorganisms such as yeast and certain bacteria break down sugar solution into alcohol and carbon-di-oxide.

It is an irreversible process as the alcohol formed cannot be turned back into sugar. Thus, fermentation is a chemical change.



Louis Pasteur (1822-1895), a French chemist and microbiologist was the first person to describe the process of fermentation.

He described that fermentation occurs in the absence of air and in the presence of micro organisms such as yeast. He discovered the cure for rabies.

3.4.5 Chemical reaction of baking soda with lemon

Baking soda is sodium hydrogen carbonate and lemon juice contains citric acid. So, when these two substances are mixed together, then a chemical change takes place between sodium hydrogen carbonate and citric acid to form three new substances: sodium citrate, carbon-di-oxide and water. The chemical change can be written in the form of a word equation as follows:-

Sodium hydrogen carbonate + citric acid → sodium citrate + carbon dioxide + water

ACTIVITY 8

When baking soda and lemon juice are mixed together, then bubbles of carbon-di-oxide are formed along with the formation of some salt and water. Take 10 ml of lemon juice and add pinch by pinch of baking soda to it. Actually when we mix baking soda with lemon juice, we will hear a hissing sound when bubbles of carbon-di-oxide coming out and rising in the reaction vessel.

3.5 Conditions needed for a chemical change

We know that firing of crackers is a chemical change. Some crackers explode only when thrown against a wall or struck with a hard substance. Thus, we could see that c**hange in pressure** may also bring about a chemical change.

When lemon juice is mixed with soda water, they produce brisk effervescence which is otherwise not possible when they are separate. So we can say that many chemical changes occur only when the **substances are made to physically contact with each other.**

We have tasted raw rice and cooked rice, Have not we? They are different in their taste. Cooking is a process that is involved in the stated example, wherein rice is boiled with sufficient water. It is the heat and the water that had brought the change in texture and taste of the rice before and after cooking. Thus we can say that **heating** is a condition needed for a chemical change to occur.

We know the use of vanaspathi in cooking vanaspathi is obtained from vegetable oils by addition of hydrogen to the oils. nickel, platinum or palladium are used as catalyst during the process of hydrogenation of oils.

Catalysts are substances that speed up the process of a chemical change and it will not undergo any change during the course of the reaction. For example, yeast acts as the catalyst in the fermentation of sugar. You will learn more about catalyst in your higher classes.

Water is a chemical compound that remains as water when undisturbed. But if a few drops of an acid is added to water and subjected to electrolysis by passing electric current, it decomposes into hydrogen and oxygen. So, we can understand that **electric current** is also a condition that is needed for effecting a chemical change.

Thus we can conclude that physical contact of the substances, heat, light, electricity, applying pressure are some of the different conditions needed for chemical changes to occur.