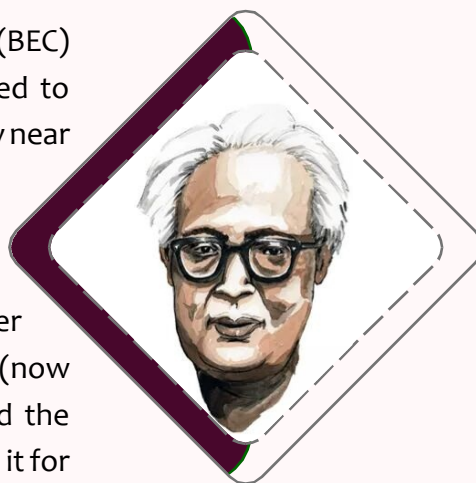
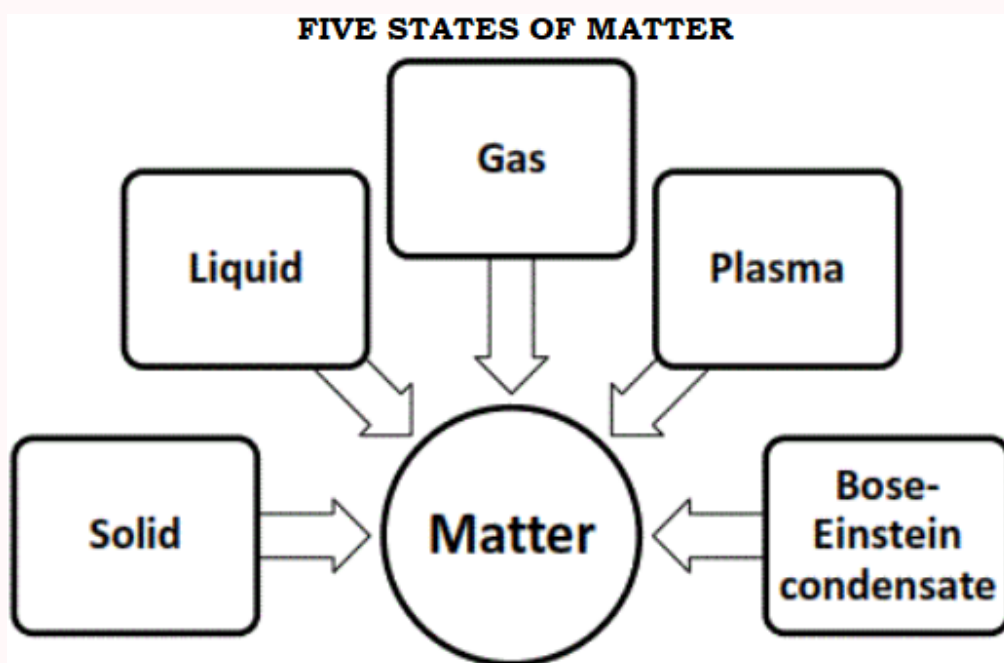


# NATURE OF MATTER

**Satyendra Nath Bose:** A Bose–Einstein condensate (BEC) is a state of matter of a dilute gas of bosons cooled to temperatures very close to absolute zero (that is, very near 0 K or  $-273.15^{\circ}\text{C}$ ). Under such conditions, a large fraction of bosons occupy the lowest quantum state, at which point macroscopic quantum phenomena become apparent. Bose first sent a paper to Einstein on the quantum statistics of light quanta (now called photons). Einstein was impressed, translated the paper himself from English to German and submitted it for Bose to the magazine physics, which published it.



## CONCEPT MAP



## CONCEPT 1.1

**Introduction:**

The whole universe is composed of **Matter** and **Energy**.

Chemistry is the branch of science which deals with the study of composition, structure and properties of **matter** and the various changes it undergoes. (We study about energy in Physics).

**Matter:** Matter is anything that has mass and occupies space and can be perceived by our senses. Matter exists in many forms. As we look at our surroundings, we see a large variety of things with different shapes, sizes and textures. Everything in this universe is made up of material which scientists have named “matter”. The air we breathe, the food we eat, stones, clouds, stars, plants and animals, even a small drop of water or a particle of sand each thing is matter. We can also see as we look around that all the things mentioned above occupy space, that is, volume and have mass.

Matter basically exists in three states, namely solids, liquids and gases. Irrespective of the state of matter, the basic units of matter are only molecules. The three states of matter differ with respect to the manner of molecular arrangements which brings about change in physical behaviour of the substances in their respective states. The various characteristics of matter which determine the physical behaviour are envisaged in kinetic molecular theory of matter.

**Characteristics of matter:**

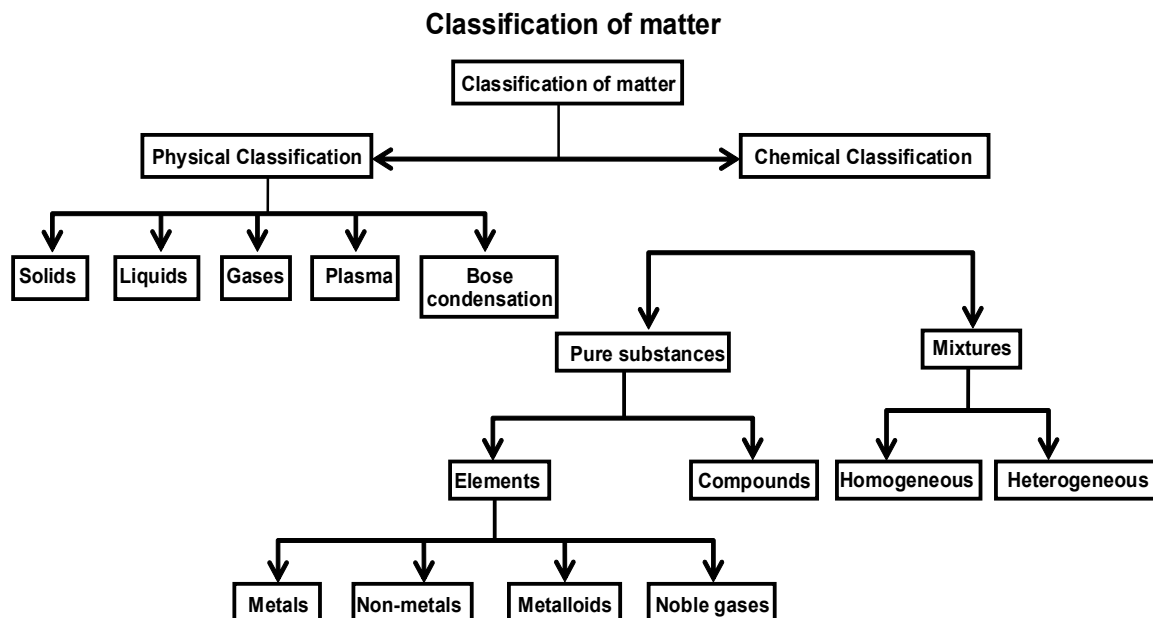
1. Matter is made up of tiny particles called **Molecules**.
2. The molecules in turn are made up of small particles called **Atoms**.
3. The molecules are so small that they are not visible to our naked eye.
4. Molecules of matter are in **constant vibration**.
5. All material bodies have mass and hence have weight
6. All materials occupy space.

In different states of matter, the arrangement of molecules is different.

**Classification of matter:**

As there are so many kinds of matter, a scientific study of matter becomes easier if we classify matter based on some characteristics. Matter can be classified based on two factors:

1. Physical classification
2. Chemical classification



### Physical classification of matter:

Matter is composed of extremely small particles. Based on the arrangement of these particles, matter is mainly divided into three types. They are solids, liquids and gases. These are also called physical states of matter. This classification is also based on differences of certain physical properties namely, mass, volume, shape, rigidity, density and arrangement of particles.

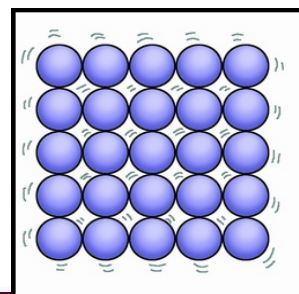
On the basis of molecular theory of matter, we can explain the internal nature of solids, liquids and gases.

**Solids:** In solids, the molecules are closely packed up. Their positions are almost fixed. That is why, solids retain their shape, and they have a fixed volume. The force of attraction between molecules which is known as 'Intermolecular force' exercises a greater influence in solids. However, the space between molecules is very small.

**Example:** Ice, a brick, a piece of chalk, a metallic pot does not change its shape or volume on its own.

### General properties of solids:

1. Solids have fixed shape and fixed volume.
2. Generally, solids cannot be compressed.
3. A solid does not flow.
4. A solid expands very little on being heated.
5. Solids have very less interparticle spaces and very high interparticle attraction.





## CLASSROOM DISCUSSION QUESTIONS

CDQ  
1.1

- What is the branch of science that deals with the study of composition, structure, and properties of matter?**  
(A) Biology (B) Chemistry  
(C) Physics (D) Geology
- According to the passage, what is matter?**  
(A) Anything that has energy and occupies space  
(B) Anything that is visible to the naked eye  
(C) Anything that has mass and occupies space  
(D) Anything that has weight
- What are the basic units of matter called?**  
(A) Cells (B) Particles  
(C) Molecules (D) Atoms
- Which statement about molecules is true according to the passage?**  
(A) Molecules are visible to the naked eye  
(B) Molecules are not made up of atoms  
(C) Molecules are in constant rest  
(D) Molecules are in constant vibration
- What determines the physical behavior of matter, according to the passage?**  
(A) Volume only  
(B) Mass only  
(C) Characteristics of matter and kinetic molecular theory  
(D) Weight only
- In which state of matter are molecules closely packed up and almost fixed in position?**  
(A) Liquids (B) Gases  
(C) Solids (D) Plasma
- What is the force of attraction between molecules in solids called?**  
(A) Kinetic energy  
(B) Chemical bond  
(C) Intermolecular force  
(D) Potential energy
- Which of the following is a general property of solids mentioned in the passage?**  
(A) Solids have variable shape and fixed volume  
(B) Solids can be easily compressed  
(C) Solids flow readily  
(D) Solids have fixed shape and fixed volume
- How do solids behave when heated, according to the passage?**  
(A) They contract  
(B) They remain unaffected  
(C) They expand very little  
(D) They evaporate
- What is the classification of matter based on the arrangement of particles into solids, liquids, and gases called?**  
(A) Physical classification  
(B) Chemical classification  
(C) Molecular classification  
(D) Atomic classification

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken in Minutes 

1 A B C D	2 A B C D	3 A B C D	4 A B C D	5 A B C D
6 A B C D	7 A B C D	8 A B C D	9 A B C D	10 A B C D



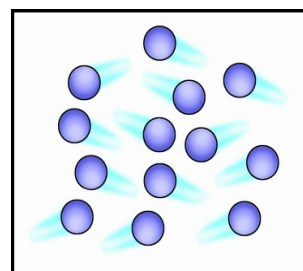
## CONCEPT 1.2

**Liquids:** In liquids, the molecules are not packed as closely as in solids. Liquids, therefore, change their shape easily but not their volume on their own. The intermolecular space, that is the distance between molecules in a liquid is more than that in solids and, hence, the force of attraction between the molecules is weaker. Hence, the molecules in a liquid are free to move about but continue to interact with one another. That is why, a liquid does not possess a definite shape and takes the shape of the container.

**Example:** Water, milk, alcohol, tea, coffee etc.

### General properties of liquids:

1. A liquid has no fixed shape. It takes the shape of its container.
2. A liquid can be compressed only to a small extent.
3. Liquids can flow.
4. A liquid expands (or) contracts more than a solid.
5. Liquids have more interparticle spaces and less interparticle attraction compared to solids.

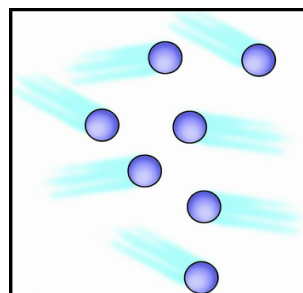


**Gases:** In gases, the molecules are at a greater distance from one another as compared to solids and liquids. They are free to move. Gases have therefore, neither a fixed shape nor a fixed volume. In a gas, the molecules move very fast. Their average speed is about 1600 km/hr. Also, the molecules are separated from one another by wide spaces. The interacting force between the molecules is, therefore, very weak, and molecules enjoy full freedom of movement. The molecular force of interaction in a gas depends upon density. The force is non-existent if the density is low. It begins to acquire some value as the density begins to increase. Hence, a gas has neither a definite volume nor a definite shape.

**Example:** Oxygen, carbon dioxide, and nitrogen etc.

### General properties of gases:

1. A gas has neither a fixed volume nor a fixed shape. It assumes the volume and shape of the container.
2. Gases can be compressed to a much larger extent than solids and liquids.
3. A gas expands to a greater extent on being heated.
4. Gases freely mix with one another. Because the molecules of a gas can easily occupy the large intermolecular spaces of another gas. This property is known as **diffusion**.
5. Gases have very large interparticle spaces and negligible interparticle attractions.



**What causes a difference in states?**

Molecules attract each other with a force. This force is called **intermolecular force**. There is also some space between the molecules. This space is called **intermolecular space**.

The greater the intermolecular force, the closer will be the molecules to each other. The weaker the intermolecular force, the further apart will be the molecules.

**Plasma state (Fourth state of matter):** Plasma is the fourth state of matter. Plasma is similar to the gaseous state. Plasma is made by heating a gas. Atoms and molecules in the gas lose all electrons and form ions and electrons to coexist. The plasma is produced in sun and stars because of very high temperature. The sun and stars glow because of the presence of plasma in them. Plasma occurs naturally and makes up the stuff of our sun, the core of stars and occurs in supernovas. On earth, plasma is naturally occurring in flames, lightning, the northern and southern lights.

Plasmas have a very low density, for example the Solar wind which averages only 10 particles per cubic cm. Inter-particle collisions are unlikely - hence these plasmas are termed collision less.

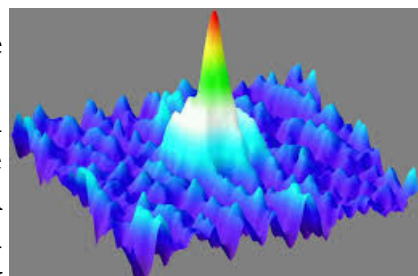
**Finding a Plasma:** While natural plasmas aren't found around you that often, man-made plasmas are everywhere. Think about fluorescent light bulbs or neon sign tubes. They are not like regular light bulbs. Inside the long tube is a gas. Electricity flows through the tube when the light is turned on. The electricity acts as an energy source and charges up the gas. This charging and exciting of the atoms creates glowing plasma inside the bulb, having a special colour depending on the nature of gas.

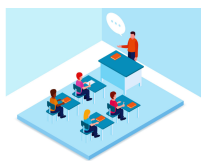
**Plasma state****Bose-Einstein condensate or BEC (Fifth state of matter):**

In 1924, **Albert Einstein** and **Satyendra Nath Bose** predicted the "Bose-Einstein Condensate" (BEC), which is referred as the fifth state of matter.

A Bose-Einstein condensate (BEC) is a state of matter of a dilute gas of bosons cooled to temperatures very close to absolute zero (that is, very near 0K or  $-273.14^{\circ}\text{C}$ ).

Under such conditions, a large fraction of the atoms collapse into the lowest quantum state, producing a superfluid. The Bose-Einstein condensate occurs at ultra-low temperature, close to the point that the atoms are not moving at all. A Bose-Einstein condensate is a gaseous superfluid phase formed by atoms cooled to temperatures very near to absolute zero.

**Bose-Einstein condensate**



## CLASSROOM DISCUSSION QUESTIONS

CDQ  
1.2

- What property allows liquids to change their shape easily but not their volume on their own?**
  - Strong intermolecular force
  - Weak intermolecular force
  - Fixed intermolecular distance
  - Absence of intermolecular force
- Which of the following is a general property of liquids mentioned in the passage?**
  - Liquids have fixed shape and fixed volume
  - Liquids cannot flow
  - Liquids can be compressed easily
  - Liquids take the shape of their container
- What determines the physical behavior of gases, according to the passage?**
  - Mass only
  - Characteristics of matter and kinetic molecular theory
  - Volume only
  - Weight only
- Which state of matter has molecules at a greater distance from one another and no fixed shape or volume?**
  - Solids
  - Liquids
  - Gases
  - Plasmas
- What is the force between molecules in gases called?**
  - Interatomic force
  - Intermolecular force
  - Intraparticle force
  - Intraatomic force
- Which state of matter assumes both the volume and shape of its container?**
  - Solids
  - Liquids
  - Gases
  - Plasmas
- What property allows gases to be compressed to a much larger extent than solids and liquids?**
  - Weak interparticle attractions
  - Fixed shape
  - High density
  - Fixed volume
- What is the fourth state of matter mentioned in the passage?**
  - Solids
  - Liquids
  - Gases
  - Plasma
- How is plasma formed?**
  - By cooling a gas
  - By heating a solid
  - By heating a gas
  - By cooling a liquid
- What is the fifth state of matter predicted by Albert Einstein and Satyendra Nath Bose?**
  - Plasma
  - Gases
  - Liquids
  - Bose-Einstein condensate

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken in Minutes

1 A B C D	2 A B C D	3 A B C D	4 A B C D	5 A B C D
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## CONCEPT 1.3

## Interconversion of matter into different states:

The phenomenon of change of matter, from one state to another state and back to original state, by altering the conditions of temperature and pressure, is called **interconversion of matter**.

## Altering the temperature of matter:

- 1. Interconversion of matter, on heating:** A block of ice at  $0^{\circ}\text{C}$ , placed in a beaker and heated. It changes to liquid water. Heat the water till it boils. It slowly gets converted to vapour (gas). From this observation, it is clear that the solids convert into liquids and liquids in turn convert to gas, on heating.

**Melting:** The process of changing a solid substance into liquid by heating is called **melting**. For example, when ice (solid) changes into water (liquid), it is called melting of ice. A solid substance can be melted only by applying heat. The melting of a substances takes place at a fixed temperature.



**Melting point:** The temperature at which a solid substance melts and changes into a liquid is called **melting point** of the substance.

## Melting points of some solid substances:

Solids	Ice ( $\text{H}_2\text{O}$ )	Sodium chloride ( $\text{NaCl}$ )	Iron ( $\text{Fe}$ )
Melting point	$0^{\circ}\text{C}$	$800^{\circ}\text{C}$	$1535^{\circ}\text{C}$

## Evaporation:

The gaseous state of a liquid is also called its vapour state. Most of the liquids keep on changing into vapours slowly even at room temperature. The changing of a liquid into vapours (or) gas is called **evaporation**. The evaporation of a liquid can take place at all temperatures.

**Boiling:** When a liquid is heated continuously, then its temperature goes on rising and its evaporation (changing into vapours) takes place faster and faster. At a certain temperature, the liquid changes into vapours (a gas) very rapidly and we say that the liquid has started boiling. The rapid changing of a liquid into vapours (or) gas on heating is called **boiling**. The boiling of a liquid takes place at a fixed temperature.



**Boiling point:** The temperature at which a liquid boils and changes into vapours (or) gas very rapidly is called

Boiling of Water

**boiling point** of the liquid for example, water boils at a temperature of  $100^{\circ}\text{C}$  to form a gas is called steam, so the boiling point of water is  $100^{\circ}\text{C}$ .

### Boiling points of some liquids:

<b>Liquid</b>	Water	Chloroform	Sulphuric acid
<b>Boiling point</b>	$100^{\circ}\text{C}$	$62^{\circ}\text{C}$	$337^{\circ}\text{C}$

**Do you know?** Evaporation is a slower process than boiling because it occurs at the surface of a liquid at all temperatures below boiling point, while boiling is a faster process that happens throughout the liquid at the boiling point.

**Sublimation:** A few substances change directly from solid to gas on heating without coming into liquid state. This process is called **sublimation**, and such substances are called sublimates.

**For example:** Iodine, Ammonium chloride, camphor and Naphthalene are sublimable substances.

**2. Interconversion of matter by cooling:** Collect some water vapour (gas) and cool it. We will notice that it becomes liquid water. On cooling further, the liquid water gets converted to ice (solid). A reverse process of heating is taking place on cooling. That is, a gas is converted to liquid and liquid is converted to solid, by cooling.

**Condensation:** We have just seen when water is heated, it changes into steam (or) water vapour. The reverse of this is also true. That is, if we cool the steam, it changes back into water (liquid state). The process of changing a gas (or) vapours into a liquid by cooling is called **condensation**.

For example, the mirror in the bathroom during a shower becomes foggy because warmer water vapour in the air hits the cooler surface of the mirror.

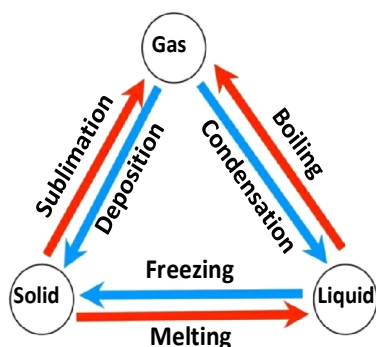


**Condensation of vapours**

**Freezing:** We have seen that when ice is heated, it melts to form water. The reverse of this is also true. That is, when a liquid is cooled, it changes into solid. For example, when water is cooled, it freezes to form ice. The process of changing of state from liquid to solid by cooling, is also called **freezing** (or) **solidification**.



**Freezing of water into ice**







## CLASSROOM DISCUSSION QUESTIONS

CDQ  
1.3

- What is the process of changing a solid substance into a liquid by heating called?**
  - Freezing
  - Evaporation
  - Melting
  - Sublimation
- What is the temperature at which a solid substance melts and changes into a liquid called?**
  - Freezing point
  - Boiling point
  - Condensation point
  - Melting point
- What is the process of changing a liquid into vapors (or gas) at all temperatures called?**
  - Boiling
  - Sublimation
  - Evaporation
  - Condensation
- At what temperature does water boil and change into vapor (gas) very rapidly?**
  - 0°C
  - 62°C
  - 100°C
  - 280°C
- What is the temperature at which a liquid boils called?**
  - Freezing point
  - Condensation point
  - Sublimation point
  - Boiling point
- Which of the following substances undergoes sublimation?**
  - Water
  - Iron
  - Iodine
  - Sulphuric acid
- What is the reverse process of boiling called?**
  - Condensation
  - Evaporation
  - Melting
  - Sublimation
- What is the process of changing a gas (or vapors) into a liquid by cooling called?**
  - Boiling
  - Condensation
  - Melting
  - Sublimation
- What occurs when a few substances change directly from solid to gas on heating without becoming a liquid?**
  - Melting
  - Evaporation
  - Sublimation
  - Condensation
- What is the process of changing a liquid to a solid by cooling called?**
  - Melting
  - Freezing
  - Boiling
  - Evaporation

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken in Minutes 

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6 A B C D	7 A B C D	8 A B C D	9 A B C D	10 A B C D

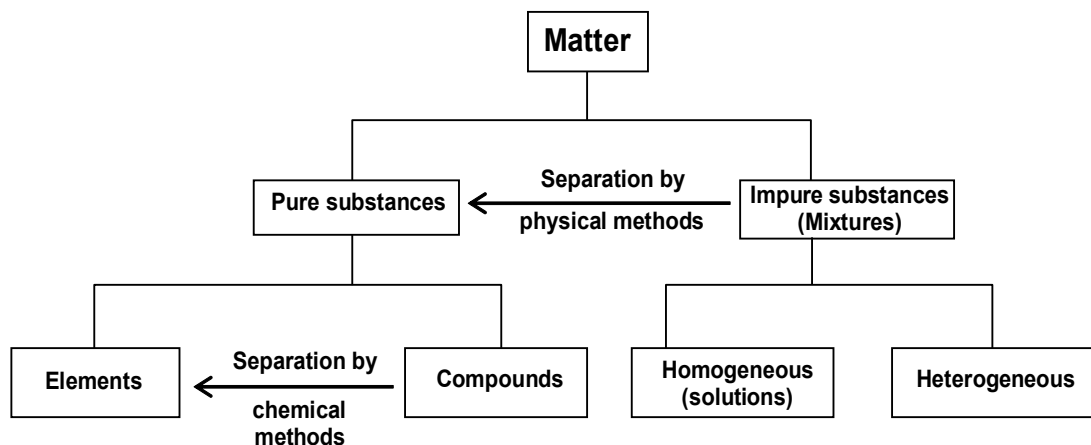
## CONCEPT 1.4

### Classification of Matter based on chemical composition:

When we talk about matter, usually we talk about a substance, which possesses distinct properties and has a definite composition. For example, sugar (sucrose), table salt (sodium chloride), water, gasoline, etc. All substances do not have the same composition but yet can be identified by their unique properties.

Matter is classified into two broad categories, namely, pure substances and mixtures.

Pure substances are further divided into two categories as elements and compounds. Similarly, mixtures are also classified into two types, homogeneous mixtures and heterogeneous mixtures. Mixtures can be separated into pure substances by physical methods.



### Pure substances:

A pure chemical substance is any matter that has a fixed chemical composition and characteristic properties. For example, Oxygen is a pure chemical substance that is a colourless, odourless gas. The substance containing particles of only one kind are **pure substances**.

**Example:** Iron, silver, oxygen, carbon dioxide, sodium chloride etc. Pure substances are further divided into elements and compounds.

A pure substance can be either an element or a compound. First of all, the elements are the building blocks of our nature.

### I. Elements:

An element is a substance that is either discovered in the nature or synthesized in the laboratory in pure form that cannot be separated into simpler substances by chemical methods. In order to call it as an element, its properties must be unique, no two elements are alike.



## Nature of Matter

Elements carry the names and symbols.

**Example:** Hydrogen (H), oxygen (O), nitrogen (N), sulphur (S), carbon (C) etc.

### Few things to know about the elements:

- Names of the elements are given by its inventor(s).
- Sometimes, they are named after the place like an element Berkelium (Bk) after its discovery in Berkeley (University of California, Berkeley).
- Sometimes, their names are based on planet, like element Mercury (Hg) named after the planet mercury.
- Sometimes, the name is given to honour the great scientist, like Curium (Cm) after Madame Curie.

### Characteristics of elements:

**i) Nature:** An element is pure and homogeneous substance.

**ii) Melting and boiling points:** It has characteristic melting and boiling points.

**iii) Separation of compounds:** An element cannot be broken-down into simpler substances, by any physical (or) chemical means.

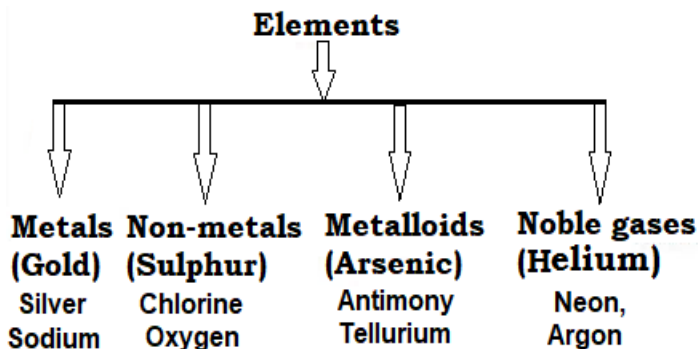
**iv) Nature of atom:** An element is made up of same kind of atoms. Different elements are made up of different kinds of atoms.

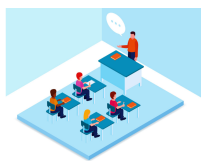
**v) Chemical reaction:** An element may chemically react with other element(s) to form compound(s). For example, hydrogen combines with oxygen to form water and with chlorine to form hydrogen chloride.

### Classification of Elements:

There are more than 118 elements known today, out of these, 92 elements are naturally occurring elements and remaining are artificially synthesised (man-made). On the basis of their general characteristics, they are broadly divided into four groups.

1. Metals
2. Non-metals
3. Metalloids
4. Inert gases





## CLASSROOM DISCUSSION QUESTIONS

CDQ  
1.4

- What are substances that possess distinct properties and have a definite composition called?**
  - Mixtures
  - Compounds
  - Pure substances
  - Elements
- Which of the following is a characteristic of pure substances?**
  - They can be separated into simpler substances by physical methods
  - They have variable chemical compositions
  - They have fixed chemical compositions
  - They exhibit properties that vary depending on the conditions
- What category of pure substances cannot be separated into simpler substances by chemical methods?**
  - Mixtures
  - Compounds
  - Elements
  - Homogeneous mixtures
- Which of the following is NOT a characteristic of elements?**
  - They are homogeneous substances
  - They have characteristic melting and boiling points
  - They can be broken down into simpler substances
  - They are made up of the same kind of atoms
- What is the basis for naming elements?**
  - Their atomic number
  - Their atomic mass
  - The place of their discovery
  - The number of their isotopes
- Which of the following is NOT a group of elements based on their general characteristics?**
  - Metals
  - Non-metals
  - Halogens
  - Metalloids
- How many naturally occurring elements are there?**
  - 100
  - 92
  - 118
  - 120
- Which group of elements is typically found to the right of the periodic table?**
  - Metals
  - Non-metals
  - Metalloids
  - Noble gases
- What are the building blocks of nature called?**
  - Atoms
  - Compounds
  - Molecules
  - Mixtures
- How many elements are currently known?**
  - 92
  - 118
  - 100
  - 120

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken in Minutes

1 A B C D	2 A B C D	3 A B C D	4 A B C D	5 A B C D
6 A B C D	7 A B C D	8 A B C D	9 A B C D	10 A B C D

## CONCEPT 1.5

## 1. Metals:

Metallic elements in general exhibit the following characteristics:

- All metals are solids at room temperature.
- Metals are good conductors of heat and electricity.
- Metals are malleable, ductile and lustrous in nature.
- Metals are strong. They have high tensile strength.
- Most of the metals are hard.
- Metals have high densities.
- Metals are sonorous. That is, metals make sound when hit with an object.

## Exceptions:

- Mercury is a liquid metal at normal or room temperature and gallium becomes liquid at above 30°C temperature.
- Zinc metal is non-malleable and non-ductile at room temperature.
- Some metals like sodium and potassium are soft metals, even they can be cut with a knife.

**Example:** Iron (Fe), gold (Au), copper (Cu), aluminium (Al), silver (Ag), etc.

## 2. Non - Metals:

Non-metals in general exhibit the following characteristic properties.

- Non-metals are not hard.
- Non-metals have dull surface. They do not shine.
- Most non-metals are soft solids or gases.
- Non-metals are non-malleable.
- Non-metals are non-ductile.
- Non-metals are brittle *i.e.*, they break into pieces on being hammered (like glass).
- Non-metals are bad conductors of heat and electricity.
- Non-metals are non-sonorous - they do not produce any sound when struck.

## Exceptions:

- **Graphite** (A form of carbon) has a lustre and is a good conductor of heat and electricity.
- **Bromide** is a liquid non-metal.

**Example:** Carbon (C), oxygen (O), sulphur (S), hydrogen (H), nitrogen (N), etc.

### 3. Metalloids:

Metalloids exhibit the following properties that lie in between that of metals and non-metals.

**Example:** Boron (B), silicon (Si), germanium (Ge), arsenic (Ar), antimony (Sb), tellurium (Te) and polonium (Po).

### 4. Inert Gases:

The gaseous elements which do not combine with other elements and even themselves and exist as individual atoms are called inert gases.

**Example:** Helium(He), neon(Ne), argon (Ar), krypton(Kr), xenon(Xe), radon(Rn) (Radioactive element).

Inert gases are also called noble gases, aerogens, rare gases, zero group elements.

### Atom:

Suppose by some means, we could divide an element into similar and smaller parts, there would be a limit after which it will not be possible to divide it any further, or even if it could be divided, it would lose the properties of the element. This particle is the atom of the element.

The smallest particle of an element that retains the properties of the element is called the **atom** of the element.

An element is made up of only one kind of atoms. All atoms of an element are identical (there are exceptions to this, about which you will read in higher classes), but atoms of one element are different from the atoms of any other element.

For example, all atoms of oxygen are identical. Similarly, all atoms of nitrogen are identical. But atoms of oxygen are different from the atoms of nitrogen.

### Molecule:

An atom can sometimes exist alone and sometimes in groups. A group of atoms is called a **molecule**. A molecule can always exist by itself. A molecule may contain similar or dissimilar atoms.

### Example:

Molecules with similar atoms		Molecules with different atoms	
Molecule	Formula	Molecule	Formula
Oxygen	O <sub>2</sub>	Water	H <sub>2</sub> O
Hydrogen	H <sub>2</sub>	Sodium chloride	NaCl
Chlorine	Cl <sub>2</sub>	Calcium oxide	CaO
Nitrogen	N <sub>2</sub>	Ammonia	NH <sub>3</sub>



## CLASSROOM DISCUSSION QUESTIONS

CDQ  
1.5

- Which of the following is NOT a characteristic of metals?
  - Good conductors of heat and electricity
  - Malleable and ductile
  - Brittle
  - Solid at room temperature
- Which of the following is an exception to the characteristics of metals?
  - Mercury being a liquid at room temperature
  - Zinc being malleable and ductile
  - Sodium and Potassium being soft metals
  - All of the above
- What characteristic property do non-metals generally exhibit?
  - Malleability and ductility
  - Shininess
  - Good conductors of heat and electricity
  - Being brittle
- Which of the following is NOT a property of non-metals?
  - Good conductors of heat and electricity
  - Dull surface
  - Soft solids or gases
  - Malleable and ductile
- What category of elements exhibits properties that lie between metals and non-metals?
  - Metals
  - Non-metals
  - Metalloids
  - Inert gases
- What is another term for inert gases?
  - Aerogens
  - Noble gases
  - Rare gases
  - All of the above
- What is the smallest particle of an element that retains its properties called?
  - Molecule
  - Atom
  - Compound
  - Ion
- Which statement about atoms is true?
  - Atoms of different elements are identical
  - Atoms can be further divided into smaller parts
  - All atoms have the same properties
  - Atoms of one element are different from atoms of any other element
- What is a group of atoms called?
  - Element
  - Atom
  - Molecule
  - Compound
- Which of the following is NOT an example of a molecule?
  - Carbon dioxide ( $\text{CO}_2$ )
  - Nitrogen gas ( $\text{N}_2$ )
  - Hydrogen atom ( $\text{H}$ )
  - Water molecule ( $\text{H}_2\text{O}$ )

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken in Minutes

1 A B C D	2 A B C D	3 A B C D	4 A B C D	5 A B C D
6 A B C D	7 A B C D	8 A B C D	9 A B C D	10 A B C D

**CONCEPT 1.6**

Atoms of most elements can exist alone, e.g. iron, gold, aluminium or silver. But in certain gaseous elements, such as hydrogen, nitrogen, oxygen, chlorine or iodine, atoms cannot exist alone. They can exist only in pairs. A molecule of these elements contains two similar atoms. Some molecules even contain three similar atoms. For example, ozone gas has its molecules with three atoms of oxygen ( $O_3$ ).

We can therefore define a molecule as:

A **molecule** is the smallest particle of an element or a compound that can exist by itself.

The molecule of an element contains one or more atoms of the same kind. The molecule of a compound contains two or more atoms of different kinds.

From the above discussions, we can conclude the following facts.

- The smallest particle of compound is known as its **molecule**.
- The molecules of compounds can be broken down into the elements from which they are made.
- A molecule is the smallest particles of an element or a compound, which shows all the properties of that substance (element or compound).
- Symbol represents one atom of an element. On the other hand, molecular formulae represent one molecule of an element or a compound.

**II. Compounds:**

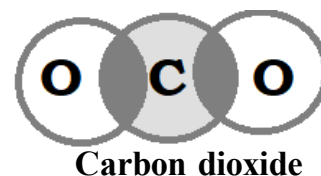
A compound is the substance formed by the chemical union of two or more elements in a definite ratio, which is fixed by the nature. We cannot change this ratio, no matter who does it.

For example, water is made up of one part oxygen and two parts hydrogen. This ratio is fixed by the nature, and we cannot alter this. When the compound is formed, altogether a new substance is formed and the properties of which are quite different from its reacting elements. Like elements, compounds also carry names and symbols that you come across in a later chapter.

For understanding what a compound is, consider the facts given below:

1. There are only 26 letters in the English alphabet. Different combinations of these letters make a large number of words.
2. Only ten numerals from 0 to 9 make innumerable numbers.
3. A variety in music is obtained by using different combinations of only a few basic units musical notes.

Similarly, compounds are formed by the combination of elements. For example, one atom of carbon combines with two atoms of oxygen to form the molecule of a compound, carbon dioxide. Thus the molecule is the smallest particle of the compound. It has dissimilar atoms.



There are millions of different compounds around you. Probably everything you can see is one type of compound or another. When elements join and become compounds, the new compounds formed have few or none of the physical or chemical properties of the original elements. They have a new life of their own.

For example:

Element **sodium** (Na) alone is soft and silvery shiny metal and that can easily cut with knife. It is a very reactive metal. Its melting point is  $97.6^{\circ}\text{C}$  and it reacts violently with water.

Element **chlorine** consists of chlorine molecules ( $\text{Cl}_2$ ). Chlorine is a non-metal yellowish green gas. It is highly toxic, and it was used as a warfare agent during world war-I. Its boiling point is  $-34^{\circ}\text{C}$ .

But when sodium and chlorine ( $\text{Cl}$ ) combine, they form a non-reactive substance called **sodium chloride** (table salt,  $\text{NaCl}$ ). It is a brittle, colourless crystalline hard solid having a melting point of  $800^{\circ}\text{C}$ . It does not react with water as sodium does and not toxic to humans as chlorine but an essential component of all living organisms.

Thus, a compound is a substance, composed of two or more elements, chemically combined in a definite proportion.

Compound	Formula	Chemical name
Table salt	$\text{NaCl}$	Sodium Chloride
Baking powder	$\text{NaHCO}_3$	Sodium bicarbonate
Vinegar	$\text{C}_2\text{H}_4\text{O}_2$	Acetic acid
Table sugar	$\text{C}_{12}\text{H}_{22}\text{O}_{11}$	Sucrose
Chalk/limestone	$\text{CaCO}_3$	Calcium carbonate
Bleaching powder	$\text{Ca}(\text{OCl})_2$	Calcium hypochlorite
Gobar gas (Biogas)	$\text{CH}_4$	Methane
Oil of vitriol (Battery acid)	$\text{H}_2\text{SO}_4$	Sulphuric acid
Quick lime	$\text{CaO}$	Calcium oxide
Silica (Sand)	$\text{SiO}_2$	Silicon dioxide

### Impure substances:

When two or more substances (either elements or compounds) combine in any proportion then the resultant substance so obtained is called a **mixture**. We study about these mixtures in further classes.

1. Anything which occupies space and has mass is called **matter**.





# CLASSROOM DISCUSSION QUESTIONS

CDQ  
1.6

- What is the definition of a molecule?**
  - The smallest particle of an element
  - The smallest particle of a compound
  - A combination of atoms of the same kind
  - A combination of atoms of different kinds
- Which of the following statements about molecules is true?**
  - Molecules of compounds can only contain atoms of the same kind
  - Molecules of elements can only contain atoms of different kinds
  - Molecules of compounds can contain atoms of different kinds
  - Molecules of elements cannot exist alone
- What is a compound?**
  - A mixture of elements
  - A combination of atoms of the same kind
  - A substance formed by the chemical union of two or more elements in a definite ratio
  - A substance formed by the physical union of two or more elements
- What determines the ratio of elements in a compound?**
  - Chemical reactions
  - Physical properties
  - Nature
  - Temperature
- How are compounds different from their constituent elements?**
  - Compounds have the same physical and chemical properties as their elements
  - Compounds have fewer physical and chemical properties than their elements
  - Compounds have the same physical properties but different chemical properties as their elements
  - Compounds have different physical and chemical properties than their elements
- What is an example of a compound mentioned in the passage?**
  - Sodium (Na)
  - Chlorine (Cl)
  - Oxygen (O)
  - Sodium chloride (NaCl)
- Which statement about mixtures is true?**
  - Mixtures can only contain elements
  - Mixtures can contain only compounds
  - Mixtures can contain both elements and compounds
  - Mixtures can only contain impure substances
- What happens when two or more substances combine in any proportion?**
  - A compound is formed
  - A mixture is formed
  - An element is formed
  - A molecule is formed
- Which of the following is NOT a characteristic of a compound?**
  - Formed by the chemical union of elements
  - Fixed ratio of elements
  - Properties different from its elements
  - Can exist alone
- What is the primary difference between a molecule and a compound?**
  - Molecules contain only one kind of atom
  - Compounds contain only one kind of atom
  - Molecules can exist alone
  - Compounds can exist alone

MARK YOUR ANSWERS WITH PEN ONLY. Time Taken in Minutes

1 A B C D	2 A B C D	3 A B C D	4 A B C D	5 A B C D
6 A B C D	7 A B C D	8 A B C D	9 A B C D	10 A B C D

2. Matter is made up of tiny particles called molecules.
3. The matter around us exists in three states. They are solids, liquids and gases.
4. Molecules attract each other with a force. This force is called **intermolecular force**. There is also some space between the molecules this is called **intermolecular space**.
5. The fourth states of matter are **Plasma**. Plasma is ionized gas.
6. The collapse of the atoms into a single quantum state is known as **Bose-Condensation** (or) **Bose-Einstein condensate** is fifth state of matter.
7. The process by which a solid changes to liquids by absorbing heat, is called **melting**.
8. The temperature at which a solid substance melts and changes into a liquid is called **melting point** of the substance.
9. The process by which a liquid changes to gas (vapour) by absorbing Heat, is called **boiling** (or) **vaporisation**.
10. The temperature at which a liquid boils and changes into vapours (or gas) very rapidly is called **boiling point** of the liquid.
11. The process by which a gas converted to a liquid, by giving out heat is called **liquefaction** (or) **condensation**.
12. The process by which a liquid is converted to solid, is known as **solidifications** (or) **freezing**.
13. The constant temperature at which a liquid changes to a solid, is known as **freezing point**.
14. The changing of a liquid into vapours (or gas) is called **evaporation**. The evaporation of a liquid can take place at all temperatures.
15. **Metals** are hard, lustrous, malleable, ductile, sonorous and good conductors of heat and electricity. Examples: Fe, Cu, Al, Ca, Mg etc.
16. **Non- metals** are low melting point and boiling points non lustrous, non-malleable, non-ductile, non-sonorous and poor conductors of heat and electricity. Examples: C, N, P, O, S etc.
17. **Metalloids** exhibit the properties that lie in between that of metals and non-metals. Examples: B, Si, Ge, As, Sb, Te, Po etc.
18. **Inert gases** are also called noble gases, aerogens, rare gases, zero group elements. Examples: Helium (He), neon (Ne), argon (Ar), krypton (Kr), xeon (Xe), radon (Rn).
19. The smallest particle of an element that retains the properties of the element is called an **atom** of the element.
20. An atom can sometimes exist alone and sometimes in groups. A group of atoms is called a **molecule**.
21. When two atoms of hydrogen combine with one atom of oxygen, a molecule of water is formed. Water is not an element, it is a **compound**.

## ADVANCED WORKSHEET



## Single Correct Answer Type (S.C.A.T)

1. **Physical classification of matter is based on differences of certain physical properties of the following.**  
(A) Mass  
(B) Rigidity  
(C) Arrangement  
(D) All
2. **The molecular force of interactions in a gas depends upon the \_\_\_\_.**  
(A) Density  
(B) Temperature  
(C) Rigidity  
(D) Both A & B
3. **Which of the following is a sublimable substance?**  
(A) Sulphuric acid  
(B) Ammonium chloride  
(C) Table salt  
(D) Water
4. **Symbol for Nitrogen is:**  
(A) Ni (B) Ng  
(C) N (D) Nt
5. **Bromine is a \_\_\_\_.**  
(A) Liquid (B) Solid  
(C) Gas (D) Plasma
6. **Highly reactive metal is:**  
(A) Iron (B) Silver  
(C) Sodium (D) Gold
7. **Which one of the following is a compound?**  
(A) Hydrogen  
(B) Nitrogen  
(C) Air  
(D) Carbon dioxide
8. **The boiling point of a substance is the temperature at which it changes from:**  
(A) Solid to liquid  
(B) Liquid to solid  
(C) Liquid to gas  
(D) Gas to solid
9. **Metals can be hammered into thin sheets. This property is called:**  
(A) Density  
(B) Malleability  
(C) Ductility  
(D) Strength
10. **The smallest particle of an element or a compound that can exist by itself is:**  
(A) An atom  
(B) A molecule  
(C) An element  
(D) A compound

**11. In a compound, elements are always present in a \_\_\_\_.**

- (A) Fixed ratio
- (B) Variable ratio
- (C) Same ratio
- (D) None of these

**12. Which of these will not change its state upon heating?**

- (A) Ice
- (B) Water vapour
- (C) Milk
- (D) Water

**13. Certain substances exist in the solid state because:**

- (A) Intermolecular forces are weak
- (B) Molecules can slide over one another
- (C) Molecules are tightly packed
- (D) Molecular motion is very fast

**14. The Inter particle attractions are very high in:**

- (A) Vapour                      (B) Water
- (C) Ice                              (D)  $\text{NH}_3$

**15. In a gas the average speed of the molecules is about:**

- (A) 700 km/hr
- (B) 180 km/hr
- (C) 1600 km/hr
- (D) 100 km/hr

**16. The boiling point of  $\text{H}_2\text{SO}_4$  is:**

- (A)  $10^\circ\text{C}$                       (B)  $100^\circ\text{C}$
- (C)  $337^\circ\text{C}$                       (D)  $152^\circ\text{C}$

**17. Which element named after madame curie?**

- (A) Curium
- (B) Berkelium
- (C) Mercury
- (D) Pluto

**18. Metal Which becomes liquid at  $300^\circ\text{C}$  Temperature?**

- (A) Mercury
- (B) Indium
- (C) Gallium
- (D) Bromine

**19. Molecular formula of ozone is:**

- (A)  $\text{O}_3$
- (B)  $\text{O}_2$
- (C)  $\text{ZnO}$
- (D)  $\text{CaO}$

**20. The Inter particle attractions are very high in \_\_\_\_.**

- (A) Vapour
- (B) Water
- (C) Ice
- (D)  $\text{NH}_3$

**21. Plasma is made by heating a \_\_\_\_.**

- (A) Solid
- (B) Gas
- (C) Liquid
- (D) None

**22. Water boils at:**

- (A)  $100^{\circ}\text{C}$
- (B)  $62^{\circ}\text{C}$
- (C)  $0^{\circ}\text{C}$
- (D)  $200^{\circ}\text{C}$

**23. Hydrogen is:**

- (A) Element
- (B) Pure substance
- (C) Both (A) & (B)
- (D) Mixture

**24. Which of the following carbon form has some metallic properties?**

- (A) Graphite
- (B) Diamond
- (C) Coal
- (D) Coke

**25. The fixed ratio of oxygen and Hydrogen by volume to form water is:**

- (A) 1 : 2
- (B) 2 : 1
- (C) 1 : 1
- (D) 2 : 3

**26. A substance that has no definite shape or volume and can spread to occupy any available space is:**

- (A) Sugar
- (B) Milk
- (C) Oxygen
- (D) Oil

**27. The fifth state of matter is:**

- (A) Solid
- (B) Gas
- (C) Liquid
- (D) Bose-Einstein condensate

**28. The intermolecular forces are minimum in case of:**

- (A) Solids
- (B) Liquids
- (C) Gases
- (D) None of these

**29. The intermolecular forces are maximum in case of:**

- (A) Copper
- (B) Water
- (C) Carbon dioxide
- (D) Hydrogen

**30. Which one of the following is a property of gases?**

- (A) They have no rigidity
- (B) They can diffuse
- (C) They have definite mass
- (D) All of these

**31. Liquids can flow easily, which of the following is not a correct reason for it?**

- (A) Intermolecular forces are very strong
- (B) Molecules are far from each other
- (C) Molecules can slide over each other
- (D) Molecular motion is very fast

**32. Which of the following elements is a non-metal?**

- (A) Mercury
- (B) Lead
- (C) Zinc
- (D) Carbon

**33. The melting point of a substance is the temperature at which it changes from:**

- (A) Gas to solid
- (B) Liquid to solid
- (C) Solid to liquid
- (D) Solid to gas

**34. An element is made up of:**

- (A) Only one kind of atoms
- (B) Only two kinds of atoms
- (C) Many kinds of atoms
- (D) None of these

**35. Which one of the following is not a property of gases?**

- (A) They have a definite volume
- (B) They have no definite shape
- (C) They have definite mass
- (D) They can diffuse

**36. Which of the following will diffuse faster than the others?**

- (A) Water
- (B) Petrol
- (C) Perfume
- (D) Milk

**37. Among the following, metalloid is:**

- (A) Iron
- (B) Carbon
- (C) Antimony
- (D) Sulphur



**Multi Correct Question (M.C.Q)**

**38. Calcium carbonate is also known as:**

- (A) Limestone
- (B) Chalk
- (C) Gobar gas
- (D) sand

**39. Which of the following are pure substances?**

- (A) Elements
- (B) Compounds
- (C) Mixtures
- (D) Non-metals

**40. Choose the properties of non-metals?**

- (A) Hard
- (B) Brittle
- (C) Sonorous
- (D) Bad conductors of Heat & Electricity

**41. Plasma is occurring in:**

- (A) Flames
- (B) Lightening
- (C) Super Novas
- (D) Sun & Stars

**42. Inert gases are also known as:**

- (A) Noble gases
- (B) Aerogens
- (C) Rare gases
- (D) Alkali metal

**43. The whole universe is composed of \_\_\_\_\_ and \_\_\_\_\_.**

- (A) Matter
- (B) Energy
- (C) Soil
- (D) Water

**44. Choose the correct statement(s).**

- (A) Gases can be compressed
- (B) Solids do not diffuse
- (C) Liquids have less rigidity
- (D) Solids have least intermolecular space

**45. What are the physical classifications of matter?**

- (A) Solids
- (B) Elements
- (C) Gases
- (D) Compounds

**46. Every matter occupies \_\_\_\_\_ and has \_\_\_\_\_.**

- (A) Space
- (B) Colour
- (C) Mass
- (D) Taste

**47. What are the properties of a metal?**

- (A) Malleable
- (B) Ductile
- (C) Bad conductor
- (D) High density

**48. In which of the following states, matter can flow?**

- (A) Solid
- (B) Liquid
- (C) Gas
- (D) All

**49. Which of the following substances are sublimable solids?**

- (A) Sodium
- (B) Iodine
- (C) Camphor
- (D) Ammonium chloride



## Comprehension Passage (C.P.T)

## Passage - I

**Interconversion of matter involves change of state of matter from one state to another state and back to its original state due to change in temperature and pressure.**

**50. The constant temperature at which a gas changes into liquid state is called:**

- (A) Liquefaction point
- (B) Freezing point
- (C) Boiling point
- (D) Melting point

**51. The change in state from liquid to solid is known as:**

- (A) Evaporation
- (B) Vaporizations
- (C) Freezing
- (D) Condensation

**52. The melting point of ice is:**

- (A)  $100^{\circ}\text{C}$
- (B)  $0^{\circ}\text{C}$
- (C)  $10^{\circ}\text{C}$
- (D)  $-100^{\circ}\text{C}$

## passage - ii

**Atoms and molecules in the gas lose all electrons and forms ions and electrons to co-exist. The plasma is produced in Sun and Stars because of very high temperature. The Sun & Stars glow because of the presence of plasma in them plasma has very 'low' density, for example the solar wind which averages on 10 particles per cubic cm.**

**Inter particle collisions are unlikely-hence these plasmas are termed as collision less.**

**53. Solar wind which averages on \_\_\_ particles per cubic cm.**

- (A) 10
- (B) 20
- (C) 5
- (D) 0

**54. Plasma is produced in sun and stars because of very high:**

- (A) Temperature
- (B) Pressure
- (C) Volume
- (D) Electrons

**55. Atoms and molecules in the gas lose all electrons and forms \_\_\_ to co-exist in plasma state.**

- (A) Only ions
- (B) Only electrons
- (C) Ions & electrons
- (D) None



## Matrix Matching Type (M.M.T.)

## Set-I

## Column - I

55. Ice  
56. Dew  
57. Hails  
58. Steam

## Column - II

- (A) Solid form of water  
(B) Liquid form of water  
(C) Gaseous form of water  
(D) Formed when water is cooled

## Set-II

## Column - I

59. Bleaching powder  
60. Gobar gas  
61. Battery acid  
62. Sucrose  
63. Sand

## Column - II

- (A) Silicon dioxide  
(B) Sugar  
(C) Calcium hypochlorite  
(D) Sulphuric acid  
(E) Methane

## Assertion Reason Type (A.R.T.)

- (A) Assertion and Reason are true and Reason is the correct explanation of Assertion  
(B) Assertion and Reason are true but Reason is not the correct explanation of Assertion  
(C) Assertion is true but Reason is false  
(D) Assertion is false but Reason is true

64. **Assertion (A):** Some sugar can be added to a glassful of water without causing an overflow.

**Reason (R):** Liquids have spaces present between the molecules.

65. **Assertion (A):** When solid melts, its temperature remains same.

**Reason (R):** The heat gets used up in changing the state by overcoming the forces of attraction between the particles.

## Statement Type (S.T.)

- (A) Both statements are correct  
(B) Both statements are incorrect  
(C) Statement I is correct statement II is incorrect  
(D) Statement I is incorrect Statement II is correct

66. **Statement - I:** Solids cannot be compressed.

**Statement - II:** This is due to compact arrangement of molecules.

**67. Statement - I:** An element cannot be broken down into simple substance, by any physical or chemical means.

**Statement - II:** The substance containing particles of only one kind is called "pure substance".

**68. Statement - I:** The inter-molecular spaces are very small and so intermolecular forces of attraction are negligible in gases.

**Statement-II:** Gases have a definite mass but no definite shape.

## Integer Type Question (I.T.Q.)

**69.** \_\_\_\_\_ states of matter exist in the universe.

**70.** Elements are classified into \_\_\_\_\_ types.

## Analytical Approach Type (A.A.T.)

**71. Any material which has a definite volume, but no definite shape is called:**

- (A) Gaseous                      (B) Liquid  
(C) Plasma                      (D) Solid

**72. The decreasing order of densities of solids, liquids and gases for a given mass is:**

- (A) Solids > Gases > Liquids  
(B) Gases > Solids > Liquids  
(C) Liquids > Gases > Solids  
(D) Solids > Liquids > Gases

**73. Which of the following is not an example of vaporization?**

- (A) Dry air gains water vapour as it moves over the ocean  
(B) Water droplets form on a mirror  
(C) Wet pavement dries after a rain  
(D) Bubbles form as water boils

**74. When ice melts, its particles:**

- (A) Come close together and lose energy  
(B) Gain energy and begin to move  
(C) Lose energy and begin to move  
(D) All of these

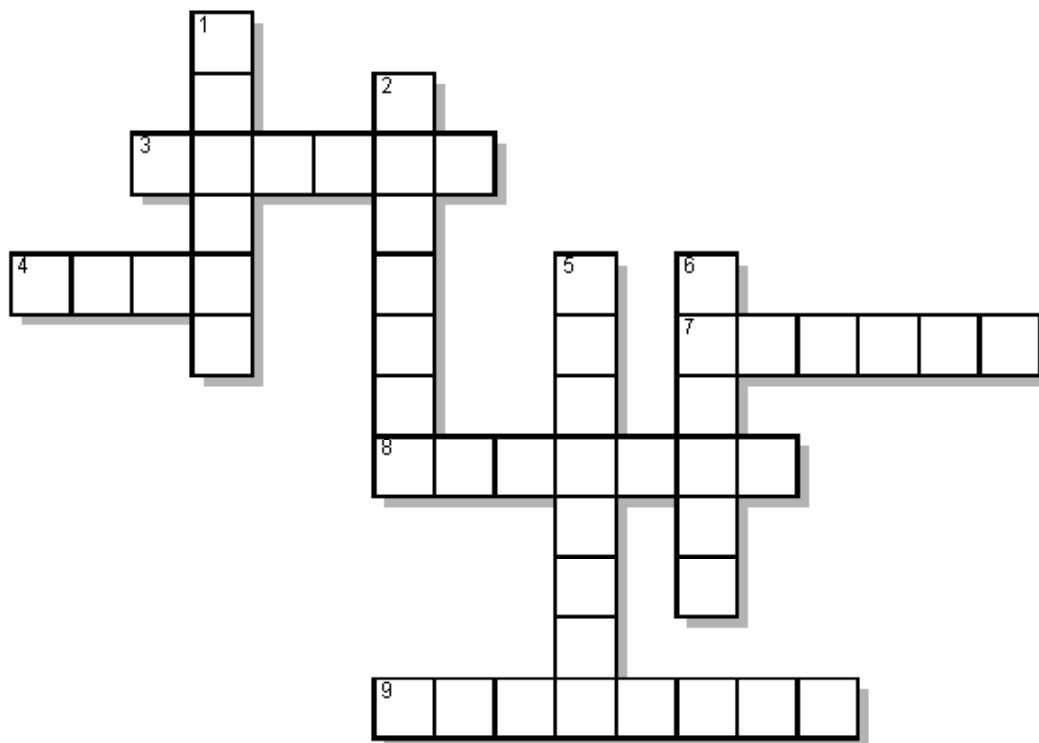
**75. When a liquid is heated, its particles:**

- (A) Vibrate faster  
(B) Slow down and form patterns  
(C) Release energy to the surroundings  
(D) Converts into solid

**76. A student poured an equal amount of water into 4 containers as shown below. What result does this experiment show?**



- (A) Water has definite volume.  
(B) Water has no definite shape.  
(C) Water has definite mass.  
(D) Water has no definite volume.

**Across: (→)**

3. Anything that occupies space and has mass.
4. The smallest particle of an element that retains the properties of the element.
7. An example for the sublimable substances.
8. Inter molecular attractions are least in \_\_\_\_ state.
9. The process of conversion of liquid into solid.

**Down: (↓)**

1. The state of matter which contains ionized gas particles and electrons.
2. The process of conversion of solid into liquid.
5. The smallest particle of an element or a compound that can exist individually.
6. The state of matter which has fixed volume but no fixed shape.

## NOTES

[illegible]