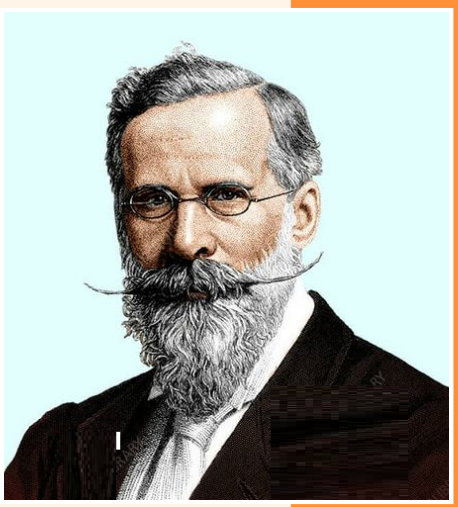
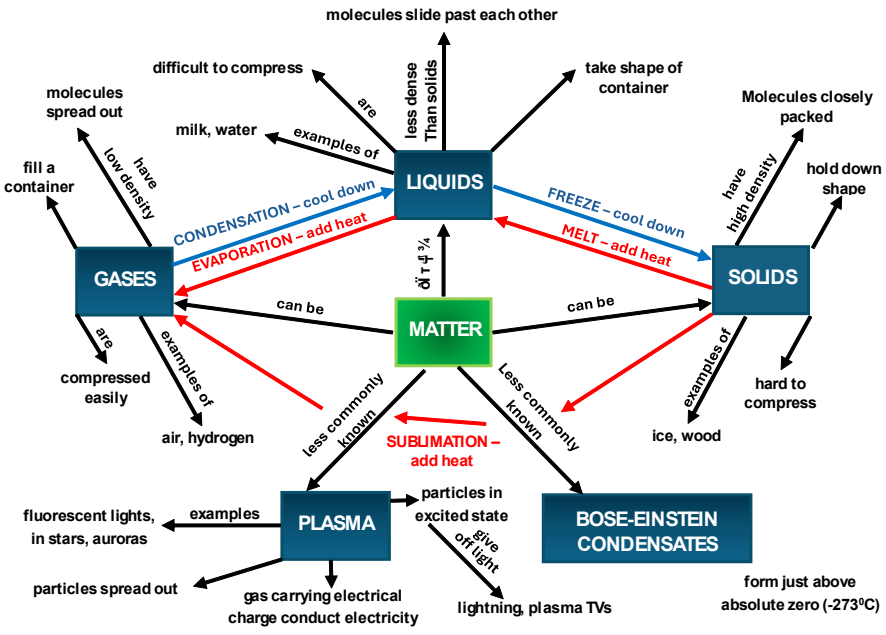
1 MATTER

William Crookes: Plasma was first identified by **Sir William Crookes** in 1879 (he called it "radiant matter"). The term "plasma" was coined by Irving Langmuir in 1928. Lewis Tonks and Harold Mott-Smith, both of whom worked with Irving Langmuir in the 1920s, recall that Langmuir first used the word "plasma" in analogy with blood. Mott-Smith recalls that the transport of electrons from thermionic filaments reminded Langmuir of "the way blood plasma carries red and white corpuscles and germs.



CONCEPT MAP

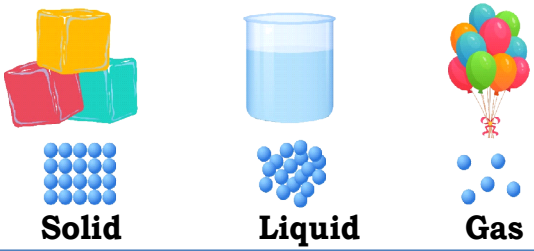


Concept 1

Chemistry, a branch of science, explores matter - anything that has mass, occupies space, and is sensed by us. Our world comprises various forms of matter, from the air we breathe to stones, clouds, and more. All things, no matter how small, have mass and volume.

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 exists in three states - solids, liquids, and gases. Each state consists of particles (atoms or molecules) arranged differently.



Note: A vacuum is an area/space containing no matter.

Here are Some General Characteristics of Matter:

- **Mass:** Mass refers to the amount of matter. Even invisible things like air have mass, as shown by experiments.
- **Space Occupation:** Matter takes up space. Imagine filling a bookshelf with books or trying to place two stools in one corner: it's impossible due to space occupation.
- **Inertia:** Objects stay put or in motion until an external force acts, known as inertia. A ball on the ground won't move unless someone pushes it.
- **Gravity's Effect:** Gravity pulls objects toward the Earth. That is why objects fall and water flows downhill.
- **Conservation of Matter:** In any chemical reaction, the total mass before and after the change remains the same. Lavoisier's experiment with tin and oxygen showcased this, leading to the law of conservation of mass.

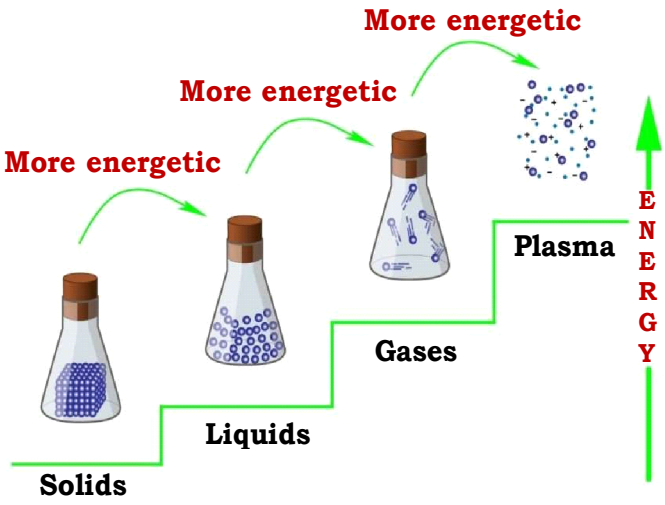
Theories about Matter:

Atomic Theory of Matter:

Long ago, Greek philosophers debated if matter was continuous or not. Imagine dividing a pencil's graphite into smaller and smaller parts. If matter was continuous, this division could go on forever. But if it wasn't, at some point, the last bit would be reached. Democritus called these ultimate bits 'atomos' or indivisible, leading to the concept of atoms. John Dalton revived this idea in the 1800s to explain chemical reactions. For example, the final division of graphite leads to atoms of carbon.

Kinetic Theory of Matter:

This theory explains states of matter. It says all matter is made of tiny particles(atoms or molecules) that are constantly moving.



- In solids, the particles are so tightly bound to each other that they can only vibrate but not move to another location.
- In liquids, the particles have enough free space to move about, but they still attract one another.
- In gases, the particles are far apart and can move about freely since there is much free space.
- Solids change into liquids, and liquids into gases, when the particles gain more kinetic energy, like when being heated and can move apart from one another.
- When the molecules vibrate more quickly upon heating, some of it escapes from the matter.

The Main Postulates of Kinetic Theory of Matter are as follows:

- Matter consists of molecules. These are the smallest particles, which are capable of free existence and retain all the chemical properties of the parent substance.
- The molecules are always in a state of random continuous motion.
- The molecules exert forces on one another. These forces depend upon intermolecular distance
- All collisions between the particles of matter are perfectly elastic.

Riddle

I am invisible but can make you feel hot.
I am odourless but can make you feel cold.
I am tasteless but can cause a fire.
What am I?

Self Assessment Test - 01

1. **Which of the following is a characteristic of matter mentioned in the passage?**
   (A) Flexibility (B) Transparency
   (C) Mass (D) Sound
2. **What is inertia, as mentioned in the passage?**
   (A) Objects staying put or in motion until acted upon by an external force
   (B) The force of gravity pulling objects toward the Earth
   (C) The ability of matter to occupy space
   (D) The amount of matter in an object
3. **According to the passage, what is the effect of gravity?**
   (A) Pushes objects away from the Earth
   (B) Causes objects to float in mid-air
   (C) Pulls objects toward the Earth
   (D) Nullifies the effects of other forces
4. **According to the kinetic theory of matter, what happens to the particles in solids upon heating?**
   (A) They gain more kinetic energy and vibrate in their places
   (B) They slow down and come closer together
   (C) They remain stationary
   (D) They escape from the matter
5. **What does the law of conservation of matter state?**
   (A) Matter can be created but not destroyed
   (B) Matter can be destroyed but not created
   (C) The total mass of a closed system remains constant over time
   (D) The mass of any object is directly proportional to its volume
6. **What are the main postulates of the kinetic theory of matter?**
   (A) Matter consists of atoms, which are in constant motion
   (B) Matter consists of molecules, which are capable of free existence and are always in a state of random continuous motion
   (C) Matter consists of electrons, protons, and neutrons, which revolve around each other
   (D) Matter consists of particles that are perfectly elastic
7. **In which state of matter are the particles far apart and can move about freely?**
   (A) Solids (B) Liquids
   (C) Gases (D) Plasma
8. **What does the branch of science, chemistry, explore?**
   (A) Energy (B) Time
   (C) Matter (D) Space

MARK YOUR ANSWERS WITH PEN ONLY.

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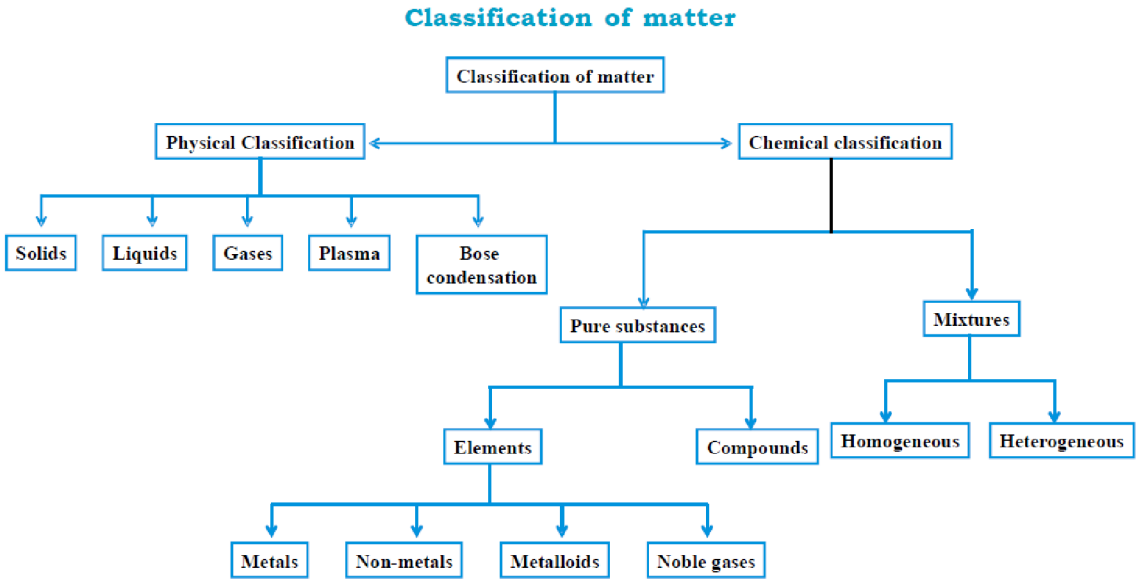
6 Ⓐ Ⓑ Ⓒ Ⓓ	7 Ⓐ Ⓑ Ⓒ Ⓓ	8 Ⓐ Ⓑ Ⓒ Ⓓ	9 Ⓐ Ⓑ Ⓒ Ⓓ	10 Ⓐ Ⓑ Ⓒ Ⓓ

Concept 2

States of Matter:

Matter, everything around us, can be classified in two ways: by physical characteristics and by chemical characteristics.



Everything around us, from the air we breathe to the things we touch, is made of tiny particles called atoms and molecules. These particles make up what we call 'matter.' Matter has mass (weight) and takes up space. Matter includes everything that has mass and occupies space.

Scientists have identified five main forms, or states, of matter. These states are solids, liquids, gases, plasmas, and Bose-Einstein condensates. Let's focus on the first three:

Solids: Imagine a block of ice or a wooden table. In solids, the particles (atoms or molecules) are tightly packed together. They're like a group of friends holding hands, staying close and not moving much. This closeness makes solids keep their shape and volume, giving them stability. If you try to squash a solid, it won't easily change shape unless you heat or break it.

Liquids: Think of water, juice, or even oil. In liquids, the particles are still close but can move around more freely compared to solids. They're like friends in a room who can move about but not too far from each other. Liquids take the shape of whatever container they're in because their particles can flow and slide past each other. They have a definite volume but no fixed shape of their own.

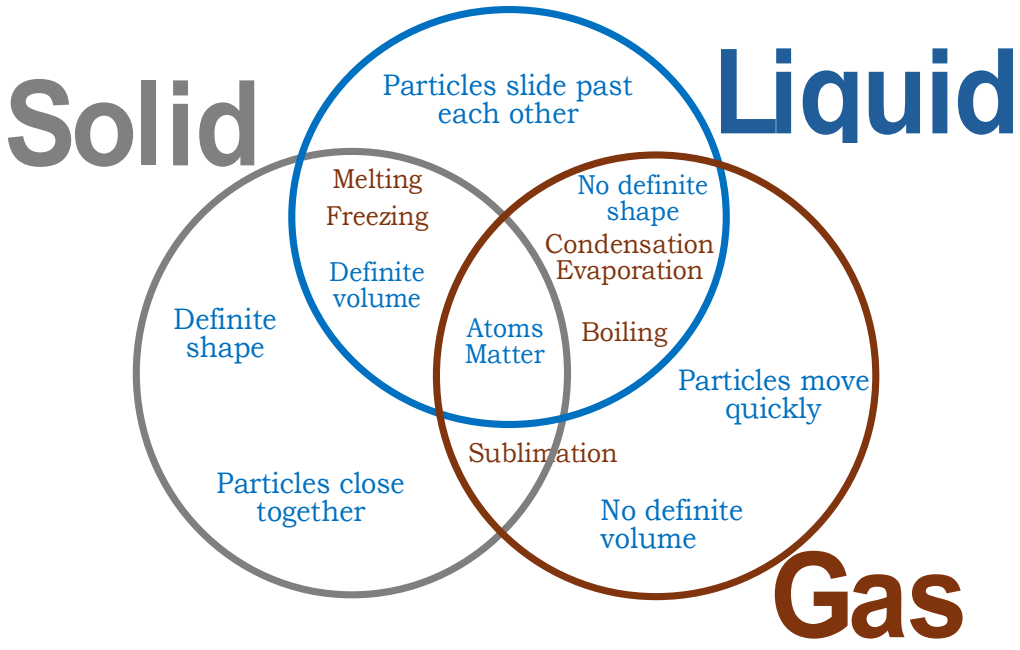
Gases: Consider the air around us. In gases, the particles move freely and have lots of space between them. They're like people at a bustling fair, moving all over the place.

Gases don't have a fixed shape or volume; they expand to fill the container they're in. They're easily compressed because their particles are far apart. The molecules in a gas are in a continuous motion in all possible directions in the complete space available within the container in which it is enclosed.

In the beginning of the 17th century, scientists started realizing that some form of matter can exist in a form that is similar to air. The Belgian Chemist Jan Baptista van Helmont coined the word gas by altering the Greek word "chaos" which means "space". This word explains the ability of a gas to fill any amount of space.

Comparing Solids, Liquids and Gases:

Properties	Solids	Liquids	Gases
Mass	It has	It has	It has
Volume	Fixed	Fixed	Not fixed
Shape	Fixed	Shape of the container	Shape of the container
Rigidity	More	Less	No
Interparticle spaces	Less	More	Most
Forces between particles	Strong	Weak	Nearly none
Density	More	Less	Least
Number of particles	Many	Fewer	Least
Free surfaces	Many	One	None
Diffusion	Do not diffuse	May be	Rapidly diffuse
Mixing	Least	Somewhat	Mix easily



Self Assessment Test - 02

1. **In which state of matter do particles have the most freedom to move around?**
   (A) Solids
   (B) Liquids
   (C) Gases
   (D) Bose-Einstein condensates
2. **What is the main characteristic of liquids regarding their shape and volume?**
   (A) Fixed shape and volume
   (B) Fixed shape but no fixed volume
   (C) No fixed shape but fixed volume
   (D) No fixed shape or volume
3. **Who coined the term "Gas" by altering the Greek word "Chaos"?**
   (A) Isaac Newton
   (B) Jan Baptista van Helmont
   (C) Albert Einstein
   (D) Robert Boyle
4. **Which state of matter has the highest density?**
   (A) Solids
   (B) Liquids
   (C) Gases
   (D) Plasmas
5. **What property is common to all three states of matter: solids, liquids, and gases?**
   (A) Fixed shape
   (B) Rigidity
   (C) Mass
   (D) Definite volume
6. **How do gases behave in a container?**
   (A) They keep their shape and volume
   (B) They take the shape of the container but keep their volume
   (C) They take the shape and volume of the container
   (D) They do not take the shape or volume of the container
7. **Which state of matter can be easily compressed due to the large spaces between particles?**
   (A) Solids
   (B) Liquids
   (C) Gases
   (D) Bose-Einstein condensates
8. **The ability of a substance to flow is best shown by:**
   (A) Solids
   (B) Liquids
   (C) Gases
   (D) Both liquids and gases

MARK YOUR ANSWERS WITH PEN ONLY.

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Concept 3

Plasma State (Fourth State of Matter):

Plasma is the fourth state of matter. Plasma is similar to the gaseous state. The state consists of super energetic and super excited particles in the form of ionized gases. 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 the sun and stars due to 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.

Note: The approximate composition of the sun by mass is:
Hydrogen – 73-74%, helium – 24-25% and
other elements-2% (including oxygen, carbon, neon and iron)

On earth, plasma is naturally occurring in flames, lightning, the northern and southern lights.

Northern and southern lights are caused by solar particles colliding with atoms in the Earth's atmosphere, which strip away electrons and create ions that emit light.

Plasma Formation:

Raising a gas's temperature causes atoms to lose electrons, creating plasma. Space plasmas have low density and rare collisions, like the Solar wind's 10 particles per cubic centimetre.


Plasma state

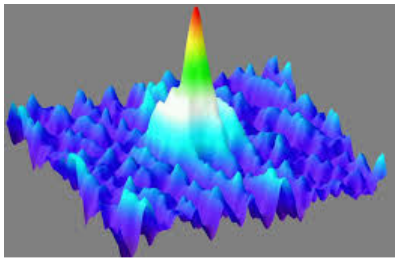
Finding a Plasma: While natural plasmas aren't found around you that often, man-made plasmas are everywhere. Think about fluorescent light bulbs or neon sign tubes result from electricity exciting gases, creating glowing plasma with unique colours based on the gas.

Bose-Einstein Condensate - The Fifth State of Matter:

Back in 1924, Albert Einstein and Satyendra Nath Bose predicted the existence of a new state of matter called "Bose-Einstein Condensate" (BEC).

What is BEC?

It's a state of matter formed by chilling a gas of bosons (a type of particle) to temperatures very close to absolute zero, nearly -273.14 °C. At such ultra-low temperatures, lots of atoms gather into the lowest energy state, creating a superfluid.

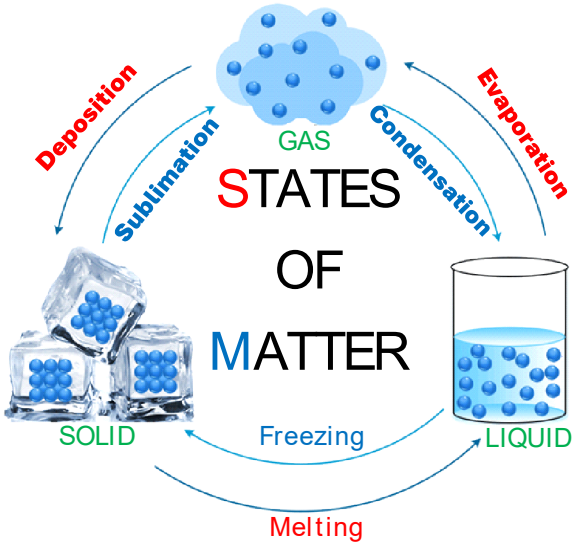

Bose-Einstein condensate

How Does it Form?

As temperatures drop drastically, atoms stop moving much and gather into a single quantum state, which scientists call Bose condensation or Bose-Einstein Condensate.

Interconversion of States of Matter:

Matter can switch between different forms: solids, liquids, and gases by changing temperature or pressure. This swap is called the interconversion of states of matter.



Melting or Fusion: Melting is the process in which solid changes into a liquid at a particular temperature.

Melting Point: The temperature at which a solid melts to become a liquid at the atmospheric pressure is called its melting point.

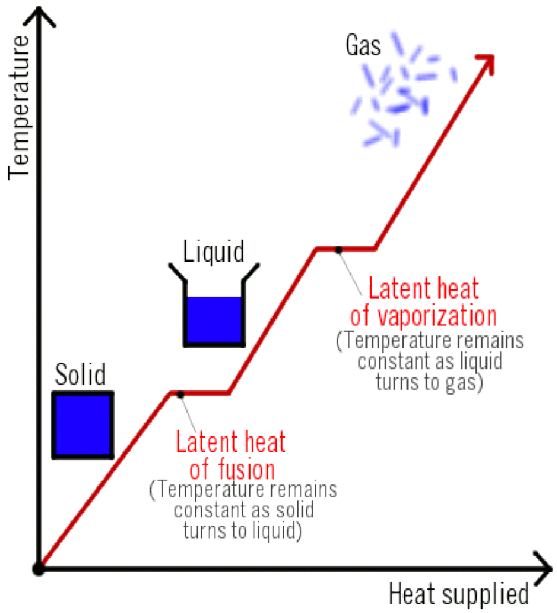
Latent Heat: The word 'latent' means hidden. The characteristic amount of energy absorbed or released by a substance during a change in its physical state that occurs without changing its temperature is known as latent heat.

Latent Heat of Fusion: Latent heat of fusion is the amount of heat energy required to change 1 kg of a solid into liquid at atmospheric pressure at its melting point.

Boiling: Boiling is the process in which a liquid changes into a vapour at a particular temperature.

Boiling Point: The temperature at which a liquid starts boiling at the atmospheric pressure is known as its boiling point.

Latent Heat of Vaporization: Latent heat of vaporization is the amount of heat energy required to change 1 kg of liquid into a gas at atmospheric pressure at the boiling point.



Freezing: The process in which a liquid converts into a solid, is called freezing or solidification.

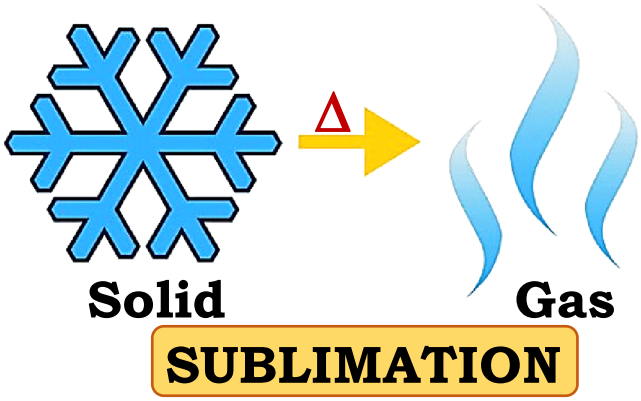
Evaporation: The process in which a liquid changes into vapour at any temperature below its boiling point is evaporation. Evaporation is a surface phenomenon. i.e., evaporation takes place at the surface of the liquid.

Misconception :

Misconception: When a solid or liquid is heated, the particles themselves get bigger.
Correction: At higher temperature, particles move more rapidly and take up more space, but the particle themselves do not physically expand or change size.

Condensation: The process in which vapour changes to a liquid is called condensation.

Sublimation: The process in which a solid, on heating, directly changes into gas without changing into liquid, and a gas, on cooling, directly changes to solid without changing into liquid is called sublimation.



Liquefaction Process: A gas is liquefied by applying high pressure and reducing the temperature.

Method: It is typically achieved by cooling the gas to a temperature below its boiling point or by increasing the pressure.

Example:

- **Natural Gas (LNG):** Liquefying natural gas (primarily methane) to liquid state at very low temperatures (-162^{0}C or -260^{0}F) reduces its volume by a factor of about 600, making it easier to transport and store.
- **Coal Liquefaction:** Converting solid coal into liquid form for use as a fuel substitute.

Self Assessment Test - 03

1. **Which state of matter is characterized by super energetic and excited particles in the form of ionized gases?**
   (A) Solid
   (B) Liquid
   (C) Gas
   (D) Plasma
2. **What natural phenomenon on Earth involves plasma?**
   (A) Ocean tides
   (B) Tornadoes
   (C) Lightning
   (D) Earthquakes
3. **What is created when gas is heated until its atoms lose electrons and form ions and electrons?**
   (A) Solid
   (B) Liquid
   (C) Plasma
   (D) Bose-Einstein Condensate
4. **At what temperature does Bose-Einstein Condensate form?**
   (A) Room temperature
   (B) High temperature
   (C) Absolute zero temperature
   (D) Boiling point
5. **What process involves a solid changing directly into a gas without becoming a liquid first?**
   (A) Melting
   (B) Boiling
   (C) Sublimation
   (D) Evaporation
6. **What is the term for the amount of heat energy required to change 1 kg of a solid into a liquid at atmospheric pressure?**
   (A) Latent heat of fusion
   (B) Latent heat of vaporization
   (C) Melting point
   (D) Boiling point
7. **What is the process called when a liquid changes into vapour at any temperature below its boiling point?**
   (A) Boiling
   (B) Evaporation
   (C) Condensation
   (D) Freezing
8. **What is the temperature at which a liquid starts boiling at atmospheric pressure known as?**
   (A) Freezing point
   (B) Melting point
   (C) Boiling point
   (D) Condensation point

MARK YOUR ANSWERS WITH PEN ONLY.

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

Concept 4

Measurable Properties of Gases:

The characteristics of gases are described fully in terms of four parameters. They are: Volume (V), Pressure (P), Temperature (T) and Mass (or) no of moles (n).

Volume:

The 'volume of a gas' refers to the amount of space occupied by a gas within a container and is directly dependent on the containers volume.

Gases readily expand to fill the container they are in, unlike solids and liquids. Thus

- The volume of the container is the volume of gas sample.
- Volume of a gas is measured with gas burette (or) by eudiometer.
- Volume expressed in litres (L), mL, cubic centimetre (cc), cubic metres (m^3)

  1L = 1000 ml 1ml = 10^{-3} L

  1L = 1 dm 1dm^3 = 10^3 cm^3 [$\because$ 1 dm = 10cm]

- S.I unit of volume is cubic meter.

  $1m^3 = 10^3\ dm^3 = 10^6\ cm^3 = 10^6$ ml $= 10^3$ L

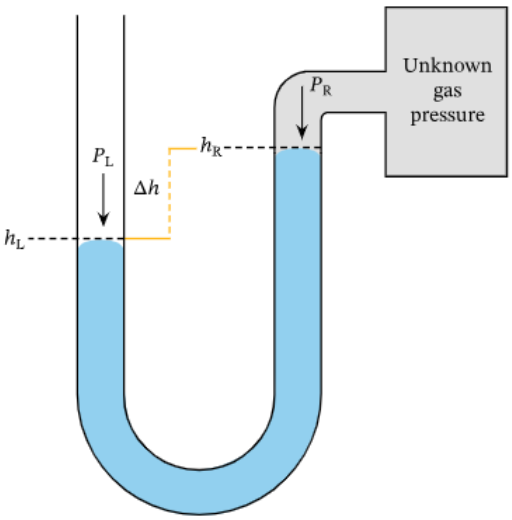
- The number of molecules in 22.4 litres of a gas measured under S.T.P conditions are equal to avogadro number.

Pressure:

Gas molecules constantly collide with the walls of their container, exerting a force. "The pressure of the gas is the force exerted by the gas molecules per unit area on the walls of the container".

$$P = F/A$$

P = Pressure, F = Force, A = Area



- The pressure of the gases is measured by device known as manometer.

- The mass of atmospheric air pressing down on the Earth's surface exerts pressure, which is known as atmospheric pressure.
- The device used to measure the atmospheric pressure exerted by a gas is known as a barometer.
- The common unit of pressure is atmosphere.

1 atmosphere = 76 cm of Hg (mercury)

= 760 mm of Hg = 760 Torr

S.I. Unit of pressure is Pascal (pa)

1 Pascal (pa) = 1 Newton/m^2

Pascal is defined as the pressure exerted when a force of 1 Newton acts on a $1m^2$ area.

1 atm = 101.325×10^3 Nm^{-2} = 101.325 kpa

Older unit of pressure is bar.

1 bar = 10^6 dyne/cm^2 = 10^5 pa

A barometer measures atmospheric pressure, while a manometer measures the pressure of a fluid or gas for a confined space.

Temperature:

Similar to other materials, gases exhibit changes in their behaviour with temperature. It reflects the average kinetic energy of their molecules.

The temperature of the gas is measure in degree centigrade or degree celsius (^oC) with the help of thermometers.

- S.I. unit of temperature is kelvin (K).

Temperature in kelvin scale (T) =

Temperature in centigrade scale (t) +273 T

T K = t^oC + 273

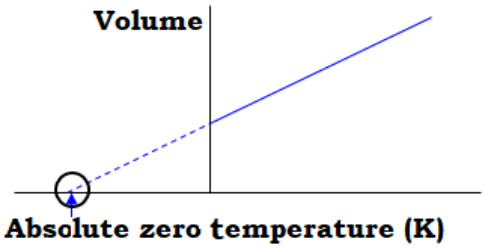
Temperature in celsius scale =

Temperature in kelvin - 273

= K – 273

Absolute Zero of Temperature: It is defined as the temperature at which no substance exists in the gaseous state. The temperature of –273^oC (0K) is called as "absolute zero" of temperature.

Absolute zero is the zero point on the kelvin temperature scale.



At absolute zero:

- The pressure of the gas becomes zero.
- The volume of the gas becomes zero.
- Kinetic energy of the gas becomes zero.

Examples: Convert 400^0C into kelvin scale.

$$\Rightarrow 400^0\,C = 400 + 273\,K$$

$$= 673\ K$$

Examples: Convert 540 K into degree celsius.

$$\Rightarrow 540 - 273$$

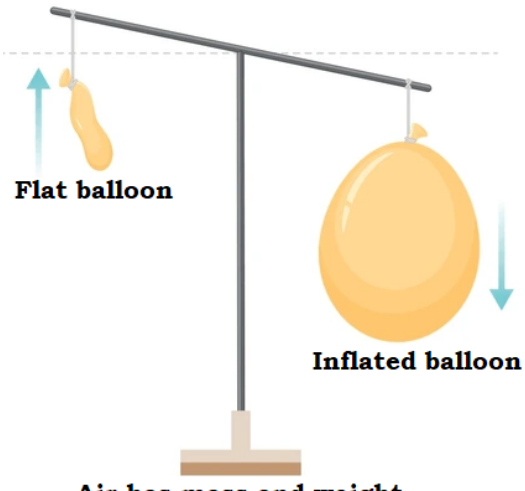
$$= 267^0C$$

Mass:

Gases have definite mass, just like any other form of matter. In C.G.S system mass of the gas is expressed in grams. In S.I system mass of the gas is expressed in kilograms.

$$1kg = 10^3 \text{ grams}$$

- Mass of a gas does not change with temperature.



Air has mass and weight

In the experimental diagram above, it is proved that air has mass and weight because the inflated balloon weighs more than the deflated one. The extra mass comes from the air inside the balloon.

Self Assessment Test - 04

1. **What device is commonly used to measure the volume of a gas sample?**
   (A) Thermometer
   (B) Manometer
   (C) Gas burette
   (D) Barometer
2. **What is the SI unit of volume?**
   (A) Litres (L)
   (B) Millilitres (ml)
   (C) Cubic metre (m^3)
   (D) Cubic centimetre (cc)
3. **How is pressure defined in terms of force and area?**
   (A) P = F/V
   (B) P = V/A
   (C) P = F/A
   (D) P = A/F
4. **What is the common unit of pressure?**
   (A) Newton (N)
   (B) Atmosphere (atm)
   (C) Pascal (Pa)
   (D) Torr
5. **What is the SI unit of temperature?**
   (A) Celsius (°C)
   (B) Kelvin (K)
   (C) Fahrenheit (°F)
   (D) Rankine (°R)
6. **What is the temperature in Kelvin scale if it is 25°C?**
   (A) 273 K
   (B) 298 K
   (C) 298°C
   (D) 273°C
7. **At what temperature does absolute zero occur?**
   (A) -273°C
   (B) 0°C
   (C) 100°C
   (D) 273 K
8. **What happens to the pressure, volume, and kinetic energy of a gas at absolute zero temperature?**
   (A) They all increase
   (B) They all decrease
   (C) They all become zero
   (D) They remain constant

MARK YOUR ANSWERS WITH PEN ONLY.

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

Concept 5

Gas Laws:

By changing the pressure or temperature of any gas its volume also changes. The nature of the change is almost same for all gases. Therefore, many scientists studied them in detail and gave some laws which are known as gas laws. These gas laws relate the pressure, volume and temperature of a gas.

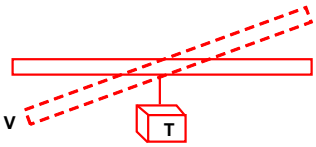
Boyle's Law:

The volume of given quantity of gas is decreased with an increase in pressure. This behaviour was generalized for all gases by Robert Boyle in 1662. The generalized statement is known as Boyle's law.

"The volume of a given mass of gas is inversely proportional to its pressure at any given temperature".

Here's how to remember Boyle's law:

Pressure (P) and volume (V) are like friends on a seesaw. When one goes up, the other goes down.



The amount of gas (n) and the temperature (T) are like the weight on the seesaw. If they stay the same, the seesaw stays balanced.

If a given mass of gas occupies a volume = V, pressure = P at temperature = T; according to Boyle's law:

$$P \propto \frac{1}{V} \quad (T = \text{constant})$$

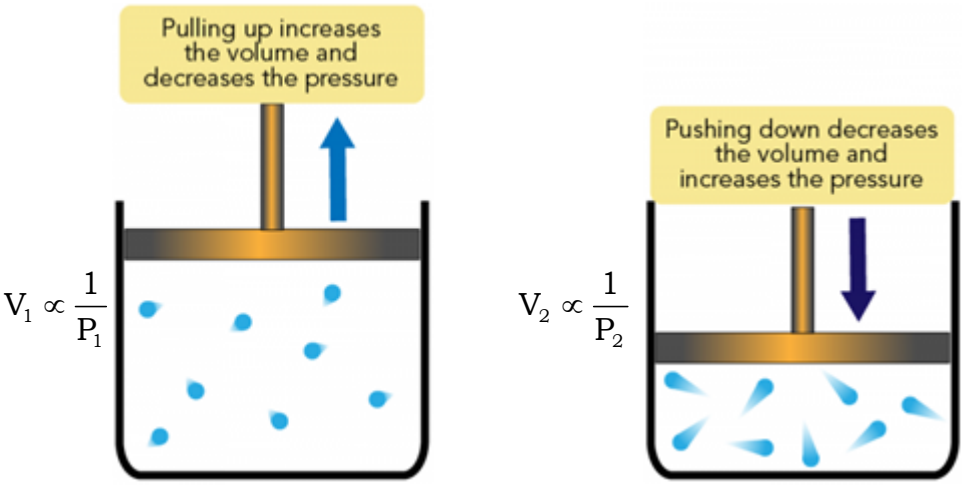
$$\Rightarrow P = (K)\ \frac{1}{V}$$

Where K is a proportionality constant

$$\Rightarrow PV = K$$

Knowledge Box

When we open a soda bottle, the pressure decreases and the gas expands, causing the fizz.



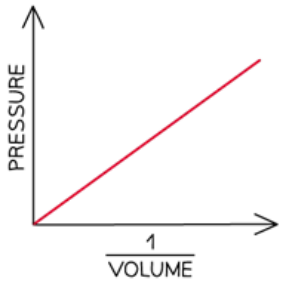
If the temperature of the gas is kept constant, such that its volume changes from V_1 to V_2, when corresponding pressures are P_1 and P_2 respectively, then according to Boyle's law:

$P_1V_1 = K$ ...(i) and

$P_2V_2 = K$ ...(ii)

Comparing (i) and (ii) , we get $\mathbf{P_1V_1 = P_2V_2}$

The above relation is called **Boyle's law equation**.



From the above equation, the Boyle's law can be defined as: "the product of pressure and volume of a given mass of dry gas is constant quantity when temperature kept constant".

Riddle

I explained the behaviour of gases around, in chemistry, my principles are found. What am I, with laws profound?

Solved Examples:

1. A given mass of gas is allowed to expand from a volume of 250 ml to 500 ml. Pressure of the gas after expansion is found to be 3atmospheres. What was the pressure of gas before expansion?

Data:

Initial volume (V_1) = 250 ml Final volume (V_2) = 500 ml

Initial pressure(P_1) =? Final pressure (P_2) = 3 atm

Sol: According to Boyle's law $P_1V_1 = P_2V_2$

$$\Rightarrow \quad P_1 = \frac{P_2V_2}{V_1} = \frac{3\times500}{250} = 6 \text{ atm}$$

$\therefore$ The pressure (P_1) before expansion was 6.0 atmospheres.

2. A given mass of gas in a sealed container is with an initial volume of 300 millilitres and a pressure of 4 atmospheres. If the volume changes to 450 millilitres, what will be the new pressure assuming the temperature remains constant?

Data:

Initial pressure (P_1) = 4 atm Initial volume (V_1) = 300 ml

Final volume (V_2) = 450 ml Final pressure (P_2) =?

Sol: Using Boyle's Law formula $P_1 \times V_1 = P_2 \times V_2$

$$P_2 = \frac{P1 \times V1}{V2} = \frac{4\times300}{450} = \frac{1200}{450}$$

$= 2.67$ atmospheres

$\therefore$ The final pressure of the gas will be 2.67 atmospheres.

Self Assessment Test - 05

1. **If the pressure of a gas is doubled at constant temperature, its volume will:**
   (A) Double
   (B) Become half
   (C) Remain same
   (D) Become four times
2. **What does Boyle's law state?**
   (A) The volume of a gas is directly proportional to its pressure at constant temperature.
   (B) The volume of a gas is inversely proportional to its pressure at constant temperature.
   (C) The volume of a gas is directly proportional to its temperature at constant pressure.
   (D) The volume of a gas is inversely proportional to its temperature at constant pressure.
3. **What is the Boyle's law equation?**
   (A) $P_1V_1 = P_2V_2$
   (B) $P_1V_2 = P_2V_1$
   (C) $P_1V_1 = P_1V_2$
   (D) $P_2V_1 = P_2V_2$
4. **According to Boyle's law, what happens to the product of pressure and volume when the temperature is kept constant?**
   (A) It decreases
   (B) It increases
   (C) It remains constant
   (D) It becomes zero
5. **In the solved example, what was the initial pressure of the gas before expansion?**
   (A) 4 atm
   (B) 6 atm
   (C) 2.67 atm
   (D) 3 atm
6. **In the solved example, what was the initial volume of the gas before expansion?**
   (A) 250 mL
   (B) 500 mL
   (C) 300 mL
   (D) 450 mL
7. **In the solved example, what was the final pressure of the gas after expansion?**
   (A) 4 atm
   (B) 6 atm
   (C) 2.67 atm
   (D) 3 atm
8. **What unit is used to measure pressure in Boyle's law?**
   (A) Newton (N)
   (B) Atmosphere (atm)
   (C) Pascal (Pa)
   (D) Millimetre of mercury (mmHg)

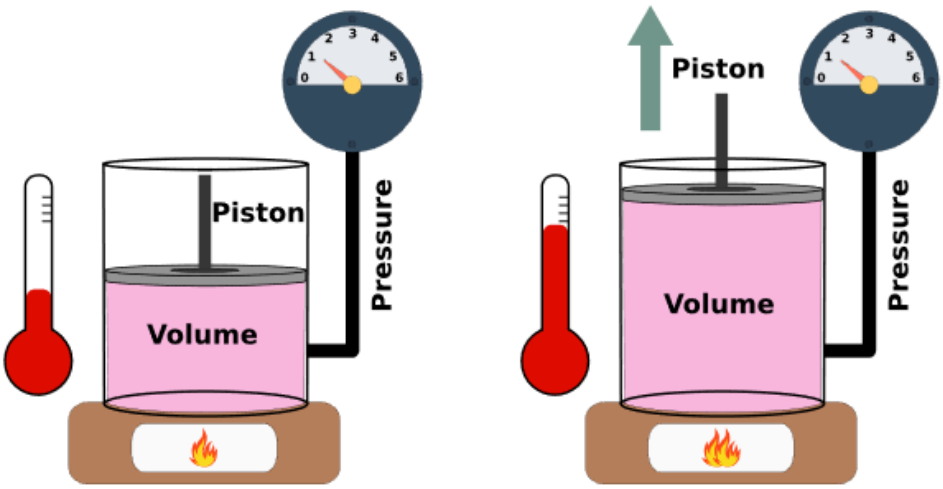
MARK YOUR ANSWERS WITH PEN ONLY.

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

Concept 6

Charles' Law:

This law was proposed by Charles', and it provides the relation between the volume and absolute temperature of a gas. It states that "the volume of a fixed mass of a gas is directly proportional to its absolute temperature, provided the pressure remains constant".

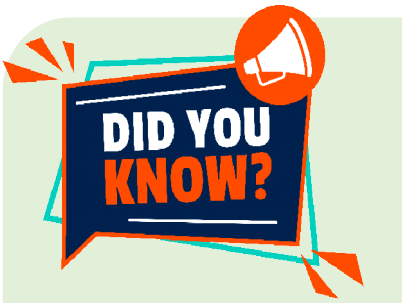


On the basis of several experimental observations Charles' law can be stated as follows:

At constant pressure, the volume of a given mass of gas increases with an increase in temperature or decreases with a decrease in temperature by a value of 1/273 of the original volume at 0^0C, for every one degree centigrade change in temperature.

Let V_0 be volume of a gas at 0^0C and V_t be the volume of the gas at t^0C at constant pressure.

$$\therefore \quad V_t = V_o + V_o \frac{1}{273} t \qquad \Rightarrow \quad V_t = V_o \left(1 + \frac{t}{273}\right)$$



When we bake a cake, the rising of the dough is related to Charle's law. As oven heats up, the air inside the cake expands, causing the cake to rise.

According to Charles' law "the volume of a given mass of a dry gas at constant pressure is directly proportional to absolute temperature".

$$V \propto T \text{ (When pressure is constant)}$$

$$V = KT \text{ or } V/T = K \text{ (Where K is proportionality constant)}$$

If we consider V_1 is the volume of a gas at T_1 temperature and V_2 is the volume at T_2 temperature, such that pressure of the given mass of gas remains constant, then

$\frac{V_1}{T_1} = K$ .....(i) $\frac{V_2}{T_2} = K$ .....(ii)

Comparing (i) and (ii), we get $\Rightarrow \frac{V_1}{V_2} = \frac{T_1}{T_2} = \frac{t_1 + 273}{t_2 + 273}$

The above equation is called Charles' law equation. Where V_1, T_1 are the respective initial values and V_2, T_2 are the respective final values.

Volume Occupied by Any Gas at –273 °C:

If t = –273 °C, the volume occupied by the gas at –273 °C is given by

$$V_{-273} = V_o\left(1 + \frac{-273}{273}\right) = V_o(1-1) = 0$$

$\therefore$ Volume of the gas at $-273^0C = V_{-273}$ = **Zero**

This temperature (-273^0C) is called **absolute zero**.

Absolute Zero of Temperature: It is defined as the temperature at which no substance exists in the gaseous state. The temperature of -273^0C (0 K) is called as "absolute zero" of temperature.

Note: Scientists suggested that temperature from centigrade degree (^0C) should be converted to kelvin scale (absolute degrees) in all numerical calculations.

Example:

$0^0C = 0 + 273K = 273\ K$; $1^oC = 1+273K = 274K$

$10^0C = 10 + 273\ K = 283\ K$; $-10^oC = -10+273K = 263K$

$-273^0C = -273 + 273\ K = 0\ K$

Solved Example:

250 ml of oxygen gas was collected at 27°C. If the volume of a gas was reduced to 100 ml, calculate the temperature to which the gas is cooled. All these changes were done at 1 atmospheric pressure.

Data:

Initial volume of gas (V_1) = 250 ml; Final volume of gas (V_2) = 100 ml

Initial temperature (T_1) = 27°C = 300K; Final temperature (T_2) =?

Sol: According to Charle's Law $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (at constant pressure)

$$\Rightarrow T_2 = \frac{V_2 T_1}{V_1} = \frac{100 \times 300}{250} = 120K$$

$\therefore$ T_2 in $^0C = 120 - 273 = -153^0C$

Self Assessment Test - 06

1. **The temperature used in Charles' law calculations must be expressed in:**
   (A) Celsius scale
   (B) Kelvin scale
   (C) Fahrenheit scale
   (D) Any scale

2. **What does Charles' law state?**
   (A) The volume of a gas is directly proportional to its pressure at constant temperature.
   (B) The volume of a gas is directly proportional to its temperature at constant pressure.
   (C) The pressure of a gas is directly proportional to its temperature at constant volume.
   (D) The pressure of a gas is inversely proportional to its temperature at constant volume.

3. **What is the relationship between volume and absolute temperature according to Charles' law?**
   (A) $V \propto T$ (B) $V \propto \frac{1}{T}$
   (C) $V \propto T^2$ (D) $V \propto \frac{1}{T^2}$

4. **In the solved example, what was the final volume of the gas?**
   (A) 250 ml (B) 300 ml
   (C) 100 ml (D) 120 ml

5. **What is the volume of a gas at –273°C according to Charles' law?**
   (A) Same as the initial volume at 0°C
   (B) Zero
   (C) Double the initial volume at 0°C
   (D) Cannot be determined

6. **What is the significance of –273°C in Charles' law?**
   (A) It represents the highest temperature recorded.
   (B) It is the temperature at which gases have maximum volume.
   (C) It is the temperature at which gases have minimum volume.
   (D) It is absolute zero, the point at which no substance exists in the gaseous state.

7. **If the temperature of a gas increases from 300 K to 600 K at constant pressure, its volume will:**
   (A) Become half
   (B) Remain same
   (C) Double
   (D) Become four times

MARK YOUR ANSWERS WITH PEN ONLY.

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

Concept 7

Gay-Lussac's Law:

According to Gay-Lussac's law of combining volumes "whenever gases react chemically the volumes of gaseous reactants and products bear a simple ratio to each other at same temperature and pressure".

Let's take an example to make it clear.

$$H_2(g) + Cl_2(g) \rightarrow 2HCl$$

If we take one volume of hydrogen and one volume of chlorine, both would react with each other to form two volumes of hydrogen chloride. Based on Gay-Lussac's results, Avogadro gave his hypotheses that, at the same pressure and temperature, equal volumes of gas contain equal numbers of molecules (Avogadro's Law).

Knowledge Box

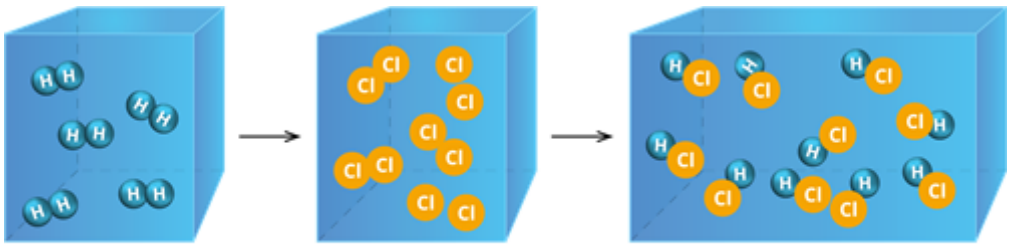
If you heat a sealed can, it can explode, this is because the pressure inside the can increases as the temperature rises (at constant volume).

1 molecule of hydrogen + 1 molecule of chlorine → 2 molecules of hydrogen chloride.

It can also be expressed in a different way, for example, consider 100 mL of hydrogen combined with 100 mL of chlorine to give 200 mL of hydrogen chloride.

Hydrogen (100 mL) + Chlorine (100 mL) → Hydrogen chloride (200 mL)

Thus, the volumes of hydrogen and chlorine which combine (i.e., 100mL and 100mL) bear a simple ratio of 1:1 and thus the simple ratio volumes are 1:1:2.



Gay–Lussac's law states that for a fixed amount of gas at constant volume, the pressure of the gas directly proportional to its absolute temperature.

$$P \propto T \quad \Rightarrow \quad P = KT \quad \Rightarrow \quad \frac{P}{T} = K \quad \therefore \frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Solved Examples:

1. A mixture of C_2H_4 and O_2 is ignited. 200 ml of CO_2 is collected at STP. Find the volumes of C_2H_4 and O_2 at STP in the original mixture.

The equation of the reaction is $C_2H_4 + 3\ O_2 \rightarrow 2CO_2 + 2H_2O$

Sol: Applying Gay-Lussac's law,

$$\underset{(1\text{vol})}{C_2H_4} + \underset{(3\text{vol})}{3O_2} \rightarrow \underset{(2\text{ vol})}{2CO_2} + \underset{(\text{liquid})}{2H_2O}$$

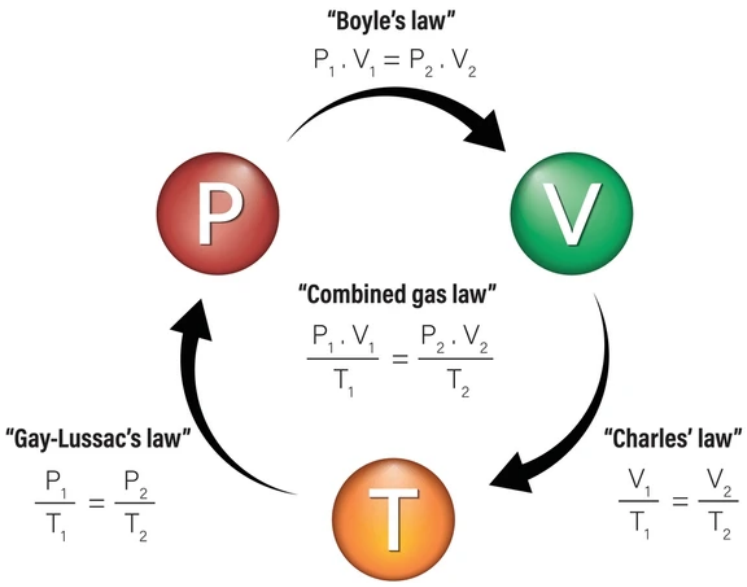
Ratio of volumes of C_2H_4 and O_2 reacting and CO_2 formed is 1:3:2.

So, if volume of CO_2 formed is 200 ml, volume of C_2H_4 required is 100 ml and volume of O_2 required is 300 ml.

This is the composition of the reactants mixture (at the starting of the reaction).

Combined Gas Law:

Since volume is proportional to temperature and inversely proportional to pressure, the three variables can be expressed together for situations in which the amount of gas is kept constant but pressure, volume, and/or temperature vary.



The ratio of a pressure and volume to the absolute temperature of a gas is a constant.

This can be expressed mathematically as: $\frac{PV}{T} = K$ then, $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

If any of the three variables remains constant, this formula reduces to one of the individual gas laws discussed above. Therefore, learning this single formula is more productive than learning each of the individual gas laws.

The combined gas law is an ideal gas law that combines Boyle's law, Charles' law and Gay-Lussac law.

We use the combined gas law to predict what will happen to a gas if the pressure, volume, and/or temperature of a set amount of gas changes.

2. 127 ml of a gas at standard temperature and pressure, STP, are heated to 82°C and allowed to expand to 233 mL. What is the resulting pressure?

***Data*:**

Initial volume (V_1) = 127 mL
Initial pressure (P_1) = 1 atm
Initial temperature = (T_1) = 273K
Final volume (V_2) = 233 mL
Final pressure (P_2) =?
Final temperature (T_2)=82°C=355 K

***Sol*:** We have combined gas law $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\Rightarrow P_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{V_2}$$

$$P_2 = \frac{1 \times 127}{273} \times \frac{355}{233} = 0.7\,\text{atm}$$

$\therefore$ The resulting pressure = 0.7 atm

3. The initial volume of a gas is 5L and final volume is 3L. Calculate the final pressure of the gas, given that the initial temperature is 273 K, the final temperature is 200 K, and initial pressure is 25 kPa.

***Data*:**

Initial pressure (P_1)= 25 kPa;
Initial volume (V_1) = 5L
Initial temperature = 273K
Final pressure (P_2) =?
Final volume (V_2) = 3L
Final temperature (T_2) = 200K

***Sol*:** According to combined gas law, $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\Rightarrow P_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{V_2}$$

$\Rightarrow P_2 = (25 \times 5 \times 200)/ (273 \times 3) = 30.525$

$\therefore$ The final pressure = = 30.525 kPa

Self Assessment Test - 07

1. What does Gay-Lussac's law of combining volumes state?

(A) Volumes of gaseous reactants and products bear a simple ratio to each other at same temperature and pressure.

(B) The volume of a gas is directly proportional to its pressure at constant temperature.

(C) Equal volumes of gas contain equal numbers of molecules at the same temperature and pressure.

(D) The volume of a gas is directly proportional to its absolute temperature at constant pressure.

2. In Gay-Lussac's law, what is the ratio of volumes of C_2H_4 and O_2 reacting to CO_2 formed in the given reaction?

(A) 1:1 (B) 1:2

(C) 1:3 (D) 2:1

3. What is the mathematical expression of the combined gas law?

(A) $PV = \frac{T}{T_0}$ (B) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

(C) $P = \frac{V}{T}$ (D) PV=nRT

4. If a gas has an initial volume of 127mL at standard pressure, what is the final pressure if the volume changes to 233mL, assuming constant temperature?

(A) 1.8 atm (B) 0.54 atm

(C) 2.5 atm (D) 0.82 atm

5. According to Gay-Lussac's law, what is the ratio of volumes of hydrogen and chlorine that combine to form hydrogen chloride?

(A) 1:1 (B) 1:2

(C) 2:1 (D) 3:1

6. According to the combined gas law, what happens if any of the three variables remains constant?

(A) The formula becomes invalid.

(B) The formula reduces to one of the individual gas laws.

(C) The volume increases infinitely.

(D) The pressure decreases exponentially.

MARK YOUR ANSWERS WITH PEN ONLY.

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

C.D.F. (Concepts, Definitions and Formulae)

1. Anything which occupies space and has mass is called **matter.**
2. The matter around us exists in three states. They are solids, liquids and gases.
3. Any material which has a definite shape and definite volume at room temperature, such that it can have any number of free surfaces is called **solid.**
4. Any material which has a definite volume, but no definite shape and one free (upper) surface is called **liquid.**
5. Any material which has neither definite shape nor definite volume is called **gas**.
6. The force of attraction between the particles are maximum in solids, intermediate in liquids and minimum in gases.
7. The process of conversion of a solid into liquid state is known as **melting**.
8. The temperature at which a liquid starts boiling at the atmospheric pressure is known as its **boiling point**.
9. The movement of air, vapours of scent and smoke is known as **diffusion**.
10. The rate of diffusion of gases is higher than that of liquids or solids.
11. A change of state directly from solid to gas without changing into liquid state (or vice versa) is called **sublimation**.
12. The solid carbon dioxide is also known as **dry ice.**
13. The heat which is given to the system during a phase change, and which is not used in raising the temperature is called **latent heat.**
14. The process of conversion of a gas into liquid by increasing pressure and decreasing temperature is called **liquefaction of gases.**
15. The process where a liquid changes into vapor at any temperature below its boiling point is **evaporation**.
16. The process, where a liquid converts into a solid, is called **freezing** or **solidification**.
17. The process where vapor changes to a liquid is called **condensation**.
18. Gases are highly compressible when compared to liquids and solids.
19. Boyle's law states that "The volume of a given mass of gas is inversely proportional to its pressure at any given temperature".
20. According to Charles' law "the volume of a given mass of a dry gas at constant pressure is directly proportional to absolute temperature".

Advanced Worksheet

LEVEL 1

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

1. What happens to the kinetic energy of gas particles at absolute zero temperature

(A) Kinetic energy of the particles increases

(B) Kinetic energy of the particles slightly decreases

(C) No change in kinetic energy of the particles

(D) Kinetic energy of the particles becomes zero.

2. Which of the following statements about the plasma state of matter is correct?

(A) Plasma is a solid form of matter found at extremely low temperatures

(B) Plasma consists of neutral atoms and is found in ice

(C) Plasma is an ionized gas with free electrons and positive ions

(D) Plasma exists only in laboratory conditions and not in nature

3. Which of the following substances is a hard substance?

(A) Butter

(B) Glass

(C) Sponge

(D) Rubber band

4. The temperature at which the solid melts to become a liquid at the atmospheric pressure is called:

(A) Boiling point

(B) Melting point

(C) Freezing point

(D) None of these

5. Anything that has mass and occupies space is called:

(A) Element

(B) Compound

(C) Matter

(D) Mixture

6. If the volume of a gas at 0^0C is V_0, then the increase in volume per 1^0C rise in temperature is

(A) V_0

(B) 1/100 of V_0

(C) 1/273 of V_0

(D) $273V_0$

7. Which of the following has no fixed volume and no fixed shape?

(A) Book (B) Brick

(C) Oxygen (D) Milk

8. Solids have ____ shape and ____ volume.

(A) definite, indefinite

(B) indefinite, definite

(C) definite, definite

(D) indefinite, indefinite

9. Liquids and gases are known as:

(A) Plasma

(B) Rigids

(C) Fluids

(D) Vapours

10. 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

11. The movement of air, vapours of scent and smoke is known as:

(A) Compressibility

(B) Mixture

(C) Diffusion

(D) None of the above

12. A gas has a volume of 200 ml at 300 K. What will be its volume at 600 K at constant pressure?

(A) 100 mL

(B) 200 mL

(C) 300 mL

(D) 400 mL

13. The property of compressibility is:

(A) Maximum in solids

(B) Least in solids

(C) Maximum in liquids

(D) Least in gases

14. According to Gay-Lussac's law, the volumes of reacting gases and products are in:

(A) Complex ratios

(B) Simple whole-number ratios

(C) No definite ratio

(D) Decimal ratios

15. The process of changing a liquid into gas is called:

(A) Vaporisation

(B) Displacement

(C) Condensation

(D) Dissociation

16. The boiling point of water at normal atmospheric pressure is:

(A) 273 K

(B) 373 K

(C) 100 K

(D) $0^{o}C$

17. Gas is composed of a large number of particles called:

(A) Crystals

(B) Ions

(C) Molecules

(D) Atoms

18. Which one of the following is not an unit of pressure?

(A) Kelvin

(B) Torr

(C) Pascal

(D) Bar

19. Boyle's law is stated at constant:

(A) Temperature

(B) Pressure

(C) Volume

(D) All the above

20. Mathematically Charle's law is written as:

(A) $P_1V_1 = P_2V_2$

(B) $V_1+T_1 = V_2+T_2$

(C) $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

(D) $V_1T_1 = V_2T_2$

21. Combined gas law is expressed mathematically as:

(A) $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

(B) $\frac{V_1}{V_2} = \frac{n_1}{n_2}$

(C) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

(D) $\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$

22. Which of the following is accompanied by cooling?

(A) Boiling

(B) Evaporation

(C) Condensation

(D) None of these

23. Which of the following pairs will not exhibit diffusion?

(A) Hydrogen, oxygen

(B) Oxygen, water

(C) Salt, sand

(D) Sugar, water

24. Which one of the following properties are not characteristics of liquids?

(A) Fluidity

(B) Definite shape

(C) Definite volume

(D) Compressibility

25. The state of matter which consists of super energetic particles in the form of ionized gases is called:

(A) Gaseous state

(B) Liquid state

(C) Bose-Einstein condensate

(D) Plasma state

26. A change of state directly from solid to gas without changing into liquid state is called:

(A) Condensation

(B) Evaporation

(C) Sublimation

(D) Solidification

27. Which is not an example of matter?

(A) Milk

(B) Sound

(C) Water

(D) Gas

28. The physical state of water in the polar ice caps and glaciers is:

(A) Liquid

(B) Gas

(C) Solid

(D) None of these

29. The conversion of gas into liquid is called:

(A) Gasification

(B) Sublimation

(C) Condensation

(D) Freezing

30. Which of the following has fixed shape and a fixed volume?

(A) Milk

(B) Water

(C) Air

(D) Sugar

31. In which state do the particles of water possess maximum energy?

(A) Solid state

(B) Liquid state

(C) Gaseous state

(D) All the above

32. Which of the following is not a characteristic of solids?

(A) High rigidity

(B) High fluidity

(C) Low compressibility

(D) High density

33. The conversion that takes place at all temperatures:

(A) Evaporation

(B) Boiling

(C) Melting

(D) Freezing

34. Convert 35°C to Kelvin:

(A) 308 K

(B) 150 K

(C) 277°C

(D) –123°C

35. The pressure of a gas at constant temperature is 2 atm and volume is 5L. If its pressure is increased by three units then what will be its new volume?

(A) 2 L

(B) 3 L

(C) 4 L

(D) 5 L

36. 300 mL of O_2 is collected at a pressure of 380 mm of mercury. What volume will this gas have at one atmosphere pressure?

(A) 600 mL

(B) 150 mL

(C) 900 mL

(D) 75 mL

LEVEL 2

Multi Correct Answer Type (M.C.A.T.)

37. Which of the following statements about temperature are correct?

(A) Temperature reflects average kinetic energy of gas molecules

(B) SI unit of temperature is Celsius

(C) Temperature is measured using a thermometer

(D) SI unit of temperature is Kelvin

38. Which of the following are correct about pressure of gases?

(A) Pressure is due to collision of gas molecules with container walls

(B) Pressure = Force × Area

(C) Pressure = Force / Area

(D) Pressure depends on molecular collisions

39. Which of the following elements have definite volume but no shape?

(A) Mercury (B) Iron

(C) Tin (D) Bromine

40. Choose the correct statement(s).

(A) Solids do not diffuse

(B) The density of liquids is relatively less than that of solids

(C) Gases exert pressure in all directions

(D) Solids cannot be compressed

41. Which of the following substances are sublimable solids?

(A) Sodium

(B) Iodine

(C) Camphor

(D) Ammonium chloride

42. As the solid melts to form liquid:

(A) Interparticle force of attraction increases

(B) Compressibility increases

(C) The energy of the particles increases

(D) Volume increases

Comprehension Passage Type (C.P.T.)

PASSAGE-I

Observe different types of matter around you. What are its different states ? We can see that matter around us exists in three different states–solid, liquid and gas. These states of matter arise due to the variation in the characteristics of the particles of matter.

43. Solids are:

(A) Non- compressible

(B) Compressible

(C) Rigid

(D) Both (A) and (C)

44. The quantity of matter in an object:

(A) Varies

(B) Is constant

(C) Increases when heated

(D) Decreases when pressure is increased

45. What is the physical state of water at room temperature?

(A) Solid

(B) Liquid

(C) Gas

(D) All the above

PASSAGE-II

Gas laws are a set of laws that describe the behaviour of gases under different conditions, relating pressure, volume and temperature.

46. If a pressure is doubled for a fixed mass of a gas, its volume will become:

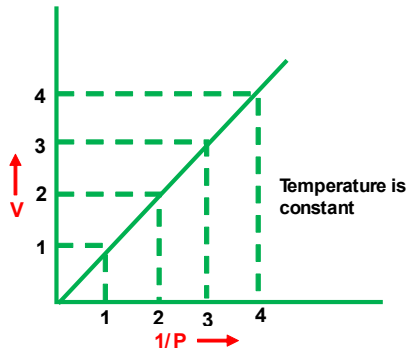
(A) 4 times

(B) 2 times

(C) $\frac{1}{2}$ times

(D) No change

47. The graph shown below gives the statement for:



(A) Henry's law

(B) Charle's law

(C) Dalton's law

(D) Boyle's law

48. Volume–temperature relationship is given by:

(A) Robert Boyle

(B) Charle's

(C) Dalton

(D) Gay-Lussac

LEVEL 3

Matrix Matching Type (M.M.T.)

SET-I

Column - I

49. Solid → Liquid

50. Solid → Gas

51. Gas → Liquid

52. Liquid → Solid

Column - II

(A) Melting

(B) Freezing

(C) Sublimation

(D) Condensation

SET-II

Match the physical quantities of matter given in column I to their SI units given in column II.

Column - I

53. Plasma

54. Sun and stars

55. Lightning

56. Neon sign tubes

Column - II

(A) Man-made plasma

(B) Natural plasma on Earth

(C) Ionized gas

(D) Glow due to super energetic particles

Assertion Reason Type (A.R.T.)

(A) Both assertion and reason are true and reason is the correct explanation of assertion

(B) Both 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

57. 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.

58. Assertion (A): A balloon expands when heated because gas particles move faster and exert more pressure on the balloon walls.

Reason (R): The volume of a gas directly proportional to its absolute temperature at constant pressure.

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

59. Statement-I: Boyle's law states that the volume of a gas inversely proportional to its pressure at constant temperature.

Statement-II: The product of pressure and volume is constant at constant temperature for a fixed amount of gas.

60. Statement-I: The combined gas law is an amalgamation of three laws which are Boyle's law, Charle's law and Gay-lussac's law.

Statement-II: When a diver descends, the pressure around him increases, causing the air in his lungs to compress.

Integer Type Questions (I.T.Q.)

61. The Sun mainly consists of hydrogen and helium. What is the approximate percentage of hydrogen in the Sun?

62. If a substance undergoes sublimation, how many phase changes are occurring?

Analytical Approach Type (A.A.T.)

63. If the absolute temperature of a gas is doubled at constant pressure. Then the volume of the gas is:

(A) Reduced to half

(B) Doubled

(C) Reduced to 1/4th

(D) Increased to 8 times

64. A gas occupies 2 litres at 27°C. If the temperature increased to 57°C at constant pressure, what is the new volume in litres?

(A) 2 litres

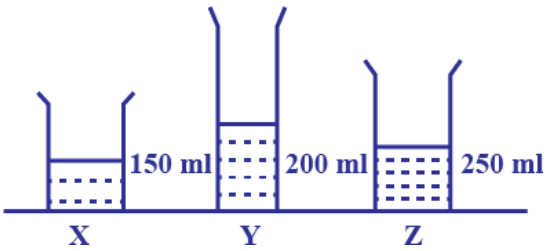
(B) 2.2 litres

(C) 2.5 litres

(D) 3 litres

Figure Based Questions (F.B.Q.)

65. Three containers X, Y and Z as shown below were filled with water and then left near an open window. The purpose was to find out whether the exposed surface area of the water affects the rate of evaporation of water.



Why was the experiment NOT a fair one?

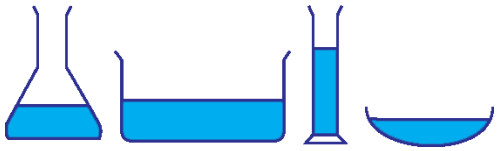
(A) The exposed surface areas were different.

(B) Different types of containers were used.

(C) The amount of water in the containers was different.

(D) The containers were not covered.

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



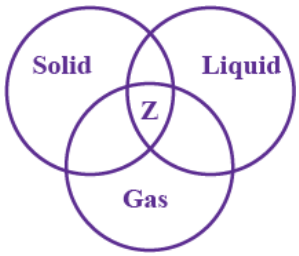
(A) Water has definite volume.

(B) Water has no definite shape.

(C) Water has definite mass.

(D) Water has no definite volume.

67. Look at the Venn diagram given below. Which of the following can be placed in 'Z'?



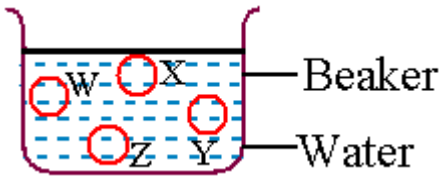
(A) Water

(B) Dry ice

(C) Salt

(D) Jelly

68. Which of the following water molecules W, X, Y or Z can easily escape to form water vapour?

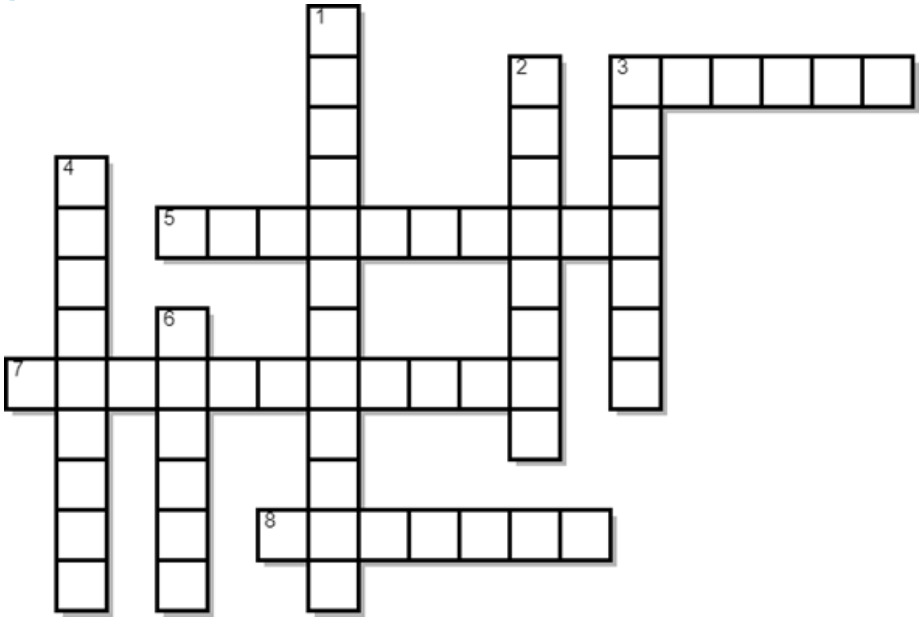


(A) W

(B) X

(C) Y

(D) Z



***ACROSS*: (→)**

3. Anything that has mass and occupies space and can be perceived by our senses is called
5. The characteristic amount of energy absorbed or released by a substance during a change in its physical state that occurs without changing its temperature is known as:
7. The process, where a solid, on heating, directly changes into gas without changing into liquid is called:
8. The process where a liquid changes into a vapour at a particular temperature:

***DOWN*: (↓)**

1. The process where vapour changes to a liquid is called:
2. The process, where a liquid converts into a solid, is called:
3. The process where solid changes into a liquid at a particular temperature:
4. The intermixing of the particles of two or more substances on their own is called:
6. _____ is the fourth state of matter.

MOVEMENT OF PARTICLES IN SOLIDS, LIQUIDS AND GASES

Aim: To demonstrate movement of particles in solids, liquids and gases.

Materials required: For making this model we need:

- A transparent jar
- A rubber balloon or piece of stretchable rubber sheet A string
- Few chick-peas or black gram or dry green peas.

Procedure:

- Put the seeds in the jar.
- Sew the string to the centre of the rubber sheet and put some tape to keep it tied securely.
- Stretch and tie the rubber sheet on the mouth of the jar.
- Your model is ready. Now run your fingers up and down the string first tugging at it slowly and then rapidly.