- Science & Technology

- CHEMISTRY
  - Part 1

- CHEMISTRY:
  Chemistry is a branch of science concerned with the study of matter. Chemistry deals with the structure & the composition of matter and with the changes that matter undergoes.

- MATTER:
  Everything in this universe is made up of matter. Matter is defined as anything which
  - occupies space
  - has mass
  - may be perceived by our senses

- NON-MATTER:
  Heat, light, electricity and sound are not matter.
  -they have no mass
  -they do not occupy space

- ATOMS
  All matter are composed of very very small tiny particles.
  Democritus named these tiny particles as ATOMS.
  A drop of water has 10^{21} particles.

- CHARACTERSTICS OF PARTICLES
  - are very very small
  - have spaces between them
  -are constantly moving
  -attract each other

- STATES OF MATTER
  There are three physical states of matter
  -Solid. Steel, stone
  -Liquid Oil, water
  -Gas Air

Physical Properties of Solids Liquids and Gases

PROPERTIES	SOLIDS	LIQUIDS	GASES
Shape	Definite	Acquires the shape of the container	Acquires the shape of the container
Compressibility	Not possible	Very little	Highly compressible
Fluidity	Not possible	Can flow	Can flow
Density	High	Lower than solids	Very low
Packing of Particles	Densely packed	Less closely packed	Least closely packed
Interparticle force	Strongest	Weaker than solid	Negligible

Chemical Reaction

- A chemical reaction involves a chemical change, in which substances react to form new substance/s. The new substances have new properties. Chemical change is irreversible.

Changes in State of Matter

- Melting: The process of change of a solid substance into its liquid state when heated is called melting. Melting of a substance happens at a particular temperature. This specific constant temperature is called MELTING POINT of that solid.

  The Melting Point is a characteristic property of solids. The Melting Point increases when the pressure is increased.

Solids	Melting Point
Ice	0 ^{o} C
Silver	961^{o} C
Iron	1535^{o} C
Salt	800^{o} C

Changes in State of Matter

- The melting point of a substance is a fixed temperature. But if there are impurities in a substance it changes considerably. The melting point of a mixture of ice and salt is -15^{o}C. It is considerably lower than that of pure ice which is 0^{o}C.

  Freezing or Solidification: The process of change of matter from the liquid to the solid state, at a particular temperature is called freezing or solidification

- Boiling: Boiling is the process of change of a liquid in to a vapour, at a particular temperature. The temperature at which a liquid changes to vapour is called boiling point.

Changes in State of Matter

- Evaporation: The process of conversion of a substance from the liquid state to its vapour state at any temperature below its boiling point is called evaporation or vaporization

  Condensation: is the process of change of a state of a substance from its gaseous to liquid state at a particular temperature.

  Pure liquids have fixed boiling point

Liquids	Boiling Point
Water	100^{o}C
Alcohol	78^{o} C
Sulphuric Acid	280^{o}C
Chloroform	62^{o} C

Changes in State of Matter

- Sublimation: Sublimation is the process by which a solid on heating directly changes into its vapour (Gaseous state).
- This happens without changing in to liquid. Conversely the gas directly changes into solid.

  ex. Camphor, Naphthalene, solid carbon dioxide

  Solid Carbon dioxide temperature -78.5^{0}C

Law of Conservation of Mass

- It states that mass can neither be created nor destroyed in a chemical reaction.
  OR
  During any change physical or chemical matter is neither created nor destroyed. However it may change from one form to another.

- $CaCO_{3.} \rightarrow CaO + CO_{2.}$

  If 100g of Calcium Carbonate is heated it will give 56 g of Calcium oxide and 44 g of Carbon dioxide.

  Some matter may get converted in to form of energy.

Gases

- In a gas inter-particle attraction is weak and inter-particle space is very large. The particles are free to move randomly in the entire available space.
  All gases show uniform behaviour under similar conditions of temperature and pressure irrespective of their chemical nature or colour or odour.

- Properties of Gases:
  - Gases are made up of tiny particles moving randomly.
  - Gases have neither a fixed volume nor a fixed shape
  - Gases exert pressure in all direction
  - Gases are highly compressible
  - Gases are highly expansible
  - Gases have low density
  - Gases have a natural tendency of mixing with one another (Diffusion)
  - Gases can be liquified

Gas Laws

- An increase in pressure at constant temperature causes a decrease in the volume of a gas: conversely, if the volume of a fixed mass of a gas at constant temperature is Decreased, the pressure of the gas Increases.
- A decrease in pressure at constant temperature causes an increases in the volume of a gas, conversely, if the volume of a fixed mass of a gas at constant temperature is Increased, the pressure of the gas Decreases.
- An increase in temperature at constant pressure causes an increase in volume and a decrease in temperature at constant pressure causes a decrease in volume.
- The volume of a given mass of a gas is inversely proportional to its pressure at constant temperature.
- The density of gas decreases with increase in temperature.

Significance of Gas Laws

- On increasing pressure, volume decreases. The gas becomes more dense. Thus at constant temperature, the density of a gas is directly proportional to its pressure.

  Atmospheric pressure is low at high altitudes, so air is less dense. Hence a lesser volume of oxygen is available for breathing. This is the reason why mountaineers have to carry oxygen cylinders with them.

- As the density decreases with increase in temperature, this the reason why hot air is filled in balloons.

Absolute zero

- The particles (Molecules) of matter (Solid, Liquid and Gas) are in constant motion. Thus we can say the molecules have energy (Kinetic).
- As the temperature increases, the molecular motion increases, and when the temperature decreases, the molecular motion also decreases.
- This suggests that when the temperature is zero, the molecules motion will stop completely.
- This fact is used to define temperature scale Kelvin.
  On this scale the temperature at which the molecular motion completely stops is called absolute zero.
- With increase in pressure and lowering of temperature the volume of gas decreases. The temperature at which the volume of hypothetical gas becomes zero is absolute zero of temperature.
  This temperature is minus (-) 273^{o} C.
  This is the lowest temperature that can ever be reached.
- However, practically speaking, this temperature. Is impossible to attain. All gases liquefy or solidify before reaching this temperature.

Substances

- Millions of substances are known to us.
  Substances can be Pure or Impure.
  PURE SUBSTANCE: A pure substance is a homogeneous material with a definite, invariable chemical composition, and definite invariable physical and chemical properties.
  Ex. Sodium Chloride (common salt) is a pure substance. This is because all samples of Sodium Chloride have the same composition. 23 parts by weight of Sodium and 35.5 parts by weight of Chlorine.

- IMPURE SUBSTANCES: Impure substances consist of two or more different kinds of molecules whose composition by weight per unit volume is not fixed.

  Ex. Air, sea water, solution of Sodium Chloride and water.

Elements

- An element is a pure substance. It cannot be converted in to anything simpler than itself by any physical or chemical process. Elements are the basic substances from which all other substances are made.
  An element is a pure substance composed of only one kind of atoms.

- Some elements are called radioactive elements such as thorium because they emit radiations.

- Over 90% of the earth's crust consists of only five elements:- Oxygen, Silicon, Aluminium, Iron and Calcium.
  Carbon and Hydrogen account for 90% mass of the human body.

Elements: facts about elements

- 117 elements are known
- 92 elements occur in nature
- 13 elements occur as non-metals
- 5 elements occur as metalloids
- 6 elements occur as noble gases
- 11 elements are in gaseous state at room temperature
- two elements mercury and bromine are liquid at room temperature
- Gallium and Caesium become liquid at a temperature slightly above room temperature

Metals

- Metals are hard solids. They have lustre.
- They are good conductor of heat and electricity.
- They are ductile.
- They are malleable.
- Most of them high melting and high boiling point.
- They produce sound when struck.

Ex. Gold, Iron, Lead, Tin, Copper, Aluminium

Non-metals

- They exist in all three states- solids, liquids and gas.
  Ex. Carbon, Sulphur, Iodine are solids
  Bromine is a liquid
  Hydrogen, Oxygen, Nitrogen are Gases
  They do not have lustre. They are bad conductor of heat and electricity. They are neither malleable nor ductile. They have low melting and boiling point.
  Exceptions:
  Graphite and Iodine have lustre.
- Carbon fibre is ductile.
- Graphite is good conductor of electricity. It also has high melting point.
- Diamond has high melting point and boiling point.

Metalloid

- They show the properties of both metals and non-metals. Ex. Silicon, Arsenic, Antimony, Germanium, Bismuth.
- Metalloids (Semiconductors) are important components of electronic devices.
- Antimony is used in alloys such as pewter and as a flame retardant in plastics
- Boron is used as a bonding agent in magnets and other chemical substances.

Noble Gases

They are gaseous in nature.

They are chemically inactive or inert. Helium has the lowest boiling point of any known substance. 4.1K
Ex. Helium, Neon, Argon, Krypton, Xenon, Radon

Helium is used in balloons. It does not burn in air like hydrogen. Helium is less soluble in water than nitrogen. When inhaled it dissolves in the blood stream in smaller quantities than nitrogen. For this reason a mixture of helium and oxygen in place of natural air for divers. Avoids “bends”

Helium is used in all electric arc processes in the industry.

Molecule

- Most atoms do not exist in a free state. They exist in a combined state. They combine with the atoms of same element or atoms of different element. The combined state of atoms is called Molecule. Molecule is capable of existing in a free state. A molecule is the smallest particle of a pure substance.

- Molecule of same type of atoms Ex. Oxygen. O_2 called Molecule of an Element. It is made up of two atoms of Oxygen.

  Ozone O_3 It is made up of three atoms of Oxygen. Molecule of different types of atoms Ex. Water. H_2O Two atoms of Hydrogen and one of Oxygen.

Compound

- A compound is a pure substance composed of two or more elements combined chemically in a fixed proportions by mass. The properties of a compound are different from the properties of its constituent elements.
  Ex. Common or table salt is Sodium Chloride. It is made up of two elements Sodium and Chlorine.

- Sodium: is a soft metal. It reacts violently with water. Poisonous if swallowed.
  Chlorine: is a greenish yellow gas with a choking smell. It is poisonous in nature.

- Combining these two element is formed is Common Salt is non-poisonous and we eat every day.

Compound

- Same elements can combine with each other in different proportions and can give different compounds.
- Ex. Hydrogen combining with Oxygen can give:
- Water H_2O
- Hydrogen Peroxide. H_2O_2
  In Water two hydrogen atoms are combined with one atom of Oxygen
  In Hydrogen Peroxide two atoms of Oxygen combine with two atoms of Hydrogen.

Characteristics of a Compound

- A compound contains atoms of two or more elements combined by chemical forces

- It has homogeneous composition. All sample of compound will show same composition
  Ex. Water from lake, river or pond will have same composition.

- Water is composed of two elements, hydrogen and oxygen. They are combined in a fixed proportion. (8:1) by mass. 89% of Oxygen and 11% of Hydrogen
  The properties of water are different from those of its constituent elements, as water is a liquid, while its constituent elements hydrogen and oxygen are gases.

- Thank You