CHEMISTRY DIGEST

Chemistry, a branch of physical science, is the study of the composition, properties and behavior of matter.

Father of modern chemistry :- Antoine Lavoisier was a French nobleman and chemist central to the 18th-century chemical revolution and a large influence on both the history of chemistry and the history of biology. He is widely considered in popular literature as the "father of modern chemistry"

MATTER

In general it exists in 3 states i.e.,

(i) Solid

(ii) liquid

(iii) gas.

Now-a-days there is a discussion on two more states of matter

i.e., Plasma {Ionised gases containing super energetic and super excited particles }

and Bose-Einstein condensates or BEC (a gas at super low temperatures with extremely low density).

Boiling Point

- The temperature at which liquid converts in to vapours is called its boiling point.
- Boiling point of water is 100°C.
- The boiling point increases in the presence of impurities.
- That's why boiling point of sea water is more than the boiling point of pure water (as the former contains impurity).

- It usually decreases at high altitudes, that's why at high altitudes, the boiling point of water is less than 100°C and more time is required to cook a food.

Melting Point

- It is a temperature at which a substance converts from its solid state to liquid state.
- Melting point of ice is 0°C; It decrease in the presence of impurity

Atom, Molecule and Element

- Atom is the smallest particle of a matter that takes part in chemical reactions, but cannot exist in free state.

- Atom is made of electrons, protons and neutrons.

- Protons and neutrons reside in the nucleus (at the centre of atom)

  whereas electrons revolve around the nucleus.

- **Atoms combine to form molecules**, the smallest part of matter which can exist in free state.

Isotopes and Isobars

- Isotopes have the same number of protons (i.e., atomic number), but different number of neutrons and mass number (atomic number + number of neutrons)

- The number of nucleons (both protons and neutrons) in the nucleus is the atom's mass number, and each **isotope** of a given element has a different mass number.

- For **example**, carbon-12, carbon-13 and carbon-14 are three **isotopes** of the element carbon with mass numbers 12, 13 and 14 respectively.

- Isobars have the same mass number but different atomic number.

- **Isobars** are atoms (nuclides) of different chemical elements that have the same number of nucleons.

- Correspondingly, **isobars** differ in atomic number (or number of protons) but have the same mass number.

- Example: 18Ar40, 19K40

Dating Techniques

- Radiocarbon dating is used to determine the age of carbon bearing materials like wood, animal fossils etc.

- Uranium dating is used to determine the age of Earth, minerals and rocks.

Battery

- Battery is a device, used to convert chemical energy into electrical energy and is of two types

(i) Primary batteries (non-rechargeable) act as galvanic cell, e.g., dry cell, mercury cell etc.

(ii) Secondary Batteries: (rechargeable) Act as galvanic as well as voltaic cell

E.g., lead storage battery, nickel cadmium battery etc.

Corrosion

- The oxidative deterioration of a metal surface by the action of environment is called corrosion, an electrochemical process.

- When iron exposed in to air, iron surface turns brown due to the formation of hydrated ferric oxide (Fe203.xH20) which is also called rust,

- Silver - Surface turns black due to the formation of silver sulphide (Ag2S)

Renewable Non-renewable Natural Resources

- Renewable resources are available in large excess (get renewed with time) , i.e., never ends, e.g, air, sunlight etc.

- Non-renewable resources are available in limited quantity and end, if used excessively, after a limited period of time. e.g., mineral, coal, petroleum, natural gas etc.

Fuels

- The substance, which produce heat and light on combustion are called fuels.

- A strong foul smelling substance, called ethyl mercaptan is added to LPG to detect its leakage as LPG is an odourless gas.

Some important fuels and their compositions

1.Water Gas

Carbon monoxide (co) + hydrogen(h2)

Produced By passing stream over red hot coke

2.Producer Gas

Carbon monoxide (CO) + Nitrogen (N2)

Produced By passing insufficient air over red hot coke

3.Coal Gas

Hydrogen + methane + Ethylene + Acetyene + CO +Nitrogen

Produced By fractional distillation

4. Natural Gas

Methane(83%) + Ethane

Produced From petroleum

5.Liquefied Petroleum Gas (LPG)

Propane and Butane + Others present in traces or small fractions are Iso-butane, butylene, n-butane, propylene etc.

Produced From petroleum (LPG is normally odorless, small amounts of a pungent gas such as ethanethiol (also known as ethyl mercaptan)

6.Compressed Natural Gas (CNG)

Methane (CH_4) 95% (methane stored at high pressure) can be used in place of gasoline (petrol), Diesel fuel and propane/LPG)

Produced From petroleum

7.Biogas or Gobar Gas

Methane (CH_4) + Carbon dioxide (CO_2) + Hydrogen (H_2)+ Nitrogen (N_2)

Produced From organic wastes

Physical and Chemical Changes

- Physical changes are the change, which only affect the physical properties like colour, hardness, density, melting point etc. of matter, but do not affect the composition and chemical properties of matter.

- A physical change is temporary, while a chemical change is permanent.

- Crystallisation, sublimation, 'boiling, melting, vaporisation, cutting of trees, dissolving sugar or salt in water etc. are physical changes.

- Chemical changes affect the composition as well as chemical properties of matter and result in the formation of a new substance

- Burning of fuel, burning of candle and paper, electrolysis of water, photosynthesis, ripening of fruits etc, are examples of chemical changes

Coal

Coal is obtained by carbonization of vegetable matter and is available in different varieties:

- Peat- 60% C
- Lignite or Brown Coal – 70% C
- Bituminous – 60 to 80 % C
- Anthracite Coal – 90% C

TRICK to Remember Coal Varities is PLBA (carbon content increasing from peat to anthracite)

FLAME

Flame contains three parts

1. Innermost Part- which is black due to the presence of unburned carbon particles- has lowest temperature.

2. Middle part – is yellow due to incomplete combustion of fuel.

3. Outermost part- which is blue due to complete combustion of fuel is the hottest and used by goldsmith to heat the gold.

Fire Extinguishers

- Water extinguishes fire because as it evaporates, the vapours surround the burning substance,

cutting off the oxygen supply, thus inhibiting burning process.

- In case of electrical or oil (petrol) fires, water cannot be used as extinguisher.

  This is because water is a conductor of electricity and heavier than oil. Thus, oil floats over it and continues to burn.
- Carbon dioxide, which is generated by the reaction of baking soda with acid, is used for electrical or oil fires.

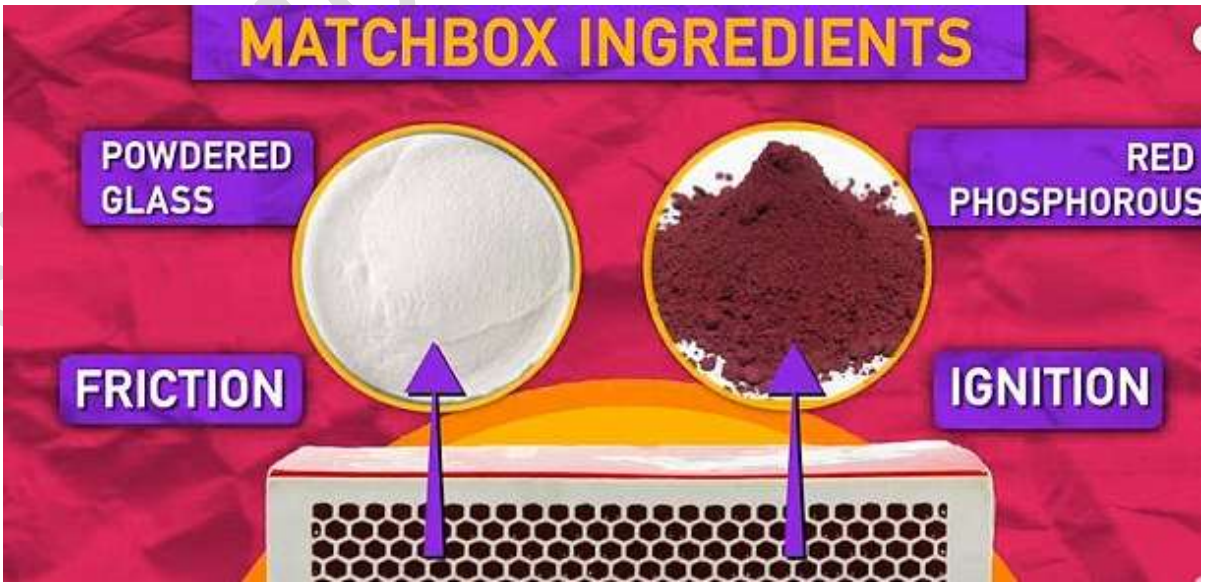
Quality of petrol is measured in terms of octane number and that of diesel in terms of cetane number.

Safety Matches

The match heads
contain **sulfur** (sometimes **antimony** tri**sulfide**)

and **oxidizing** agents (usually **potassium chlorate**), with powdered glass, colorants, fillers, and a binder made of glue and starch.

The striking surface consists of powdered glass or silica (sand), red **phosphorus**, binder, and filler.



Acids, Bases and Salts

Acids

- These are the substance, which have sour taste and turn blue litmus red.
- These are good conductor of electricity in aqueous solution.
- Pickels are always kept in glass jar because acid present in them reacts with metal to produce hydrogen gas.

Bases

- These are the substances, which have bitter taste and turn red litmus, blue.
- They give different colours in acid and base solutions.

Salts

These are the product of neutralisation reaction between an acid and a base.

 # pH is the measure of acidity/basicity.

Some Important Gases/Chemicals

Carbon Dioxide

It is an acidic oxide of carbon and is used by green plants for photosynthesis.

It does not help in burning.

Air and our breath contain carbon dioxide.

Thus, when lime water is kept in air or we pass our breath into it, the lime water turns milky.

Carbon Monoxide

It is a neutral oxide of air and has more affinity towards haemoglobin than oxygen (about 200 times more).

That's why in the environment of carbon monoxide – which is a non- poisonous gas - people die for the need of oxygen.

It is dangerous to sleep in an unventilated room with fire burning inside because the fire produces carbon monoxide and carbon dioxide gases.

Plaster of Paris

It is chemically calcium sulphate hemihydrate ($CaSO_4.1/2H_2O$)

and is prepared by heating gypsum – which is calcium sulphate dehydrate ($CaSO_4.2H_2O$) at 373 K.

On Mixing with water, plaster of Paris further sets into a hard solid, called gypsum.

USES :-- it is used to plaster fractured bones, for making toys, materials for decoration and for making surfaces smooth.

Portland Cement

- It is a complex mixture of silicates and aluminates of calcium with small amount of gypsum.
  Raw materials used for the manufacture of Portland cement are limestone and clay.

- The composition of Portland cement is calcium oxide (50-60%), alumina (5-10%), and magnesium oxide (2-3%).
  Gypsum is added to cement to decrease its rate of setting.

- In cement, if lime is in excess, cement cracks during setting and if lime is less, cement is of weak strength.

Mortar

a mixture of sand, cement and water is used for joining bricks and plastering walls.

Concrete—

a mixture of gravel, sand, cement and water is used for flooring and making roads.

Reinforced Concrete Cement (RCC)—

which is concrete with steel bars and wires is used for constructing roofs, bridges and pillars

Glass

Glass is a non-crystalline amorphous solid that is often transparent

Glass—an amorphous solid or super- cooled liquid—contains mainly silica (SiO_2).

Different substances are added to obtain glass of different colours

Colour	Substance Added
Red	Copper oxide (CuO)
Green	Chromium oxide (Cr_2O_3)
Blue	Cobalt oxide (Co0)
Brown	Iron oxide (Fe_2O_3)

Heavy water

Heavy water is water that contains heavy hydrogen or deuterium.

Deuterium differs from the hydrogen usually found in water, protium, in that each atom of deuterium contains a proton and a neutron.

Heavy water may be deuterium oxide, D_2O or it may be deuterium protium oxide, DHO.

Heavy water occurs naturally, although it is much less common than regular water.

Approximately one water molecule per twenty million water molecules is heavy water.

Hard Water

The water in which soluble bicarbonates of calcium and magnesium are present, is called temporary hard water

and in which soluble sulphates and chlorides of magnesium and calcium are present is called permanent hard water.

How to Remove hardness of Water ?

The temporary hardness of water is removed by boiling or by adding calcium hydroxide, $Ca(OH)_2$— the Clark's process

The permanent hardness of water is removed by adding sodium carbonate (Na_2CO_3), or calgon (sodium hexametaphosphate, $Na_2[Na_4(P03)$

Hardening of Oil (Hydrogenation)

Oil, an unsaturated fat when heated with nickel catalyst and hydrogen gets converted into a solid mass, called ghee, a saturated fat.

This process is called hardening of oil and is carried out through hydrogenation in the presence of nickel as a catalyst.

Ores –

Those minerals from which the metals are extracted commercially and economically and with minimum effort are called Ores of Metals.

For Example :-

1. Aluminum (Al)

Ores are (a) Bauxite (b) Corundum (c) Kryolite

$Al_2O_3 2H_2O$ Al_2O_3 Na_3AlF_6

2. Iron (Fe)

Ores are (a) Hematite (b) Magnetite (c) IronPyrite (d) Siderite

Fe_2O_3 Fe_3O_4 FeS_2 $FeCO_3$

3. Copper (Cu)

Ores are (a) Copper Pyrite (b) Copper Glance (c) Malachite

$CuFeS_2$ Cu_2S $2CuCO_3Cu(OH)_2$

4. Zinc (Zn)

(a) Zinc Blende (b) Calamine

ZnS $ZnCo_3$

5. Sodium (Na)

Ores are (a) Rock Salt (b) Sodium Carbonate

NaCl Na_2CO_3

6. Potassium (K)

Ores are (a) Karnalite (b) Salt Petre

KClMgCl6H2O KNO3

7. Lead (Pb)

Ores are (a) Galena (b) Anglesite

PbS PbCl2

8. Tin (Sn)

Ores are (a) Tin Pyrites (b) Classiterite

Cu2FeSnS4 SnO2

9. Silver (Ag)

Ore is Silver Glance Ag2S

10. Gold (Au)

Ores are (a) Calve rite (b) Sybarite

$AuTe_2$ $AgAuTe_2$

11. Mercury (Hg)

Ores are (a) Cinnabar (b) Calomel

HgS Hg_2Cl_2

12. Magnesium (Mg)

Ores are (a) Dolomite (b) Karnalite

$MgCO_3CaCO_3$ $KClMgCl_26H_2O$

13. Calcium (Ca)

Ores are (a) Lime Stone (b) Dolomite

$CaCO_3$ $MgCO_3CaCO_3$

14. Phosphorous (P)

Ores are (a) Phosphorite (b) Floreopetite

$Ca_3(PO_4)CaFe_2$ $3Ca_3(PO_4)CaFe_2$