CHEMISTRY

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

Physical and Chemical Changes

- Physical changes are the changes 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.

MATTER

- Anything which occupies space and has mass is called matter. In general, it exists in three states i.e., solid, liquid and 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 temperature with extremely low density)

Boiling Point

- The temperature at which liquid converts into vapour is called its boiling point.
- Boiling point of water is 100°C.
- The boiling point increases in the presence of impurities. That's why the 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 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

- An atom is the smallest particle of the element that can exist independently and retain all its chemical properties.
- Atom is made up of electrons, protons and neutrons.
- Protons and neutrons reside in the nucleus (at the centre of the atom) whereas electrons revolve around the nucleus.
- A molecule is the smallest part of an element or a compound capable of independent existence under ordinary conditions.
- Element contains only one type of atom. e.g. carbon (C), sulphur (S), diamond, graphite etc
- Oganesson, with symbol Og and atomic number 118 is a recent element synthesised.
- **Ununseptium** (a superheavy chemical element with atomic number 117) is a member of group-17 in the periodic table below the five halogens (fluorine, chlorine, bromine, iodine and astatine). Its synthesis was claimed in Dubna, Russia by a joint Russian-American collaboration.
- In 2014, the GSI Helmholtz Centre for Heavy Ion Research in Germany also claimed to have successfully repeated the original experiment.

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

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.

Colloids

- These are heterogeneous solutions, containing two phases : dispersed phase and dispersion medium.
- These show Tyndall effect (i.e. scattering of light by colloidal particles) and Brownian motion (zig-zag motion).
- Colloids can be dispersion medium loving (i.e. lyophilic) or dispersion medium repelling (i.e. lyophobic).

Some Colloids and their Example

Dispersed Phase	Dispersion Medium	Type of Colloid	Example
Liquid	Gas	Aerosol	Fog, clouds, mist
Solid	Gas	Aerosol (solid)	Smoke, automobile exhaust

Gas	Liquid	Foam	Shaving cream
Liquid	Liquid	Emulsion	Milk, face cream
Solid	Liquid	Sol	Mud, milk of magnesia
Gas	Solid	Foam	Foam, rubber, sponge, pumice
Liquid	Solid	Gel	Jelly, cheese, butter
Solid	Solid	Solid so	Milky glass, coloured gem stone

Battery

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

- ➔ **Primary batteries** (non-rechargeable) act as galvanic cells, e.g. dry cell, mercury cell etc.
- ➔ **Secondary batteries** (rechargeable) act as galvanic as well as voltaic cells e.g. lead storage battery, nickel cadmium battery etc.

In electrolytic refining, anode is made by impure metal and a strip of pure metal acts as cathode.

Types of Batteries

Battery	Anode	Cathode	Electrolyte	Used in
Leclanche cell	Zinc	Graphite	Paste of ammonium chloride and zinc chloride	Transistors, clocks
Mercury cell	Zinc-mercury amalgam	Paste of HgO (Mercuric oxide) and carbon	Paste of KOH and ZnO	Hearing aids and camera
Lead storage battery	Lead	Lead packed in lead dioxide	38% solution of sulphuric acid	Automobiles, invertors

Corrosion

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

- ➢ When iron is exposed into air, iron surface turns red due to the formation of hydrated ferric oxide (Fe2O3 x H_2 O) which is also called rust, silver surface turns black due to the

formation of silver sulphide (Ag_2S) and copper or bronze surfaces turn green due to the formation of basic copper carbonate, $Cu(OH)_2 .CuCO_3$.

- Corrosion of iron is called rusting and is accelerated by the presence of impurities, H + , electrolyte such as NaCl and gases like CO_2 , SO_2 , NO_2 etc.

- Corrosion is prevented by electroplating, oiling, greasing, painting, varnishing and by galvanisation (i.e. deposition of zinc layer over iron articles).

- A sliced apple, when exposed to air, turns brown after some time. This is because apple contains iron, which gets oxidised and gives a brownish colour to apple

Renewable and Non-renewable Natural Resources

- Renewable resources are available in large excess, i.e. never ends, e.g. air, sunlight etc.

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

Coal

Coal is obtained by carbonisation of vegetable matter and is available in different varieties : Peat (60% C), lignite or brown coal (70% C), bituminous coal (60% to 80% C), anthracite coal (90% C). Out of these, bituminous is the most common form.

Flame

Flame contains three parts:

1. Innermost part is black due to the presence of unburnt carbon particles and has lowest temperature.

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

3. Outermost part is blue due to complete combustion of fuel, which is the hottest part and used by goldsmiths 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 the burning process.

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

- Quality of petrol is measured in terms of octane number and that of diesel in terms of cetane number. TEL (TetraEthyl Lead) is an antiknock compound. Higher the octane number better is the quality of fuel.

Fuels

- The substance, which produces heat and light on combustion are called fuels.
- A strong foul smelling substance, called ethyl mercaptan, C H SH 2 5 , is added to LPG to detect its leakage as LPG is an odourless gas.
- The amount of heat obtained, when 1g of a fuel is burned in excess of oxygen is called calorific value.
- Vehicles carrying inflammable substances have metallic ropes, touching the ground during motion in order to provide earthing for lightning.
- Fuels used in rockets are called rocket propellants. A mixture of liquid hydrogen and liquid oxygen is the most common rocket propellant.

Some Important Fuels and their Compositions

Fuel	Composition	Sources
Water Gas	Carbon monoxide (CO) + Hydrogen (H_2)	By passing steam over red hot coke
Producer Gas	Nitrogen (N_2) + Carbon monoxide (CO) (2 : 1 ratio)	By passing insufficient air over red hot coke
Coal Gas	Hydrogen + Methane + Ethylene (C_2H_4) +Acetylene (C_2H_4) + CO + Nitrogen	By fractional distillation of wood

Natural Gas	Methane (83%) + Ethane (16%)	From petroleum
Liquified Petroleum Gas (LPG)	Butane (C_4H_8) + Propane ($C_3 H_6$)	From oil wells
Compressed Natural Gas (CNG)	Methane (CH_4) 95%	From petroleum
Biogas or Gobar Gas	Methane (CH_4) + Carbon dioxide (CO_2) + Hydrogen (H_2) + Nitrogen (N_2)	From organic wastes

Calorific Value of Some Substances

Fuel	Calorific Value (kJ/g)
Coal	25-32
Kerosene oil	48
Petrol	50
Diesel	45
Biogas	35-40
LPG	50
Cow dung	6-8
Hydrogen	150
Natural gas	35-50

Safety Matches

In safety matches, the stick consists of a mixture of antimony trisulphide and potassium chlorate at its one end. The box side contains a mixture of powdered glass and red phosphorus.

ACIDS, BASES AND SALTS

Acids

- These are the substances, which have a sour taste and turn blue litmus red.
- These are good conductors of electricity in aqueous solution.
- Pickles 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 a bitter taste, are soapy to touch and turn red litmus blue.

- ➢ Bases like NaOH, KOH, etc. are good conductors of electricity in their aqueous solution and in molten state.
- ➢ Base reacts with acid to form salt and water.

Salts

- ➢ These are the product of neutralisation reactions between an acid and a base.

- ➢ pH is the measure of acidity/basicity

Important Links for Judiciary Free Resources (Click on Each to Open Respective Pages)	
Subject Wise Mains PYQ Solution	Essay for Judiciary
Subject Wise Notes	Legal Doctrines
Landmark Judgements	GS Notes
Weekly Current Affair	Subject Wise Prelims PYQ Solution
Free Answer Writing Course	Judgement Writing
Telegram Link	Youtube Link

Some Important Compounds in Everyday Life

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 produce carbon monoxide and carbon dioxide gases

Plaster of Paris

- ➢ It is chemically calcium sulphate hemihydrate ($CaSO_4$ ½ H_2O) and is prepared by heating gypsum which is calcium sulphate dihydrate ($CaSO_4$ $2H_2O$) at 373 K

- On mixing with water, Plaster of Paris further sets into a hard solid, called gypsum. Thus, 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 a 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.

Soaps

These are sodium and potassium salts of higher fatty acids, e.g. sodium palmitate, sodium stearate, etc

Glass

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

- Different substances are added to obtain glass of different colours e.g.

Colour	Substance Added
Red	Copper oxide (CuO)
Green	Chromium oxide (Cr_2O_3)
Ruby Red	Gold chloride ($AuCl_3$)
Blue	Cobalt oxide (CoO)
Brown	Iron oxide (Fe_2O_3)

Pesticides

These chemicals are used to destroy the organisms that harm the crop. These are of following type:

Insecticides e.g. DDT, gammaxene, aluminium phosphate.

Fungicides e.g. Bordeaux mixture, organo-mercury compounds.

Herbicides e.g. Benzipram, sodium chlorate

Rodenticides e.g. Aluminium phosphide.

Heavy Water

Heavy water is **deuterium oxide** (D O), 2 molecular mass =20) which is used as a moderator in nuclear reactors. It is called heavy due to the presence of deuterium, the heavy hydrogen.

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.

- ➔ 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, $Na_2 [Na_4 (PO_3)_6]$

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.

Medicines

These are the chemicals used for treating diseases and reducing suffering from pain.

Different Medicines and their Examples

Medicine	Used to	Example
Analgesics	Reduce pain	Aspirin, paracetamol, morphine, phenacetin
Tranquillisers	To treat stress, mild and severe mental diseases	Equanil, valium, chlordiazepoxide, serotonin and meprobamate
Antiseptic	Prevent the growth of microorganisms or kill them (applied to living tissues)	Dettol (a mixture of chloroxylenol—the antiseptic and α-terpineol), savlon, iodine tincture (solution ofl 2 in alcohol water mixture), boric acid (antiseptic for

		eyes), hydrogen peroxide, iodoform
Antibiotic	Destroy microorganisms (These are obtained from microorganisms.)	Penicillin (discovered by **A Fleming** in 1929, ampicillin, amoxicillin, ofloxacin, chloramphenicol)
Antimalarial	Cure malaria	Chloroquine
Sulfa Drugs	Alternative for antibiotics	Sulphanilamide, sulphadiazine
Antacids	Reduce acidity	Baking soda, magnesium hydroxide

Polymers

- A polymer is a compound of high molecular weight formed by the combination of a larger number of molecules of one or two types of low molecular weight (known as monomers) and the process is called polymerisation.

- Polymers are the backbones of four major industries; plastics, fibres, paints and varnishes.

Some Fibres and their Monomers

Fibre	Monomers	Uses
Nylon-6,6	Adipic acid + hexamethylene diamine	In making bristles for brushes, synthetic fibres, parachutes, as a substitute for metal in bearings
Nylon-6 or perlon	Caprolactum	In making fibres, plastic tyre cords and ropes.
Terylene	Ethylene glycol and terephthalic acid	For making wash and wear fabrics, tyre cords, safety belts, tents etc
Kevlar	Terephthalic acid + 1,4-diamino benzene	For making bulletproof vests.
Lexan or polycarbonate	Diethyl carbonate + bis-phenol-A	In making bulletproof windows and safety helmets.
Polyurethanes	Toluene diisocyanate + ethylene glycol	For making washable and long lasting mattresses, cushions

Some Important Industrial Compounds

Industrial Name	Chemical Name	Chemical Formula
Alum	Potassium aluminium sulphate	$KAl(SO_4)_2$ 12H2O
Alcohol	Ethyl alcoho	C_2H_5OH
Baking soda	Sodium bicarbonate	$NaHCO_3$
Bleaching powder	Calcium oxychloride or calcium hypochlorite	$CaOCl_2$
Brine (or common salt)	Sodium chloride	NaCl
Borax	Sodium tetraborate decahydrate	$Na_2B_4O_710H_2O$
Caustic potash	Potassium hydroxide	KOH
Caustic soda	Sodium hydroxide	NaOH
Chalk (marble) or pearl	Calcium carbonate	$CaCO_3$
Chilli salt petre	Sodium nitrate	$NaNO_3$
Chloroform	Trichloromethane	$CHCl_3$
Epsom salt	Magnesium sulphate	$MgSO_47H_2O$
Glauber's salt	Sodium sulphate decahydrate	Na_2SO_4 $10H_2O$
Gypsum	Calcium sulphate dihydrate	$CaSO_4$ $2H_2O$
Hypo	Sodium thiosulphate pentahydrate	$Na_2S_2O_3$ $5H_2O$
Laughing gas	Nitrous oxide	N_2O
Lunar caustic	Silver nitrate	$AgNO_3$
Marsh gas	Methane	CH_4
Quick lime	Calcium oxide	CaO
Sal ammonia (Nausadar)	Ammonium chloride	NH_4Cl
Sapphire (Ruby)	Aluminium oxide	Al_2O_3
Slaked lime	Calcium hydroxide	$Ca(OH)_2$
Soda ash	Sodium carbonate	Na_2 CO_3
Spirit	Methyl alcohol	CH_3OH
Washing soda	Sodium carbonate decahydrate	Na_2CO_3 $10H_2O$

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