CHEMISTRY

CHEMISTRY is the science of the nature, composition and properties of material substances, and their transformations. In modern terms, chemistry deals with elements and compounds, with the atoms and molecules of which they are composed, and with the reactions between them, it is thus basic to natural phenomena and modern technology alike. Chemistry may be divided into five main parts: organic chemistry, the study of carbon compounds; inorganic chemistry, dealing with all the elements, except carbon, and their compounds; chemical analysis, the determination of what a sample contains and how much of each constituent is present; biochemistry, the study of the complex organic compounds in biological systems; and physical chemistry, which underlies all the other branches, encompassing the study of the physical properties of substances and the theoretical tools for investigating them.

A chemical ELEMENT is a simple substance composed of atoms of the same atomic number, and so incapable of chemical degradation or resolution. Elements are generally mixtures of different isotopes. Of the 106 known elements, 88 occur in nature and the rest have been synthesized. The elements are classified by physical properties as metals, metalloids and nonmetals, and by chemical properties and atomic structure according to the periodic table. Most elements exhibit allotropy (i.e. they occur in more than one form) and many are molecular (e.g. oxygen, O_2). The elements have all been built in stars from hydrogen by complex sequences of nuclear reactions.

The smallest particle of an element or compound, which can exist independently, is called a MOLECULE. A molecule contains two or more atoms bonded together in small whole numbers, e.g. O_2, a molecule of oxygen.

The ATOM is the smallest particle of an element that can exist. Atoms are the building blocks of which everything is made. They are made up of even smaller subatomic particles (protons, neutrons, and electrons). The proton and electron carry equal but opposite charges. The atom as a whole is neutral; hence the number of protons always equals the number of electrons. All atoms of the same element have the same number of protons and hence the same atomic number, but atoms of the same element may have different numbers of neutrons (isotopes). Atoms are the smallest part of an element that can take part in a chemical reaction.

An atom which has become electrically charged by gaining or losing electrons is called an ION. Cations are positively charged, e.g. Na^+, and anions are negatively charged, e.g. O^{2-}. Atoms tend to lose or gain electrons to produce an ion with the same electron configurations as a noble gas. Groups of atoms (radicals) may also form ions.

A pure substance which is made of atoms of two or more elements chemically bonded together is called a COMPOUND. The properties of compounds are quite different from the properties of the elements from which they are made, e.g. sodium is a poisonous metal which reacts very violently with water, chlorine is a poisonous gas with a choking smell, yet sodium chloride is used in cooking and is essential to life. The atoms in a compound may be held together by either ionic or covalent bonds: e.g. methane CH_4, water H_2O, sodium chloride NaCl.

The number of bonds which an atom forms with other atoms is called VALENCY. More precisely, the valency of an element is the number of electrons that it needs to form a compound or radical. The electrons may be lost, gained or shared with another atom.

An ACID is a substance which releases hydrogen ions (H^+) when added to water. Acid solutions have a pH of less than 7. Common laboratory acids are nitric acid (HNO_3), hydrochloric acid (HCl), sulfuric acid (H_2SO_4), ethanoic acid (CH_3COOH), and citric acid ($C_6H_8O_7$). Strong acids ionize completely in water, weak acids only partially. Acids turn blue litmus red, give carbon dioxide when added to carbonates, give hydrogen when added to certain metals, and neutralize alkalis.

A BASE is a substance which reacts with an acid to form a salt and water only. Bases are usually metal oxides or hydroxides, e.g. sodium hydroxide (NaOH), copper oxide (CuO), metal oxides and hydroxides which are soluble in water are known as alkalis. An alkali is a base which is soluble in water. Alkalis are usually metal hydroxides, e.g. sodium hydroxide. Ammonia solution is also an alkali. Alkalis turn red litmus blue, neutralize acids, have a pH of more than 7, and react with acids to produce a salt and water only.

SALTS are compounds formed when the hydrogen of an acid is totally or partially replaced by a metal. When an acid reacts with a metal the result is a salt and hydrogen gas. When an acid reacts with a base the result is a salt and water. The name of the salt is derived from the metal and the acid used, e.g. sulfates (sulfuric acid), nitrates (nitric acid), chlorides (hydrochloric acid).

CARBOHYDRATES are organic compounds which contain the elements carbon (C), hydrogen (H) and oxygen (O) and have the general formula $(CH_2O)_n$. There are three main groups of carbohydrates monosaccharides (glucose, fructose, ribose), disaccharides (maltose, sucrose) and polysaccharides (cellulose, starch, glycogen). Simple carbohydrates, particularly glucose, are the energy source within living cells. Long chain carbohydrates form some structural parts of cells, for example cellulose in plant cell walls. They also act as food reserves, for example glycogen in animals and starch in plants.

HYDROCARBONS are organic compounds which contain only hydrogen and carbon. Some hydrocarbons occur in plant oils, but the largest sources of all kinds of hydrocarbons are petroleum, natural gas and coal gas. They are used as fuels, for lubrication, and as starting materials for a wide variety of industrial syntheses. Common hydrocarbons include methane (CH_4), ethane (C_2H_6), and propane (C_3H_8)

ALCOHOLS are organic compounds obtained from hydrocarbons by the replacement of one or more

hydrogen atoms with hydroxyl (OH) radical. Examples of alcohols are ethanol (ethyl alcohol), methanol, glycol, and glycerol.
FATS or lipids are organic compounds which contain elements carbon, hydrogen and oxygen. They are made up of three fatty acid molecules (which may be the same or different) bonded to one glycerol molecule. Fat deposits under the skin act as a long-term energy store. These deposits also provide heat insulation. Fat is also an important constituent in the cell membrane. Its insolubility in water is utilized in the waterproofing systems of many organisms.
PROTEINS are organic compounds containing the elements carbon, hydrogen, oxygen, nitrogen and sometimes sulfur. A simple molecule of protein consists of a long chain of subunits called amino acids. These chains may be joined to other chains and folded in several different ways, resulting in very large and complex molecules. Proteins are the building blocks of cells and tissues, being important constituents of muscle, skin, bone, etc. Proteins also play a vital role as enzymes. Some hormones also have a protein structure.
A CHEMICAL CHANGE is a change in which one or more chemical substances are changed into different substances by the breaking and making of chemical bonds between the atoms. Chemical change is usually accompanied by the giving out or taking in of heat energy (exothermic vs. endothermic reactions).

carbonate
nitrate
phosphate
sulfate

chloride
dioxide
fluoride
hydrogen chloride
hydroxide
iodide
oxide

aluminum
calcium
carbon
copper
fluorine
hydrogen
iron
lead
magnesium
mercury
nitrogen
oxygen
phosphorus
potassium
silicon
sodium
sulfur

alloy
ammonia
catalyst
chain reaction
combustion
concentration
corrosion
decomposition
dissociation
electrolysis
equation
fermentation
fission
formula
mixture
ore
oxidation
photosynthesis
precipitate (v. / n.)
solution
solvent