CHEMISTRY

SALT

A salt is the compound formed when the hydrogen ion of an acid is replaced by a metal. Some salts occur in nature such as common salt in sea water and calcium trioxocarbonate (iv) (chalk on rocks).

TYPES OF SALT

There are five main types of salt

Normal salt: They are formed when all the replaceable hydrogen ions in an acid has been completely replaced by a metal. They are neutral and have a PH of 7.

$H_2SO_4 + 2NaOH – Na_2SO_4 + 2H_2O$

Acid salt: they are formed when the replaceable hydrogen ions in an acid are partially replaced by a metal. They have PH less than 7.

$H_2SO_4 + NaOH – NaHSO_4 + H_2O$
$H_2SO_4 + KOH – KHSO_4 + H_2O$

Basic salt: They are formed when there is partial replacement of the hydrogen ion in a metallic hydroxide (base) by an acidic ion.

$Ba(OH)_2 + HCl – Ba(OH)Cl + H_2O$
$Zn(OH)_2 + HCl – Zn(OH)Cl + H_2O$
They have PH greater than 7.

Double salt: They are formed when two salts crystallize from solution in definite proportion by mass. They contain two different cations. They have the general formula $M_2 + (SO_4)$. $M_2^{3+}(SO_4)_3.24H_2O$ where M^+ is a monovalent metal (eg K^+, Na^+, NH_4) and M^{3+} a trivalent metal (e.g: Al^{3+}, Cr^{3+} or Fe^{3+}).

Complex salt: They are salt composed of several parts each of which has some independent existence in solution as an ion, molecule or atom, eg: Potassium ion (iii) hexacyanide, $K_2Fe(CN)6$ and Potassium ion (ii) hexacyanide, $K_4Fe(CN)6$. Generally, complex salts are referred to as complex formation or complex ion or complexes. The transition metal ions and their atoms show a great tendency to form complex ion and molecules. The ions or molecules that donate electrons with the transitions metal are called the ligands. The formula of a complex ion is Mln, where n is usually 2, 4 or 6, L is a Lingand and M a transition metal.

GENERAL METHOD OF PREPARATION AND USES

Neutralization of an acid by a base to give salt and water only.

II. Reaction of an acid with a reactive metal e.g: Zinc and tetraoxosulphate (vi) acid.
III. Reaction of an acid with a metal oxide e.g: H_2SO_4 with copper (ii) oxide.
IV. Reaction of an acid with a trioxocarbonate (iv) acid and lead (ii) trioxocarbonate (iv)
Two soluble salt reacting to precipitate an insoluble salt.
VI. Direct combination of a metal and non metal.

METHODS OF PREPARING SOLUBLE SALT

By direct displacement of the hydrogen ion in acid by a metal more reactive than hydrogen. $Zn + 2HCl_{(aq)} – ZnCl_{(aq)} + H_2$

Reaction between an alkali and an acid

$H_2SO_{4(aq)} + CuO_{(s)} – Cu_2SO_{4(aq)} + H_2O_{(L)}$

Dilute acid and insoluble base

$H_2SO_{4(aq)} + CuCO_{3(aq)} – CuSO_{4(aq)} + H_2O_{(L)} + CO_{2(g)}$

Action of dilute acid on trioxocarbonate (iv)

$H_2SO_{4(aq)} + CuCO_{3(aq)} – CuSO_{4(aq)} + H_2O_{(L)} + CO_{2(g)}$

PREPARATION OF INSOLUBLE SALTS

By double decomposition: It involves two soluble compounds One containing a metallic radical and other acidic radical.

$AgNO_{3(aq)} + NaCl_{(aq)} – AgCu_{(s)} + NaNO_{3(aq)}$

Combination of constitute element: $Fe_{(s)} + S_{(s)} – FeS_{(s)}$

SOLUBILITY OF SALT

All common salt of sodium, K and NH_4 are soluble

All Trioxonitrate (v) salt (NO_3) are soluble

All the common chloride (Cl) salt are soluble except those of silver, lead and mercury.

All the common tetraoxosulphate salts (SO_4^{2-}) are soluble except lead, barium, Calcium.

CHARACTERISTICS OF SALTS

Deliquescent Salts

These are salts that absorb moisture and form solution when exposed to the atmosphere. They are sometimes used as drying agent. The phenomenon is known as deliquescence egs. NaOH, KOH, $MgCl_2$, $CaCl_2$ etc.

Hygroscopic Salt

These are salts that absorb moisture without forming solution when exposed to the atmosphere. They are used as drying agents and are known as desiccants. The phenomenon is hygroscopic eg. CuO (COpper (ii) oxide, CaO (Calcium (ii) oxide and conc H_2SO_4.

Efflorescent Salt

These are salts that contains a definite amount of water known as water of crystallization, such salts are described as hydrated salt and when heated. The gives off their water of crystallization. When they lose the water of crystallization, they become anhydrous salt. The phenomenon is efflorescence. It is the process whereby hydrated salt lose their water of crystallization when exposed to the atmosphere eg.

Copper (ii) tetraoxosulphate (vi) pen hydrate

$CuSO_4.5H_2O – CuSO_4 + 5H_2O$

(Blue) (Colourless)

USES OF COMMON SALT

Zinc chloride is used in refining petroleum.

Sodium chloride is used for preserving food and glazing pottery.

Potassium trioxonitrate (v) is used for making gun powder, matches and as soil fertilizers.

Magnesiun tetraoxosulphate (vi) is used as a laxative.

It is used in soap making.

Calcium trioxocarbonate (iv) is used as a medicine to neutralize the acidity in the stomach.

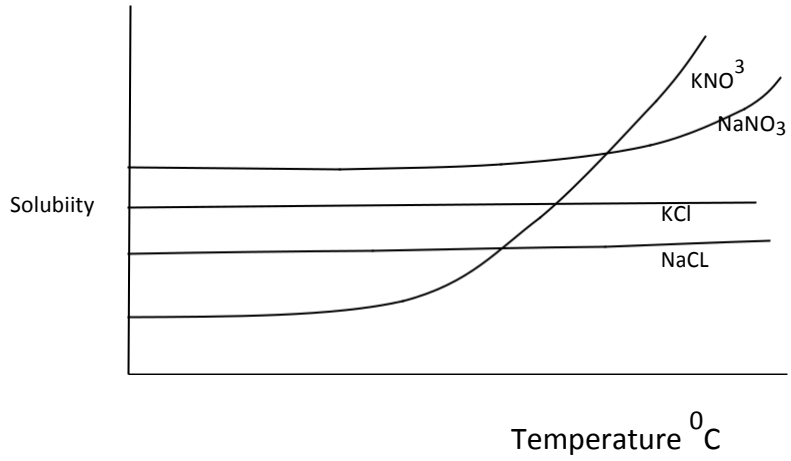
Copper (ii) tetraoxosulphate (vi) is used in drying and calico printing.

Sodium chloride is used in preserving perishable food.

SOLUBILITY OF SALTS

Solubility can be defined as the number of moles of the solid that would dissolve in |dm^3 of the liquid at the given temperature in the presence of excess of the solid. The concentration of a saturated solution is termed the solution of the substance. A saturated solution is one in which given solute dissolves in a given solvent such that no more of the solute will dissolve in the solvent at the temperature of dissolution while unsaturated solution is one which contains less solute at the given temperature.

Solubility curve



The graph of solubility against temperature is called solubility curves.

USES OF SOLUBILITY CURVES

A given mixture of solutes can be separated or purified by fractional crystallization.

The curve enables researchers to determine most suitable solvents to use and at what temperatures to extract certain chemicals from different natural sources.

The curves enable the pharmacist to determine the amount of solid drugs that must be dissolved in a given quantity of solvent to give a prescribed drug mixture.

FACTORS THAT AFFECTS SOLUBILITY

Nature of solvent and solute.

Temperature.

Pressures: Change in pressure affects the solubility of solid and liquid.

SUSPENSION

A solid is said to be in suspension in a liquid when small particles of it are contained in the liquid but not dissolved in it.

CALCULATIONS

Example 1:

If 4.28g of KNO_3 were dissolved in 17.1g of distilled water at 15^{0c}. Calculate the solubility of the solvent $moldm^{-3}$, (K = 39, N = 14, O = 16).

SOLUTION

Molar mass of KNO_3 = 39 + 14 + 16 x 3 = 101g

A.28g of KNO_3 = $\frac{4.28}{101}$ = 0.042moles

17.1g of water at 15^{0C} dissolved 0.042moles of KNO_3

$1000cm^3$ of water at 15^{0C} dissolved $\frac{4.28 \times 1000}{17.1} = 2.46$

Example 2:

When $100cm^3$ of a saturated solution $KClO_3$ at 40^{0C} is evaporated, 14g of the salts recovered. What is the solubility of $KClO_3$ at 40^{0C} ($KClO_3$ = 122.5)

Solution

Molar mass of $KClO_3$ = ~~122~~.5

No of moles of $KClO3 = \frac{14}{122.5} = 0.144$moles

At 40^{0C}, $100cm^3$ of the solution produces 0.114moles of $KClO_3$

$100cm^3$ of the solution will produce $\frac{0.114 \times 1000}{100} = 1.14$

Formular for solubility

$$\text{Solubility} = \frac{\text{mass}}{\text{volume}} \times \frac{1000}{1}$$

WATER

Water is a good solvent and occurs in its pure form in nature. Natural sources of water include; seawater, lake water, river water, spring water, well water.

Treated water is specially prepared four special purpose e.g are distilled water pipe borne water and chlorinated water .distilled water is chemically pure water prepared by condensing stem .water prepared using exchange resin is called deionized water. Distilled water is used in the laboratory for preparing reagent car batteries, drugs and in certain industrial processes.

Pipe bore water is prepared in a water treatment plant .it contains minerals solutes like sodium chlorides. Water from rainfall or river is stored in reservoir .it is prepared by various method which includes coagulation, sedimentation, filtration and disinfection.
The purified water is distributed to towns via underground pipes for domestic and industrial uses.

TYPES OF WATER

They are soft water and hard water. Hard water will not form lather readily with soap. it contains a number of dissolved salt, calcium hydrogen trioxocarbonate(iv). When soap is added to hard water, the dissolved salts in the water will react with the soap molecules

There are two types of hard water: We have temporary hard water and permanent hard water.
Temporary hardness of water can be easily removed by boiling, it is caused by the presence of dissolving calcium hydrogen trioxocarbonate(iv), $Ca(HCO_3)_2$.

It can also be removed by using slake lime, Ca(OH)2. Permanent hardness of water can only be removed by using chemicals. it is caused by the presence of calcium and magnesium ions in the form of soluble tetraoxosulphate (vi) and chlorides. Permanent hardness can be removed by precipitating the calcium and magnesium ions from solution.

EFFECT OF TEMPORARY HARDNESS

I. It causes furring of kettles and boilers due to the gradual deposition of calcium trioxocarbonate (iv) from the decomposition of calcium Hydrogen trioxocarbonate(iv).

   Stalagmites and stalactites: A calcium trioxocarbonatte (iv) structure growing downward from the roof of caves is known as stalactites while one growing upwards is known as stalagmite.

ADVANTAGES OF HARD WATER.

Hard water taste better than soft water because the dissolved mineral in it.
The calcium salts present in hard water when taken by animal, help to build strong teeth and bones.
Hard water helps animals such as snail crab to their shells.
Hard water can be supplied in pipes made of lead as this type of water does not dissolve lead.

DISADVANTAGES OF HARD WATER.

Hard water cannot be used in dyeing and tanning as the salts in it interfere with the mode of action of these processes.
Hard water causes furring of kettles and boilers while soft water does not.
For washing, Hard water requires a lot of soap before it can form a lather.

PROPERTIES OF WATER.

A good pure water must be free from impurities or dust /solid Particles.
It must be colourless.
It must be odourless.
It must be tasteless.

CARBON AND IT`S COMPOUND

Carbon is an extremely important element. it exists midway between metals and non-metals in the periodic table. it exhibits a valence of four {i.e it is tetravalent}. it also exhibits allotropy

ALLOTROPY

The ability of carbon to exist in various forms in the same physical state is known as allotropy. Diamond and graphite are two allotropic forms of crystalline carbon The others like coal, coke, charcoal, lampblack, sugar charcoal, and animal charcoal are amorphous or non-crystalline forms of carbon

DIAMOND

The diamond crystal is octahedral in shape. it is actually a giant molecule in which the carbon atom is closely packed and held together by strong covalent bonds. It is the hardest substance known, as a result only a diamond can cut a diamond, it has a high melting point, it is very dense and resistant to high temperatures and chemical attack. it is a non-conductor of electricity because there are no free valence electrons in the diamond crystals, as all of them are used in bond formation . they are used in industries in drills for mining, as abrasives to sharpen very hard tools and for cutting grass and metals. it has a sparkling brilliance when it is cut polished, making it valuable as jewelry.

GRAPHITE

It occurs naturally as plumb ago, an opaque black solid. it is soft and flakes easily because of its layered crystalline structure. it has a high melting point but is less dense than diamond. Graphite is a good conductor of electricity because of the presence of mobile electrons in the crystal lattice. It is an excellent dry lubricant

This is because it`s layered structure allows one layer to slide over another easily. Unlike oil, it is nonvolatile and not sticky, it is usually used on bicycle chains and for the bearings of some motor cars. A non-conductor may be made conductive by coating it with graphite. A mixture of graphite and clay is used as lead in pencils. and also used as black pigment in paint. Graphite occurs naturally but it can be produced industrially by heating coke in an electric furnace to a very high temperature for about 20 to 30hours. This process is called Acheson process; it requires a lot of energy.

GENERAL PROPERTIES OF CARBON.

1, It usually undergoes combustion.
2, It reacts with Sulphur at a high temperature to form carbon [iv] sulphide .
3, It reduce metallic oxides to metals.

AMORPHOUS CARBON

Carbon occurs in a number of other forms which have no definite crystalline structure. This is the soft form of carbon. Some of these non-crystalline forms includes:

Wood Charcoal: When wood is heated in the absence or limited supply of air, much of its carbon and most other elements in its various components are driven out as gases or volatile liquids. The residue is wood charcoal. This is fairly pure carbon. Its most useful property is its ability to absorb smoke and poisonous gases. For this reason, it is used in gas masks.

Animal Charcoal: If bones are heated in the absence of air, bone black or animal charcoal is obtained. Animal charcoal is carbon mixed with calcium (ii) tetraoxophosphate (v), $Ca_3(PO_4)_2$.It has the property of adsorbing colouring matter, and is used to decolourise crude sugar.

Carbon black, lamp black or soot: It can be formed whenever petroleum products, natural gas, wood or other carbon compounds burn in insufficient amount of air. Lampblack for example, forms in the chimney of kerosene lanterns. Soot is found above fireplace where Wood is burned. Carbon black is formed when petroleum, refinery oil gases or natural gas is burnt in a limited supply of air so that only the hydrogen is oxidized.

Gas carbon: This is a lamp black produced at high temperatures. It is found inside high-temperature coal retorts for the production of coal gas. It is found on the outside of cooking pots where firewood is the means of heating.

Sugar Charcoal: This is produced by dehydrating sugar with concentrated tetraoxosulphate (VI) acid. Sugar charcoal can be made either by burning sugar or by adding sugar to concentrated tetraoxosulphate (VI). In both cases, the carbon is thoroughly washed with water and dried. It is a very pure form of carbon. Charcoal has a high adsorptive capacity, this property of charcoal is utilized in the production of cane sugar. The concentrated sugar solution is filtered through charcoal to remove their yellow-brown color. Also in some systems of water purification, charcoal filtration is used to decolorize and deodorize the water. Charcoal has a strong affinity for oxygen and is a useful and Powerful reducing. The properties of amorphous carbon are:

It has a black opaque and dull colors.

- It has a density of 1.5 g / cm^3.

It is soft.

It burns in the air at about 500^{0C} to form carbon (iv)oxide.

- It is a good conductor of heat and electricity.

WOOD AND COAL AS SOURCES OF ENERGY

Wood and other biomass, as a source of energy for cooking, the firing of bricks and Pottery, manufacture of glass dyestuffs such as indigo and materials for tanning leather. Coal has been one of the most important fuels. Railway locomotive engines were run on coa Coal fires are used for cooking while laundry men use coal Iron for pressing clothes. Coal is a black organic rock, it is a very impure carbon, containing minerals and modified remains of substances present in the ancient trees and other plant life from which it was formed.

FORMATION OF COAL

When the great tree dies, they fell into the swamps and were buried under the Deep layers of sand and sediments carried by water. This period is known as the Carboniferous period. The great pressure of the weight of the sediments on top of the layers of dead vegetation caused it to turn into the hard, black rock known as coal.

TYPES OF COAL

These types of coal are arranged in the order of increasing rank.

Peat---------Lignite --------Bituminous coal ------- Anthracite.

Peat: It can be seen as coal in the making. Swamps were characterized by their high acidity very low oxygen content and a very low level of nutrients.

Lignite: As organic material matures into coal, chemical reactions occur which result in the loss of hydrogen, oxygen, and moisture. Lignite (Brown coal)is the youngest type of coal. The carbon content is about 71% compared to 60% in peat.

Bituminous coal (soft coal): It is the most abundant type of coal. The carbon content varies from 77 to 87% for all subclasses of bituminous coal.

Anthracite (hard coal): It represents the highest rank of coal. The carbon content is about 90%. When coal is heated to a very high temperature of about 1200 ^{oC} in the absence of air, it decomposes to give Four main products namely: Coal gas, coal tar, ammoniacal liquor, and Coke. This process known as destructive distillation involves heating a substance.

Coal--------- Coke + Ammoniacal liquor + Coal tar + Coal gas

Coal gas consists of a mixture of gases such as hydrogen, methane, carbon monoxide, ethane, and minute amounts of impurities such as sulfur (iv) Oxide and hydrogen sulfide, coal gas is used as a fuel in the industry.

Coal tar is a thick, brownish-black liquid. It is a mixture of many organic chemicals among which are benzene, toluenephenolphthalein, and anthracene. Coal tar is used to produce useful chemicals such as disinfectants.

Ammoniacal liquor contains mainly ammonia. It is used in the preparation of $NH_4(SO_4)_2$ which is used as a fertilizer.

Coke, the residue from the destructive distillation of coal is light and porous but chemically similar to hard coal. Coke is used as both industrial and domestic fuel.

COKE: GASIFICATION AND USES

Coke can be converted into gas. This is done by making Coke combine with oxygen of the air or with Steam. When coke combines with oxygen in the air, the product is known as producer gas. It is a mixture of one third carbon mono Oxide and two-third nitrogen by volume. The term producer gas refers to a simple arrangement for turning coke into gas. It depends on the fact that coke which is carbon burns in the oxygen of the air and gives carbon dioxide. Another way of turning Coke into gas is to make it white-hot and blow steam over it. The product obtained is known as water gas.