CONTN OF THERMOCHEMISTRY

2. ENTHALPY OF NEUTRALIZATION

The enthalpy o neutralization is the heat change that occurs when one mole of aqueous hydrogen ions completely reacts with one mole of aqueous hydroxide ions to form one mole of water. Essentially, the reaction that takes place during neutralization of any acid by any base is;

$$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$$

The enthalpy of neutralization of any strong acid and strong alkali is higher and almost constant. This is because strong acids and bases completely ionize in solution and produce many hydrogen and many hydroxyl ions respectively; which react to produce much heat; it is almost constant because in all cases the net reaction involved is the same i.e formation of water.

$$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}; \quad \Delta H = -57.3\text{kJ/mole}$$

The enthalpy of neutralization of a weak acid or alkali is less than lower (i.e less than 57.3 kJ mol^{-1}) and is not constant. This is because weak acids or alkalis are partly ionized in aqueous solution and Some heat is absorbed in causing ionization of the acid base.

Experiment to determine the enthalpy of neutralization of hydrochloric acid by sodium hydroxide.

50cm^3 of 2M sodium hydroxide is put in a plastic beaker and its temperature noted as T_1 from a thermometer.
50 cm^3 of 2M hydrochloric acid is also put in a separate plastic beaker and its temperature, T_2 noted.
Sodium hydroxide solution is transferred at once to the beaker of hydrochloric acid and the mixture stirred using a thermometer. The highest final temperature reached, T_3 is noted.
Treatment of results;
Total volume= 50+50=100cm^3
Mass of mixture = 100x1 =100g (assuming density =1g/cc)
Temperature change, $\Delta T = T_3 - \frac{[T_1 + T_2]}{2}$
Specific heat capacity = 4.2
Heat change = mass x SHC x temperature change
= $100 \times 4.2 \times \Delta T$
1000cm^3 of HCl contained 2mols
50cm^3 contained $\frac{2}{1000} \times 50 = 0.1$mol
0.1mol of HCl produced ($100 \times 4.2 \times \Delta T$)J
1 mole will produce $\frac{100 \times 4.2 \times \Delta T}{0.1}$
Enthalpy of neutralization = 4200ΔT Jmol^{-1}

NB: In this experiment, a plastic beaker or insulated calorimeter is used to reduce heat losses to the surrounding.

Examples

(b) $50cm^3$ of 2M nitric acid and $50cm^3$ of 2M potassium hydroxide solution both at 20ºC were mixed in a plastic beaker. The maximum temperature recorded was 37.2ºC.

(i) Give a reason why the plastic beaker was used in this experiment

(ii) Write an ionic equation for the reaction

(iii) Calculate the enthalpy of neutralization of sodium hydroxide by nitric acid. (assume density of solution =1g/cc and S.H.C =4.2 J g^{-1} $^oC^{-1}$)

Total volume= 50+50=100cm^3

Mass = 100x1 =100g

Heat change = mass x SHC x temperature change

= 100x4.2 x (37.2-20) = 7224J

1000cm^3 of sodium hydroxide contained 2mols

50cm^3 contained $\frac{2}{1000}$ X 50 = 0.1mol

0.1mol of NaOH produced 7224J

1 mole will produce $\frac{7224}{0.1}$ = 72240J

Enthalpy of neutralization = 72.24kJmol^{-1}

(b) If ammonia solution was used in the experiment instead of sodium hydroxide. Comment on the value of the enthalpy of neutralization that would be obtained and give a reason for your answer

2. $50cm^3$ of 0.5M sulphuric acid and $50cm^3$ of 1.0M potassium hydroxide solution in a plastic beaker. The temperature of the mixture rose by 15ºC. Calculate the enthalpy of neutralization of sulphuric acid by sodium hydroxide.
(assume density of solution =1g/cc and S.H.C =4.2 J g^{-1} $^oC^{-1}$)

Total volume= 50+50=100cm^3

Mass = 100x1 =100g

Heat change = mass x SHC x temperature change

= 100x4.2 x 15 = 6300J

1000cm^3 of H_2SO_4 contained 0.5mols

50cm^3 contained $\frac{0.5}{1000}$ X 50 = 0.025mol

1mole of H_2SO_4 produces 2mol of water

0.025mol will produce (2x0.025) =0.05mol

0.05mol of water is formed with release of 6300J

1 mole will formed with release of $\frac{6300}{0.05}$ = 126000J

Enthalpy of neutralization = 126kJmol^{-1}

Try out:

1. 80 cm^3 of 1 M nitric acid and 80 cm^3 of 1 M sodium hydroxide, both at 25 ºC were mixed in a plastic beaker. The mixture was stirred and its maximum temperature was 31.34 ºC. (specific heat capacity of the solution = 4.2J/g/ºC, density of the solution = 1 g/cm^3)
   (a) Write the ionic equation for the reaction which took place.
   (b) Calculate the

(i) Number of moles contained in 80 cm^3 of 1 M sodium hydroxide.

(ii) Heat evolved when 80 cm^3 of 1M sodium hydroxide react with 80 cm^3 of 1 M nitric acid.

(iii) Heat of neutralization.

2. Aqueous hydrogen ions react with aqueous hydroxide ions according to the equation.
   $H^+(aq) + OH^-(aq) \longrightarrow H_2O(l) \qquad \Delta H = -57\ kJ\ mol^{-1}$

   How much heat is released if

   (i) 4 mol of hydrogen ions are neutralized?

   (ii) 0.25 mol of hydrogen ions are neutralized?

   (iii) 2 mol of sulphuric acid are completely neutralized.

3. Enthalpy of solution

This is the heat change that occurs when 1 mole of a compound is dissolved in a large volume of water to form a very dilute solution.

Experiment to determine the enthalpy of solution of ammonium nitrate.

- ✓ A known volume of water (V_w), is measured and put in a plastic beaker.
- ✓ The initial temperature of water is measured and recorded as t_1
- ✓ A known mass of ammonium nitrate (m) is added to the water and the mixture stirred.
- ✓ The final stable temperature, t_2 is noted and recorded.

Assuming S.H.C of the solution = 4.2J/g/°C, density of the solution = 1 g/cm^3)

Mass of water = V_wx1 =Vg

Total mass of solution, M = (V+m)g

Heat change = mass of solution x S.H.C x temperature change
= (Mx4.2x Δ H)J

I mole of NH_4NO_4 = 14+4 +14+ 16x3 = 80g

mg of ammonium nitrate caused heat change of (Mx4.2x Δ H)J

80g will cause $= \frac{(Mx4.2x\,\Delta\,H)}{m}$ x 80 $Jmol^{-1}$

Heat of solution = $\frac{(Mx4.2x\,\Delta\,H)}{m}$ x 80 $Jmol^{-1}$

Try out:

1. 8.0g of ammonium nitrate were added to 100cm^3 of water in a plastic cup and the mixture stirred. If the temperature of water rose from 25 to 33 °C, Determine the enthalpy of solution of ammonium nitrate. Assuming S.H.C of the solution = 4.2J/g/°C, density of the solution = 1 g/cm^3)

2. The heat of solution of sulphuric acid is $-70kJmol^{-1}$. Calculate the mass of sulphuric acid that will evolve 350 kJ of heat when sulphuric acid is dissolved in water.
3. When 231 g of ammonium nitrate were dissolved in water, 75 kJ of heat were absorbed. Calculate the heat of solution of ammonium nitrate.

4. ENTHALPY OF DISPLACEMENT

This is the heat change that occurs when one mole of a less reactive element is displaced by a more reactive element. For example, when the following displacement reactions occur, heat energy is released:

$Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_4(aq)$

Or $Zn(s) + Cu^{2+}(aq) \longrightarrow Cu(s) + Zn^{2+}(aq$

$Fe(s) + Cu^{2+}(aq) \longrightarrow Cu(s) + Fe^{2+}(aq)$

NB: The enthalpy of displacement is greater if a more reactive element is in the reaction. For example, the enthalpy of displacement of copper by magnesium is greater than that by zinc.

Practical activity: see practical book

Examples:

When 2g of zinc powder was added to 50 cm^3 of 0.5 M copper(II) sulphate solution in a plastic cup and the mixture stirred, the temperature rose by 3.5 ^oC Assuming the density of the solution is 1 g/cm^3.

(a) Write an equation for the reaction that took place

(b) Calculate;

(i) The number of moles of zinc that reacted with copper (II) sulphate.

(ii) The heat change caused by the number of moles of zinc that reacted.

(iii) The heat produced if 1 mole of zinc had displaced 1 mole of copper.

Solution

(i) $Zn(s) + CuSO_4(aq) \rightarrow Cu(s) + ZnSO_4(aq)$

(ii)

1000 cm^3 of copper(II) sulphate solution contain 0.5 moles

50 cm^3 of copper(II) sulphate = $\frac{0.5 \times 50}{1000}$ = 0.025 mol

The reaction ratio of zinc to copper(II) sulphate is 1:1

Moles of zinc that reacted = 0.025 mol

(iii)

mass of copper (II) sulphate =1x50 =50g

Mass of the solution = 50 g +2g =52g

Heat evolved = 50 X 4.2 X 3.5 = 735 J

(iv)

0.025 mol of zinc evolve 735 J

1 mol of zinc would evolve $\frac{735}{0.025}$ J

= 29400 J or 29.4 kJ

Heat of displacement is -29.4 kJ/mol.

Try out:

1. When 6.5g of zinc powder were added to 250cm^3 of 0.1M copper (II) sulphate solution in a plastic cup, 5.45KJ of heat was liberated. Calculate;

(iv) The number of moles of copper (II) sulphate that reacted with zinc.

(v) The number of moles of copper displaced.

(vi) The heat energy required to displace 1 mole of copper.

FUELS

A fuel is a substance that burns in air /oxygen to produce heat. Examples of common fuels include;

Charcoal, firewood, paraffin, ethanol, etc

Each fuel has its own heat value. Heat value of a fuel is the amount of heat that can be produced when a unit mass of that fuel is completely burnt in oxygen.

It can be obtained by dividing the molar enthalpy of combustion of the fuel by its molar mass.

The table below gives heat values of common fuels

Fuel	Enthalpy of combustion (KJ/mol)	Molar mass (g/mol)	Heat values (KJ/g)
Methane	-890	16	55.62
Ethane	-1560	30	52.00
Ethanol	-1367	46	29.72
Propanol	-2021	60	33.68

Qns

With a reason, state the fuel that would be most efficient for cooking

Why do you think ethanol and propanol have lower heat values?

Write equations for combustion of each fuel.

Factors to consider when selecting a fuel for use

- The heat value of the fuel
- The cost of the fuel
- Ease of use of the fuel
- Availability of the fuel
- Pollution effects of the fuel
- Ease of storage of the fuel
- Ease of combustion of the fuel

Hydrocarbon fuels such as methane and ethane burn easily, have high heating values, are easy to use but are difficult to store and are expensive.

(e)(i) The heat of combustion of carbon is -390KJ/mol. Determine the mass of charcoal required to raise the temperature of one cup of water (500g of water) at 25.6^{o}C to the boiling point. (Assume charcoal is pure carbon. S.H.C of water is 4.2J/g^{o}C, C=12)

Heat gained by water = mass of water X S.H.C_{water} X temperature change.

= 500 X 4.2 X (100-25.6)

= 156240J

1mole of C = 12

390J is produced by 12g of carbon

156240j was produced by $\frac{12}{390}$ X 156240 = 4807.38g

Mass of carbon = 4807.38g

(ii) Given that a bag of charcoal (100Kg) costs 15000/= , find the cost of charcoal that will boil the above cup of water in (a).

4807.38g = 4807.38/100 = 4.80738kg

1kg of charcoal costs $\frac{15000}{100}$ = 150/=

Therefore, 4.80738kg will cost 4.80738x150

= 721.1/=

LAST TOPIC: APPLIED CHEMISTRY

1. **Sugar**

Ordinary sugar is sucrose (a form of carbohydrates),obtained from sugarcanes.

Manufacture of sugar:

- ✓ The sugarcane is cut into shorter pieces and washed.
- ✓ The pieces are crushed and squeezed to produce the juice.
- ✓ The cane juice is diluted with water and lime is added to it to precipitate the impurities, which are then filtered off.
- ✓ The resulting sugar solution is evaporated until sugar crystals form. Evaporation produces a mixture of sugar crystals and a thick liquid called molasses.
- ✓ The impure crystals are separated from the molasses (in a centrifuge) and purified.
- ✓ To obtain white sugar, the brown crystals are dissolved in water and passed /filtered through animal. The solution is recrystallized to obtain white sugar crystals.

The molasses are used to:

- Make animal feeds
- Make fertilizers.

Uses of sugar:

- ✓ for sweetening food
- ✓ Coating tablets (to give them a sweet taste)
- ✓ Manufacture of oral rehydration salts (ORS)
- ✓ Manufacture of syrups
- ✓ Colouring in cake.

ETHANOL (REFER TO ORGANIC CHEMISTRY NOTES)

2. Biogas

Biogas is produced by the action of bacteria on animal and plant wastes.

Making a simple biogeas digester /generator;
Animal and plant wastes are put in a container, mixed with some little water and covered to ensure that oxygen doesnot enter/to prevent aerial oxidation. The container and its contents are maintained at temperatures 25 – 30^{o}C. The anaerobic bacteria present decompose the wastes to form biogas.
NB:

- The biogas produced consists of mainly methane. Other gases include; ammonia, carbon dioxide and hydrogen sulphide.
- The quality of the biogas produced depends on the materials fed into the digester. A mixture of cow dung or human excreta mixed with bean stalks produce high quality biogas.

- The residue is used as fertilisers because it is rich in nitrogen.

3. Fertilisers

Fertilizers are substances added to the soil to improve its fertility. There are two main types of fertilizers namely natural fertilizers and artificial fertilizers.

1. **Natural fertilizers** /organic fertlizers which include animal waste, dead plants, and dead animals, generally called manure.

2. **Artificial fertilizers/inorganic fertilizers**; they should

- Contain a high proportion of the essential elements needed by plants I.e nitrogen, phosphorous and potassium.
- Be cheap
- Highly soluble in water.

NB: A disadvantage of highly soluble fertilizer is that they are easily washed away by rain. An advantage of less soluble fertilizers is that they stay in soil for a long time thus providing a constant supply of plant nutrients.

- Examples of artificial fertilizers include ammonium sulphate, ammonium nitrate, calcium phosphate, etc.

Preparation of ammonium sulphate fertilizer

Ammonia from Haber process is mixed with sulphuric acid from the contact process to form a solution of ammonium sulphate.

$$2NH_3(g) + H_2SO_4(aq) \longrightarrow (NH_4)_2SO_4(aq) + 2H_2O(l)$$

The solution is evaporated to concentrate it/make it saturated and then cooled to from crystals of ammonium sulphate. The crystals are filtered out and dried.

NB: Excess use of ammonium fertilisers makes the soil acidic.

Think!!!

1. Explain
   I. why excess use of ammonium sulphate fertilisers makes the soil acidic.
   II. Why lime (calcium oxide) is sometimes added to soil.
2. State four advantages of organic fertilizers

EXTRACTION OF METALS

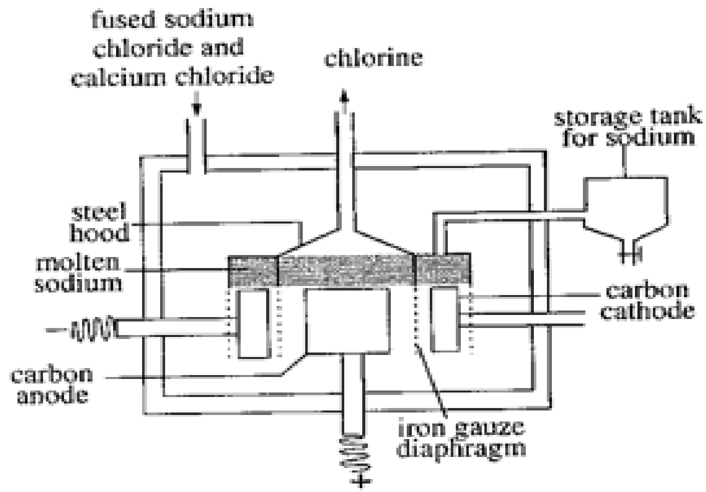
This is the process by which pure metals are obtained from their naturally occurring ores.
An ore is a naturally occurring substance that contains a compound of a metal and earth materials from which the metal can be obtained.

- The major factor determining the method used for extraction of metals from their ores is the position of the metals in the electro reactivity serie
- Very reactive metals (those higher in the activity series) potassium, sodium, calcium, magnesium are extracted by electrolysis of their fused/molten salts (chlorides salts).
- Metals in the middle of the series such as zinc, iron, lead and copper are extracted methods which involve reduction of their ores. The common reducing agents used being carbon and carbon monoxide.
- Metals lower in activity series (mercury, silver and gold) occur naturally as free metals. They are just dug up and separated from earth materials by mainly physical means.

1. Extraction of sodium

- ✓ Sodium metal is extracted by electrolysis of molten/fused sodium chloride in a down's cell; using an iron cathode and a carbon (graphite) anode.
- ✓ Calcium chloride is added to sodium chloride electrolyte to lower its melting point (from 800^{o}C to about 600^{o}C).
- ✓ At the iron cathode, sodium ions are discharged to form liquid sodium metal which is tapped off. It is collected under dry nitrogen because nitrogen is inert and therefore does not react with the liquid sodium.
- ✓ At the carbon anode, chloride ions are discharged to form chlorine gas.

Drawing of the down's cell



Reaction at the cathode:

$Na^+(l) + e \rightarrow Na(l)$

Reaction at the anode:

$2Cl^-(l) - 2e \longrightarrow Cl_2(g)$ OR

$2C1^-(l) \rightarrow Cl_2(g) + 2e^-$

Trial qn:

Explain

(i) Why sodium is extracted by electrolysis
(ii) Why calcium chloride is added to sodium chloride in the Down's cell.
(iii) The use of the iron gauze in the Down's cell.
(iv) Why liquid sodium is collected under nitrogen gas

Uses of sodium metal

- ✓ It is used in the manufacture of anti-knock compounds which are added to petrol..
- ✓ It is used in manufacture of sodium cyanide which is used in extraction of gold.
- ✓ Used in nuclear reactions to absorb some of the heat produced during the reactions.

2. Extraction of iron.

Iron can be extracted from any of the following ores:

Formula of ore	Name of ore	Name of compound present
Fe_2O_3	Haematite	Iron (iii) oxide

Fe_3O_4	Magnetite	Triiron tetraoxide
FeS_2	Iron pyrites	Iron disulphide
$FeCO_3$	Siderite/spathic iron	Iron (II) carbonate

Common ores include; haematite, magnetite and spathic iron.

Extraction from haematite or magnetite.

- Hematite or magnetite ore are first roasted and mixed with coke and limestone and the mixture fed into the blast furnace from the top; Hot air is blown into the furnance at the bottom; and reacts with hot coke to form carbon dioxide; carbon dioxide rises up and reacts with more coke to form carbon monoxide; carbon monoxide and coke reduces the iron ore (haematite/magnetite) to liquid iron which trickles down.

  $C(s) + O_2(g) \longrightarrow CO_2(g)$

  $CO_2(g) + C(s) \longrightarrow 2CO(g)$.

  $Fe_2O_4(s) + 3CO(g) \rightarrow 2Fe(l) + 3CO_2(g)$

  OR if magnetite is used;

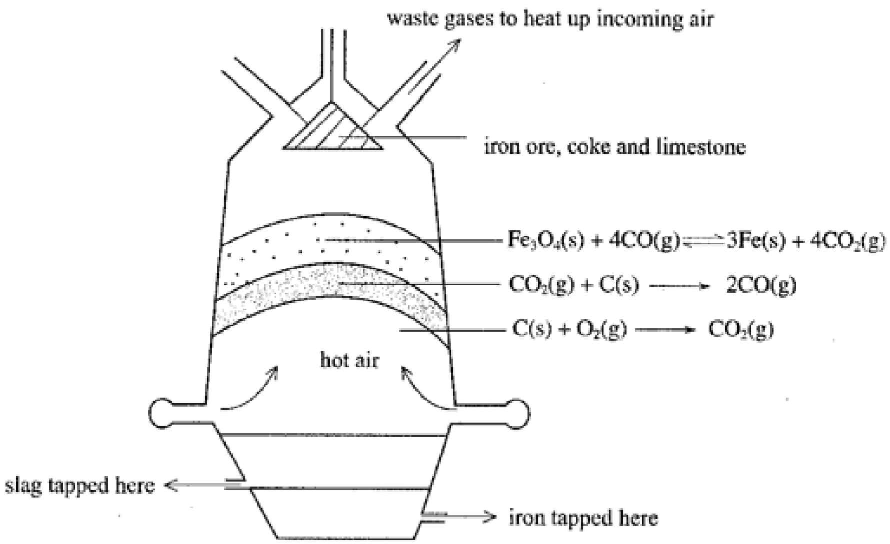
  $Fe_3O_4(s) + 4CO(g) \rightarrow 3Fe(l) + 4CO_2(g)$

- The calcium carbonate (lime stone) decomposes to form calcium oxide which reacts with the impurity, silicon dioxide/sand to form a slag of calcium silicate; which trickles down and covers molten iron to prevent it from oxidation by oxygen.

$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

$CaO(s) + SiO_2(s) \rightarrow CaSiO_3(l)$

Drawing of a blast furnace



NB:

- ✓ Other bi-products from the blast furnace include calcium silicate, calcium phosphate and waste gases such as carbon dioxide, carbon monoxide, nitrogen and sulphur dioxide.
- ✓ The hot waste gases are used to heat up air as it enters the blast furnace to save energy.
- ✓ Calcium silicate is used in making glass and in road construction while calcium phosphate is used as a fertilizer.

In case extraction from spathic iron, the ore is first roasted in air (heated in air) to convert it to iron(III) oxide.

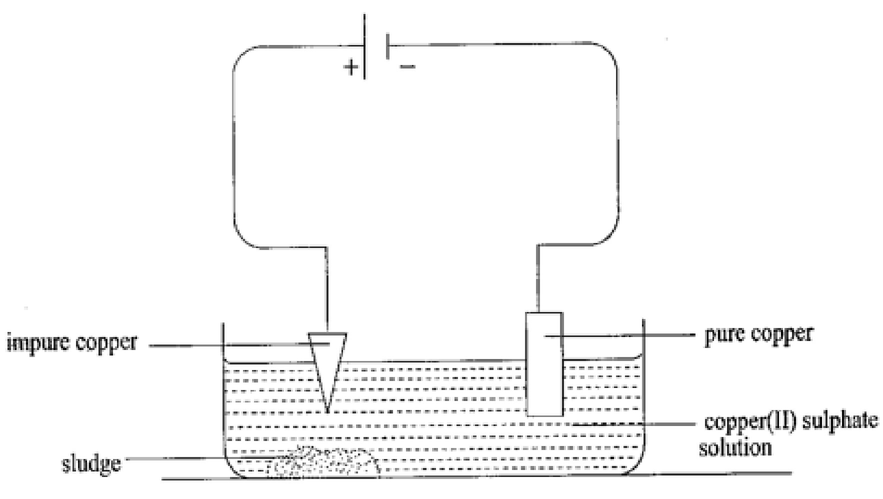
$$2FeCO_3(s) + 2O_2(g) \longrightarrow Fe_2O_3(s) + 2CO_2(g)$$

Types of iron;

- Iron from the blast furnace is impure due to presence of impurities like carbon, Sulphur etc. Its called **cast iron or Pig iron** and is used in manufacture of Bunsen burner bases and domestic boilers.
- **Wrought iron**: Is the purest form of iron obtained by purifying/refining pig iron. It is used to make iron nails, iron sheets and agricultural equipment.

Refining/purification of the impure copper

It is done by electrolysis using copper(II) sulphate solution as the electrolyte the impure copper as the anode and pure copper as the cathode as shown below:



At the anode: The anode dissolves due to loss conversion of copper atoms into copper (II) ions.

$$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$$

At the cathode: The copper(II) ions are attracted to the cathode where they gain electrons and become copper atoms. As discharge of the copper (II) ions occurs, pure copper is deposited at the cathode.

$Cu^{2+}(aq) + 2e^{-} \rightarrow Cu(s)$

Uses of copper

- ✓ Copper is used as a conductor of electric power in wires and cables.
- ✓ It is used for making bronze which is used for manufacturing ball bearings.
- ✓ It is used for making kettles for brewing beer.
- ✓ Used for making roofing sheets because it is corrosion resistant.

Alloy

An alloy is a uniform mixture of a metal and another metal or non-metal. Alloys are made to obtain desired properties of a metal such as reduced malleability and ductility, reduced melting points etc.

Alloy	**Composition**	**Uses**
Brass	Copper and zinc	Ornaments, buttons and screws
Bronze	Copper and tin	Ornaments
Duralumin	Aluminium with small amounts of magnesium, manganese and copper	Aircraft and bicycle parts
Solder	Tin and lead	Joining metals
Steel	Iron and carbon or manganese or chromium. Stainless steel contains iron, chromium and nickel.	Making car bodies, cutlery, steel bars etc
Copper coinage	Copper, tin and zinc	Coins

POLLUTION

This is the addition of harmful substances or energy to the environment in quantities which damage the environment and it components.

A pollutant a substance which when added to the environment in certain quantities can harm the environment or its components.

Types of pollution

- ✓ Water pollution
- ✓ Air pollution
- ✓ Land pollution.

(1) **Air pollution**

Is the addition of harmful gases or energy or noise to the atmosphere. It is caused by pollutant gases such as; carbon monoxide, carbon dioxide, nitrogen oxides, hydrogen sulphide, Sulphur dioxide etc. These gases are produced:

- From exhaust pipes of motor vehicles (carbon monoxide, carbon dioxide)
- Burning coal, plastics etc (carbon dioxide, carbonmonoxide)
- Industries (nitogen oxide gases, Sulphur dioxide, carbon dioxide, carbon monoxide etc)
- Burning bushes or forests.

3. Water pollution

Is the addition of substances to water in water bodies that makes it unsafe for use and harmful to its habitats. It is caused by

- Addition of untreated sewage to water bodies.
- Addition of detergents and soaps to water bodies.
- Addition of fertilizers to water bodies.
- Addition of petroleum products.
- Addition of heavy metals like lead, mercury.
- Addition of insecticides.

Indicators of water pollution

- Presence of colour in water
- Bad smell
- Possession of a particular taste.
- When the boiling point varies from 100 degrees centigrade at atmospheric pressure.
- When freezing point varies
- When a lot of water weeds grow on a water body.
- When organism in water die

Think !!! Describe how each of the above substances cause water pollution.

Effects of water pollution

- ✓ Reduces oxygen content of water bodies.
- ✓ Leads to death of water organisms like fish
- ✓ Makes water unsafe for consumption by man.
- ✓ Leads to rapid growth of water weeds.

Sewage

Sewage is water containing waste matter from toilets, bathrooms and factories. It is usually carried from residential areas and industries by underground pipes called sewers to designated areas where it is treated. After treatment, it becomes less harmful and is added to water bodies.

Sewage pollutes water by adding the following harmful components to water;

- Microorganisms like bacteria
- Nutrients like nitrates, phosphates etc (causeeutrophication)
- Organic substances
- Solid materials

In Uganda some of the sewage treatment plants are in bugoloobi and Masaka.

How sewage is treated?

- ✓ Suspended solid materials are removed by filtration. This is done by passing sewage through screens of different sizes.
- ✓ The liquid sewage is allowed into a treatment tank.
- ✓ Air is blown into the sewage tank and bacteria use it to oxidize/decompose harmful substances in sewage to less harmful substances.
- ✓ Finally, the solid materials called sludge is separated from the resulting liquid called effluent.
- ✓ Chlorine is added to the to reduce its bacteria content and allowed to join a river or lake (added to a water body)

Note:

Effluent is liquid product returned to a water body from sewage treatment.

Sludge is the solid product from sewage treatment. It is used

- As a fertilizer
- As a raw material to produce biogas
- For road surfacing

Advantages of use of biogas.

1. It is easy and cheap to produce.
2. Saves forests which would be destroyed for the production of firewood and charcoal.
3. Provides an economical way of disposal of wastes.
4. The by-products are used as fertilisers

Water treatment

Water from lakes/rivers goes through a process of treatment/purification before supply for domestic and industrial use. The process involves the following statges:

- **Sedimentation**
- **Filtration**
- **Chlorination**

- **pH adjustment and softening**

Process:

- ✓ Impure water from a lake or river is first passed through screens to remove floating debris.
- ✓ It is passed through an alum dosing tank to remove suspended particles. In this tank, potash alum/potassium aluminium sulphate is added to enable small particles collect together and sediment.
- ✓ The resulting water is then filtered by passing it through sand and gravel screens.
- ✓ Chlorine is added to the resulting water to kill germs
- ✓ Finally, soda ash (sodium carbonate) is added to adjust pH and to soften the water**.**

In Uganda, water treatment is mainly done at Gaba, kampala (Gaba water treatment plant)