Date;

OXIDATION AND REDUCTION REACTIONS.

When some metallic objects are left outside in the open moist air, they tend to lose their original colour to reddish-brown. The reactions responsible for such changes are known as oxidation and reduction. These reactions occur not only in metals but also in processes like respiration and photosynthesis. In all these processes, there is transfer of oxygen, hydrogen or electrons from one species to another.

When oxidation and reduction occur simultaneously, the entire process is known as a REDOX reaction.

OXIDATION REACTIONS.

Oxidation reaction is one which involves addition of oxygen, removal of electrons, removal of hydrogen or increase in oxidation number.

Oxidation as a gain of oxygen.

When magnesium is burnt in oxygen, it forms magnesium oxide powder (white solid).

$$2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$$

In this reaction, magnesium gains oxygen and therefore it is oxidized. This is an example of an oxidation reaction

Qn In the following equations identify the substances which are oxidized

a) Copper + oxygen → Copper (II) oxide

Copper ✓

b) hydrogen + oxygen → water

~~oxygen~~ hydrogen ✓

Oxidation as loss of hydrogen

$$CuO_{(s)} + 2NH_{3(g)} \rightarrow Cu_{(s)} + N_{2(g)} + 3H_2O_{(l)}$$

CuO → Reduced

NH_3 → Oxidised

Copper (II) oxide reduces because it loses oxygen and NH_3 is oxidised because it gains oxygen but the hydrogen.

Observation
Black solid turned to a brown grey solid.

$H_2S_{(g)} + Cl_{2(g)} \longrightarrow S_{(s)} + 2HCl_{(g)}$

H_2S - ~~Reducer~~ Oxidises because it loses hydrogen
Cl_2 - ~~Oxidiser~~ Reduces because it ~~gains~~ hydrogen

H_2S - Oxidises because it loses hydrogen
Cl_2 - Reduces because it gains hydrogen

15th February, 2024

REDUCTION REACTIONS.

Reduction reaction; Is one which involves subtraction of oxygen, addition of electrons, addition of hydrogen or decrease in oxidation number.

Reduction as lose of oxygen.

Eg Zinc + Copper (II) oxide → Zinc oxide + Copper

$Zn_{(s)} + CuO_{(s)} \longrightarrow ZnO_{(s)} + Cu_{(s)}$

Zn - Oxi Oxidises
Cu - Oxid Reduces

$2Fe_2O_{3(s)} + 3C_{(s)} \longrightarrow 4Fe_{(s)} + 3CO_{2(g)}$

Fe - Reduced
C - Oxidised

Reduction as a gain of hydrogen.

$H_{2(g)} + Cl_{2(g)} \longrightarrow 2HCl_{(g)}$ hydrogen Chloride gas

Cl_2 - Reduced because it has gained hydrogen.
H_2 -

Redox Reactions in terms of electron transfer.

Oxidation - Is the loss of electrons
Reduction - Is the gain of electrons

Consider

$Mg_{(s)} + Cl_{2(g)} \rightarrow MgCl_{2(s)}$

Mg - is oxidised because it loses its electrons

$Mg_{(s)} \longrightarrow Mg^{2+} + 2e^-$

$Cl_{2(g)} + 2e^- \longrightarrow 2Cl^-$

Mg - is oxidised because it lost two electrons

Cl_2 - is reduced because it gained two electrons

2. $AgNO_{3(aq)} + Cu_{(s)} \longrightarrow \overset{\text{greenish}}{Cu(NO_3)_{2(aq)}} + Ag_{(s)}$

$2 \mid Ag^+ + e^- \longrightarrow Ag_{(s)}$

$1 \mid Cu_{(s)} \longrightarrow Cu^{2+} + 2e^-$

$2Ag^+_{(aq)} + Cu_{(s)} \longrightarrow 2Ag_{(s)} + Cu^{2+}$

21st February, 2024.

OXIDATION NUMBER (STATE).

Is the total number of electrons that an electron atom or ion should gain or lose to form a chemical bond

How to calculate oxidation numbers

- For uncombined elements in atomic or molecular states, the oxidation number is zero.
- The charge on a monoatomic ion is its oxidation state.
- Oxygen has an oxidation state of -2 except in peroxides.
- The sum of oxidation numbers in a neutral compound is zero.
- The sum of oxidation numbers of all atoms in an ion or compound is equal to the overall charge.
- Hydrogen has oxidation state of +1 except in metal hydrides where it is -1.

Examples

1. What is the oxidation state of the following.

a) Cu → 0

b) S → 0

c) Cl → 0

d) K^+ → +1

e) O^{2-} → -2

Calculate the overall oxidation state in;

a) $CaCO_3$

$Ca = +2$

$C = +4$

$O_3 = (3 \times -2) = -6$

Overall oxidation

$+2 + 4 - 6$

$= 0$

b) $MgCl_2$

$Mg = +2$

$Cl_2 = (-1 \times 2) = -2$

Overall oxidation

$+2 - 2 = 0$

c) H_2O

$H_2 = (2 \times +1) = +2$

$O = -2$

Overall oxidation $= +2 - 2$

$= 0$

Calculate the oxidation states of the following.

a) Sulphur in sulphate

Let the oxidation number of sulphur be m

SO_4^{2-}

$m + (-2 \times 4) = -2$

$m = -2 + 8$

$m = +6$

b) Nitrogen in nitrate

NO_3^-

Let the oxidation number of nitrogen be k

$k + (-2 \times 3) = -1$

$k + (-6) = -1$

$k - 6 + 6 = -1 + 6$

$k = 5$

c) Sulphur in sulphur trioxide

SO_3

Let the oxidation of sulphur be r

r + 6 = -1

Day: Thursday
Date; 22nd Feb, 2024.

Calculating oxidation number.

Calculate the oxidation number of nitrogen in each of the following

a) NO_2

Let the oxidation number be b

$b + (-2 \times 2) = 0$

$b - 4 = 0$

$b = +4$

b) NO_3^-

Let the oxidation number be m

$m + (-2 \times 3) = -1$

$m - 6 = -1$

$m = +5$

c) NO_2^-

Let the oxidation number be j

$j + (-2 \times 2) = -1$

$j - 4 = -1$

$j = +3$

d) HNO_3

Let the oxidation number be k

$k + (-2 \times 3) = 0$

$k - 6 = 0$

$k = +6$

e) NH_3

Let the oxidation number be y

$y + (+1 \times 3) = 0$

$y + 3 = 0$

$y = +6 \quad y = -3$

f) Mg_3N_2

Let the oxidation number be

$k + 6$

$(l \times 2) + (2 \times 3) = 0$

$2l + 6 = 0$

$\frac{2l}{2} = \frac{-6^3}{2_1}$

$l = -3$

Calculate the oxidation states of the following.

a) Cr in $K_2Cr_2O_7$

Let the oxidation number be d

$(d \times 2) + (1 \times 2) + (-2 \times 7) = 0$

$2d + 2 + -14 = 0$

$2d - 12 = 0$

$\frac{2d}{2} = \frac{12}{2}$

$d = +6$

b) Mn in MnO_4^-

Let the oxidation number be p

$p + (-2 \times 4) = -1$

$p - 8 = -1$

$p = +7$

c) Cl in ClO_3^-

Let the oxidation number be z

$z + (-2 \times 3) = -1$

$z + -6 = -1$

$z - 6 = -1$

$z = +5$

23rd February, 2024.

Note:

The oxidation number for metal corresponds to the number of electrons lost by that metal.

The oxidation number of a non-metal may also correspond to the number of electrons gained by that non-metal.

Oxidation Reduction Reactions in terms of increase or decrease in oxidation number.

Oxidation reaction: Is one where there is increase in oxidation number.
Reduction reaction: Is one where there is decrease in oxidation number.

Examples.

Identify the species which have been reduced or oxidised in the following reactions.

a) $\overset{0}{Fe}_{(s)} + S_{(s)} \longrightarrow \overset{+2}{Fe}\overset{-2}{S}_{(s)}$

Fe has been oxidised because there is increase in oxidation number
S has been reduced because there is decrease in oxidation number

b) $\overset{0}{Zn}_{(s)} + Cu^{2+}_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + \overset{0}{Cu}_{(s)}$

Zn has been oxidised because there's increase in oxidation number.
Cu has been reduced because there's decrease in oxidation number.

c) $2H_2\overset{-2}{S}_{(g)} + \overset{0}{Cl}_{2(g)} \longrightarrow 2H\overset{-1}{Cl}_{(g)} + \overset{0}{S}_{(s)}$

S has been oxidised because there is increase in oxidation number.
Cl has been reduced

d) $2HgCl_{2(l)} + SnCl_{2(l)} \rightarrow \overset{+1}{Hg_2}Cl_{2(l)} + \overset{+4}{Sn}Cl_{4(l)}$

Hg - Has been reduced
Sn - Has been oxidised

Alternatively

$2 \mid Hg^{2+} + e^- \longrightarrow Hg^+$
$1 \mid Sn^{2+} \longrightarrow Sn^{4+} + 2e^-$
$2Hg^{2+}_{(aq)} + Sn^{2+}_{(aq)} \longrightarrow Sn^{4+}_{(aq)} + 2Hg^+_{(aq)}$

6th March, 2024.

Exploring oxidation and reduction

Wednesday, 6th March, 2024.

Exploring oxidation and reduction reactions in terms of electron transfer.

Qn: Write ionic equations fof each of the following reactions, clearly showing electron transfer.

a) Copper(II) ions and zinc metal

Oxidation : $Zn_{(s)} \longrightarrow Zn^{2+}_{(aq)} + 2e^-$

Reduction : $Cu^{2+} + 2e^- \rightarrow Cu$

Overall : $Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$

b) Chlorine and Iron(II) ions

Oxidation : $Fe^{2+}_{(aq)} \longrightarrow Fe^{3+} + e^-$

Reduction : $2e^- + Cl_{2(g)} \longrightarrow 2Cl^-$

$2 \mid Fe^{2+}_{(aq)} \longrightarrow Fe^{3+}_{(aq)} + e^-$

$1 \mid Cl_{2(g)} + 2e^- \longrightarrow 2Cl^-_{(aq)}$

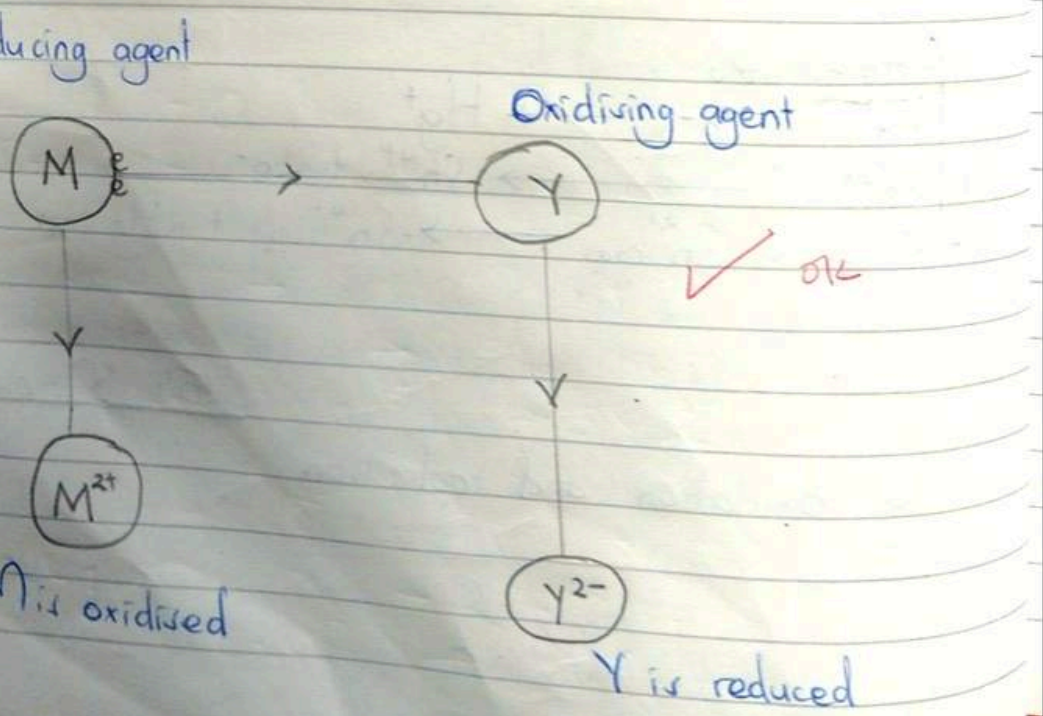
Overall : $2Fe^{2+}_{(aq)} + Cl_{2(g)} \longrightarrow 2Fe^{3+}_{(aq)} + 2Cl^-_{(aq)}$

c) Hydrogen peroxide and manganate(VII) ions in acidic medium.

OXIDISING AND REDUCING AGENTS.

An oxidising agent is a substance in a redox reaction that gains electrons, and so, gets reduced in the reaction.

A reducing agent is a substance th in a redox reaction that loses electrons, and so, gets oxidised in the reaction.



Oxidising agents

Bromine (Br_2)
Chlorine (Cl_2)
Concentrated sulphuric acid (H_2SO_4)
Nitric acid (HNO_3)
Oxygen (O_2)
Potassium permangnate ($KMnO_4$)
Potassium dichromate ($K_2Cr_2O_7$)
Hydrogen peroxide (H_2O_2)

Reducing agents

Carbon (c)
carbon monoxide (CO)
hydrogen (H_2)
hydrogen sulphide (H_2S)
metals
potassium iodide (KI)
sulphur dioxide (SO_2)
ammonia (NH_3)

c) Hydrogen peroxide and manganate (VII) ions in acidic medium.

Reduction: $MnO_4^- + 8H^+_{(aq)} + 5e^- \rightarrow Mn^{2+}_{(aq)}$

Oxidation: $H_2O_{2(aq)} \longrightarrow O_2 + 2H^+ + 2e^- + 4H_2O_{(l)}$

$2 \mid MnO_4^- + 8H^+_{(aq)} + 5e^- \longrightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$

$5 \mid H_2O_{2(aq)} \longrightarrow O_{2(g)} + 2H^+_{(aq)} + 2e^-$

Overall: $2MnO_4^-{}_{(aq)} + 6H^+_{(aq)} \longrightarrow 2Mn^{2+}_{(aq)} + 8H_2O_{(l)} + 5O_{2(g)}$

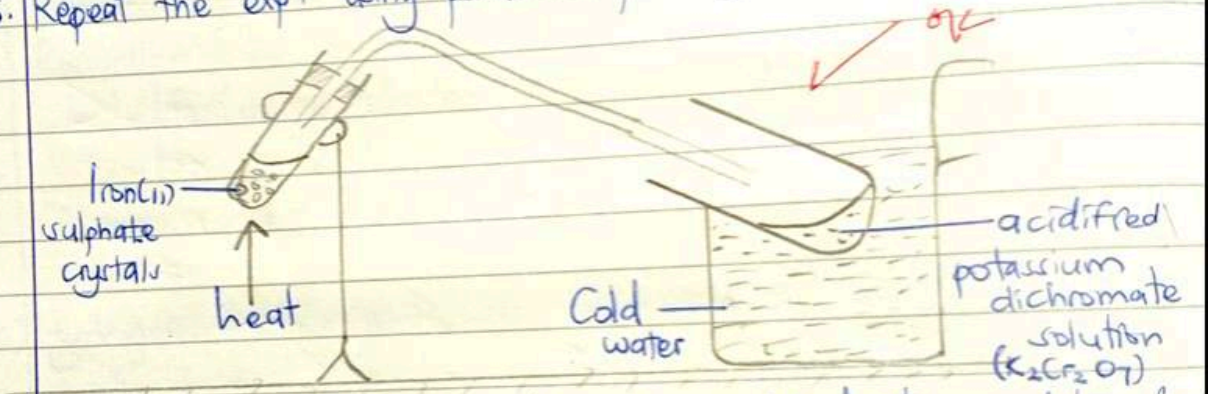
d) Magnesium metal and hydrogen ions

$Mg_{(s)} + 2H^+_{(aq)} \longrightarrow Mg^{2+} + H_{2(g)}$

Tuesday, 12th March, 2024

Reaction between sulphur dioxide and acidified Potassium dichromate. (Potassium permanganate)

1. Transfer 5cm³ of potassium dichromate solution into a boiling tube.
2. Add 3cm³ of dilute sulphuric acid to potassium dichromate solution in a boiling tube.
3. Transfer 6g of iron(II) sulphate crystals into another boiling tube
4. Hold the boiling tube containing acidified potassium dichromate sln in such a way that the delivery tube is dipped into ē sln.
5. Heat the iron(II) sulphate crystals until there is no further change in
6. Repeat the exp't using potassium permangnate soln.



State the observation made using acidified potassium dichromate sln
~~Purple solution turns colourless~~. The orange solution
The orange solution turns to green.

ii) Observation made using acidified potassium permangnate sln.
Purple solution turns colourless.

$KMnO_4 / H^+$ - Oxidising
$K_2Cr_2O_7 / H^+$ - Oxidising

5 | $SO_{2(g)} + 2H_2O_{(l)} \rightarrow SO_{4(aq)}^{-2} + 4H^+_{(aq)}$
2 | $5e^- + MnO_{4(aq)}^- + 8H^+_{(aq)} \rightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$
$5SO_{2(g)} + 2H_2O + 2MnO_{4(aq)}^- \rightarrow 5SO_{4(aq)}^{2-} + 2Mn^{2+}_{(aq)}$

3 | $SO_{2(g)} + 2H_2O_{(l)} \rightarrow SO_4^{2-} + 4H^+ + 2e^-$
1 | $6e^- + Cr_2O_{7(aq)}^{2-} + 14H^+_{(aq)} \rightarrow 2Cr^{3+}_{(aq)} + 7H_2O_{(l)}$
$3SO_{2(g)} + 2H^+_{(aq)} + Cr_2O_{7(aq)}^{2-} \rightarrow 3SO_{4(aq)}^{2-} + 2Cr^{3+}_{(aq)} + H_2$

Conclusion:

$SO_2(g)$ is a reducing agent

$KMnO_4$ / $K_2Cr_2O_7$ in acid medium are oxidising agents.

Observation

(a) In this solution

i) Sulphur dioxide acts as a reducing agent (gets oxidised) whereas acidified potassium permanganate or acidified potassium dichromate acts as an oxidising agent (gets reduced)

Note:

Sulphur dioxide is obtained by heating Iron(II) sulphate (ferrous sulphate)

$$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$$ ✓✓ ok

Importance of oxidation and reduction in everyday life.

- ✓ Extraction of metals like iron and zinc, (reduction reaction)
- ✓ Breakdown of food by cells to produce energy (oxidation reaction)
- ✓ Production of electrical energy. Electrochemical cells such as car batteries and dry cell use redox reaction.

For your own understanding

Electroplating is the application of electrolytic cells in which a thin layer of metal is deposited onto an electrically conducive surface. An electrolytic cell normally has an inert anode, but when used in electroplating, it is modified so that the anode is made of the metal whose ions are present in the electrolyte and the cathode is the metal to be electroplated.

Metals and ores from which they are extracted.

Element	Ore	Importances of the ores
Iron	Magnetite (Fe_3O_4) Haematite (Fe_2O_3)	Used in making iron bars. ✓
Zinc	Zinc blonde (ZnS)	For holding since its an insulator. ✓
Aluminium	Bauxite (Al_2O_3)	For making saucepans ✓
Copper	Copper pyrites ($CuFeS_2$)	Used for making copper wires ✓

Importances of ores:

- The ores are used to make finished materials forexample the haematite is ~~used~~ provides iron.
- Aluminium is used to make saucepans.

Importance of oxidation reduction process.

- It helps in extraction process of iron. It is used as follows;

Carbon + Oxygen → Carbon monoxide — Oxidation

Iron(ii) oxide + carbon monoxide → Iron + carbon dioxide gas

$$C_{(s)} + O_{2(g)} \rightarrow 2CO_{(g)}$$

$$FeO_{(s)} + CO_{(g)} \rightarrow Fe_{(s)} + CO_{2(g)}$$

Distinguishing between redox and non-redox reactions

A reaction in which neither oxidation nor reduction takes place is called a non-redox reaction. Examples of such rxns include;

(i) Solution of barium chloride and sodium sulphate react to give insoluble barium sulphate and the solution of sodium chloride

$$BaCl_{2(aq)} + Na_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq)}$$

(ii) Sodium hydroxide solution reacts with hydrochloric acid solution to provide produce sodium chloride ~~sln~~ and water.

$$NaOH_{(aq)} + HCl_{(aq)} \rightarrow NaCl_{(aq)} + H_2O_{(l)}$$

ELECTROLYSIS

Refers ~~to~~ to the breakdown /decomposition of an electrolyte by passing an electric current through it.

Terms involved in electrolysis

1. Electric current

Is the flow of electron from one part to another through a solid or liquid

2 Conductor

Is a solid material that allows electric current to pass through it e.g graphite, metal like Cu, Al, Zn, Na, k. Conductor have free mobile electron which move about transferring electric current

3 Insulator / Non conductor

These are solid materials that do not allow the passage of electric current e.g rubber, wood, plastics. Non conductor have electron that are lock up in the convalent bonds are not free to move.

13th March, 2024.

ELECTROLYTE

Is a molten or solution form of an ionic compound that conducts electricity

Types of electrolytes

- Strong electrolytes
- Weak electrolytes

Strong electrolytes

Are electrolyte that ionimise completely in aqeous solution. eg

- acidic solutions (HCl, H_2SO_4, HNO_3)
- salt solutions ($NaCl$, $CuSO_4$)
- molten $PbBr_2$, Lead(II) bromide
- alkali solution ($NaOH$,

Note:

In solid state, ions in ionic compounds are firmly held together by electrostatic forces of attraction are not free to move thus do not conduct electric current.

However in aqeous solutions (in water) the ions are free to move and therefore conduct electricity.

The conducting particles in aqueous solutions are the ions.

Weak electrolytes.

Are those that are partially ionised in aqueous solution eg water, ammonia solution ($NH_3(aq)$ or NH_4OH), ethanoic acid (CH_3COOH), Carbonic acid (H_2CO_3)

Non-electrolyte.

Is a solution or molten compound that doesnot conduct electricity eg paraffin, sugar solution, petrol, ethanol, trichloromethane, tetrachloromethane

Electrodes.

Are terminals where electric current enter and live the electrolyte. The electrodes are two ie anode and cathode respectively

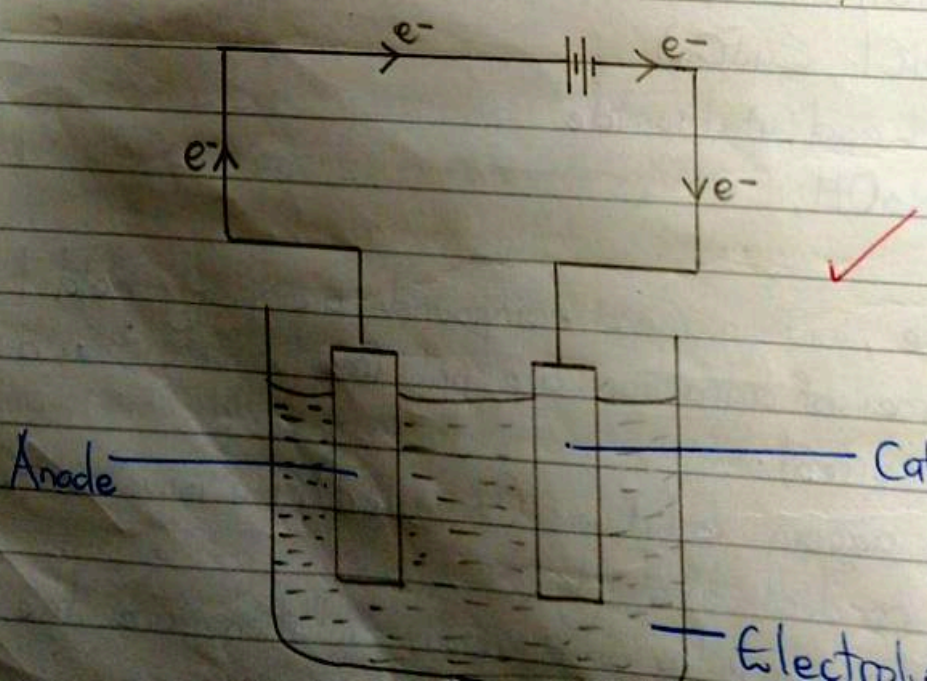
Anode.

Is a paritive electrode through which electric current enter the electrolyte.

Cathode

Is a negative electrode through which electric current leave the electrolyte.

Illustration



cation - positive ion.

During electrolysis, the positive ions move to the cathode whereas the negative ions (anions) move to the anode.

At the cathode, the cations gain electrons and are reduced and at the anode, the anions lose electrons and get oxidised.

Activity 1.3(a) : Investigating the electrical conductivity of solid and molten substances.

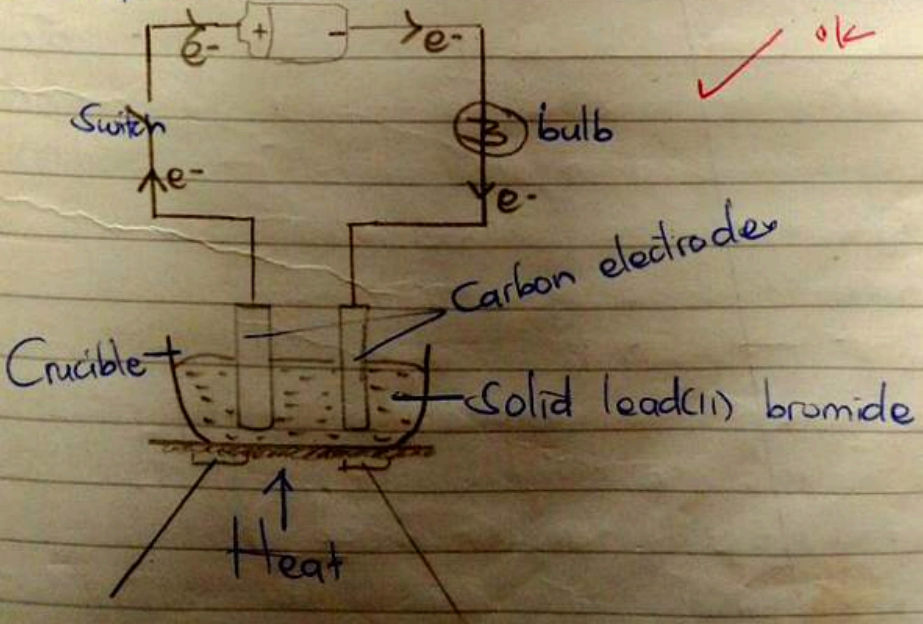
What you need

- dry cells
- carbon electrodes
- bulb
- heat source
- connecting wires
- pipeclay triangle
- spatula
- beakers
- crucible
- tripod stand
- napthalene
- lead(II) bromide powder

What to do

1. Fill two-thirds of the crucible with lead(II) bromide.
2. Place the crucible and its contents on a pipe clay triangle on a tripod stand.
3. Dip the two carbon electrodes into the solid lead(II) bromide and connect the batteries with the connecting wires.
4. Turn on the switch and check whether the bulb light up.
5. Now, heat the lead(II) bromide in the crucible until it melts.
6. Turn on the switch. Observe the changes that take place to the electrodes and bulb. Allow the current to pass through the melt for 20-30 minutes.
7. Repeat steps (1) to (6) by replacing solid lead(II) bromide with napthalene

Setup



Day: Tuesday

Date: 19th March, 2024.

Activity 1.3(b): Investigating the electrical conductivity of substances in aqueous solution.

What you need

- sodium chloride solution
- beakers
- bulb
- glucose solution and powder
- carbon electrodes
- connecting wires
- crucible
- pipe clay triangle
- dry cells
- weighing balance
- tripod stand
- sodium chloride crystals

What to do

1. Fill the beaker with sodium chloride solution until it is half-full.
2. Dip the two carbon electrodes into the sodium chloride solution and connect to the batteries by the connecting wires
3. Turn on the switch and observe the changes which take place to the electrodes and bulb.
4. Repeat steps (1) - (3) by replacing sodium chloride solution with glucose solution
5. Put 5g of sodium chloride crystals in a beaker. Dip the carbon electrodes into the crystals and connect the batteries by replacing sodium chloride solution with sodium chloride crystals.
6. Turn on the switch and check whether the bulb lights up. Record your observation
7. Repeat steps using glucose powder instead of sodium chloride crystals.

Observation and Analysis

Substance	Physical state	Does the bulb light up	Observation	Interference
Lead(II) bromide	Solid	No	No observation	No conductivity
	Molten	Yes	Cathode: Grey deposit Anode: Brown gas	Conductivity
Naphthalene	Solid	No	No observation	No conductivity
	Molten	No		
Sodium Chloride	Solid	No	No	No conductivity
	Aqueous solution	Yes	Cathode: Bubbles of a colourless gas Anode: Bubbles of a colourless gas	No conductivity
Glucose	Solid	No	No observation	No conductivity
	Aqueous	No	No observation	No conductivity

Analysis

1. For substances that conducted electricity, the bulb produced light.
2. In molten lead(II) bromide, a grey solid (Pb) was deposited at the cathode and a brown gas (Br_2) at the anode.
3. Solid lead(II) bromide did not conduct electricity because its ions are held by strong electrostatic forces of attraction thus unable to move.
4. Molten lead(II) bromide conducted electricity because the strong forces of attraction were broken and the ions became free and mobile to conduct electricity.
5. Solid sodium chloride did not conduct electricity because its ions are held by strong electrostatic forces of attraction thus unable to move.
6. Aqueous solution sodium chloride conducted electricity because the strong forces of attraction were broken and the ions became free and mobile to conduct.
7. Glucose did not conduct electricity in all states because it exists as a molecule and doesnot break down into ions.

Conclusion

Electrolytes	Non-electrolytes
- Molten lead(II) bromide	- Glucose
- Aqueous sodium chloride	- Naphthalene

PRINCIPLES OF ELECTROLYSIS

During electrolysis, negative ions migrate to the anode (positive electrode) where oxidation occurs eg $2X^- \rightarrow X_{2(g)} + 2e^-$

Positive ions move to the cathode (negative electrode) where reduction occurs during discharge eg

$M^{n+}_{(aq)} + ne^- \rightarrow M_{(s)}$

Reduction takes place at the cathode, [Reduction Cathode RC]
Oxidation takes place at the anode [Oxidation anode OA]
OILRIG (Oxidation Is Loss and Reduction Is Gain)

Factors affecting selective discharge of ions.

a) Position of ions in the electrochemical series.

Given 2 ions at the electrode an ion which is lower in the electrochemical series is discharged ~~with~~ in preference to one upper in the electrochemical series.

Electrochemical series

Cation			Anion
Li^+	Zn^{2+}		NO_3^-
K^+	Fe^{2+}		SO_4^{2-}
Ca^{2+}	Pb^{2+}	Increasing	Cl^-
Na^+	H^+	ease	Br^-
Mg^{2+}	Cu^{2+}	of	I^-
Al^{3+}	Ag^+	discharge	OH^-
Zn^{2+}			
Fe^{2+}			
Pb^{2+}			
H^+			
Cu^{2+}			
Ag^+			

b) Concentration of ions

Keeping other factors constant, an ion with a higher concentration has a higher chance of being discharged

eg:

During electrolysis of concentrated sodium chloride (Brine), chloride ions are discharged at the anode instead of the hydroxide ions/ hydroxil ions and sodium ions are discharged at the cathode instead of the sodium hydrogen ions

c) Nature of electrode

Platinum or graphite don't determine the discharge since they are inert i.e. or do not react with electrolyte but conduct electricity.

Other electrons other than graphite determine the ion to be discharged eg during electrolysis of copper(II) sulphate

d) When platinum electrodes are used:

At the anode; hydroxide ions are discharged.
At the cathode; Copper (II) ions discharged.

b) When copper electrodes are used.

At the anode

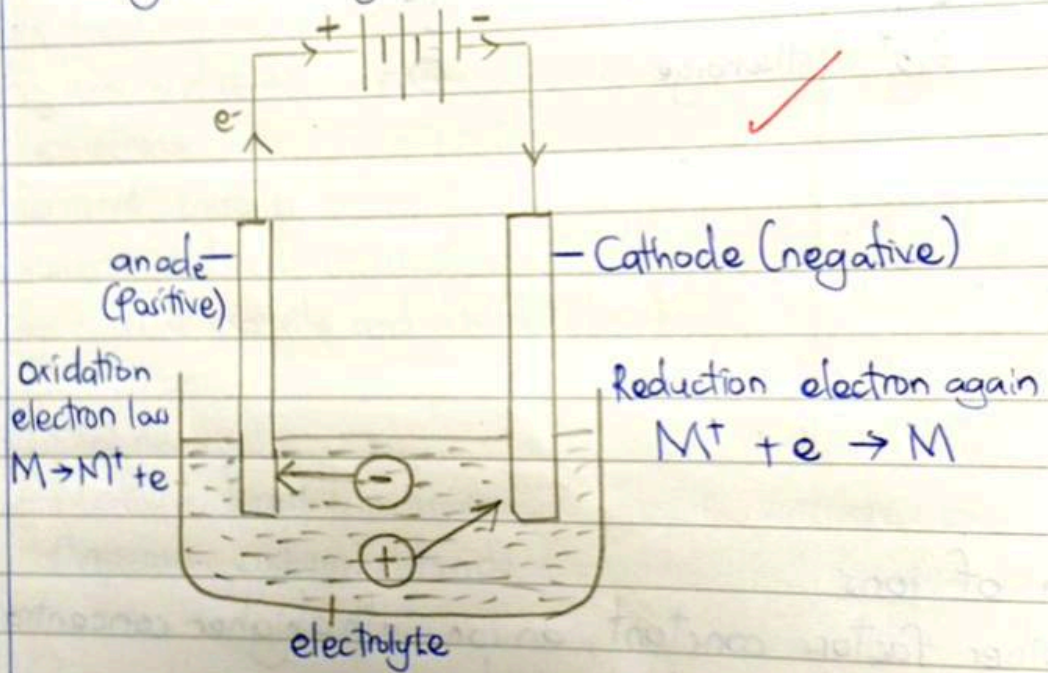
$Cu_{(s)} \rightarrow Cu^{2+} + 2e^-$

At the cathode

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

Activity 1.3(c): Analysing an electrolytic cell.

A figure showing an electrolytic cell.



1. Name the main components of an electrolytic cell.
2. Describe how the battery is connected in an electrolytic cell.
3. What kind of compounds conduct electricity in an electrolytic cell?
4. What happens to the compounds when they conduct electricity?
5. Describe the part of an electrolytic cell through which electrons enter and leave the electrolyte.
6. Describe what happens during electrolysis.

Note;

During electrolysis, electrical energy from direct current is converted to chemical energy in an electrolyte.

~~Note:~~ Ans.

1. Electrolyte
Electrodes (anode and cathode)

2. The battery cell is connected both to the anode and cathode in the electrolyte cell.

3. Aqueous solution
Molten

4. The positively charged ions move to the anode and the negatively charged ions move to the cathode after ionisation.

5. Electrons enter through the cathode and move out through the anode.

20/03/24

ELECTROLYSIS OF AQUEOUS SOLUTION.

An aqueous solution of a salt is produced when the salt is dissolved in water. It will contain anions and cations of the salt, and hydrogen and hydroxide ions from the partial dissociation of water molecules:

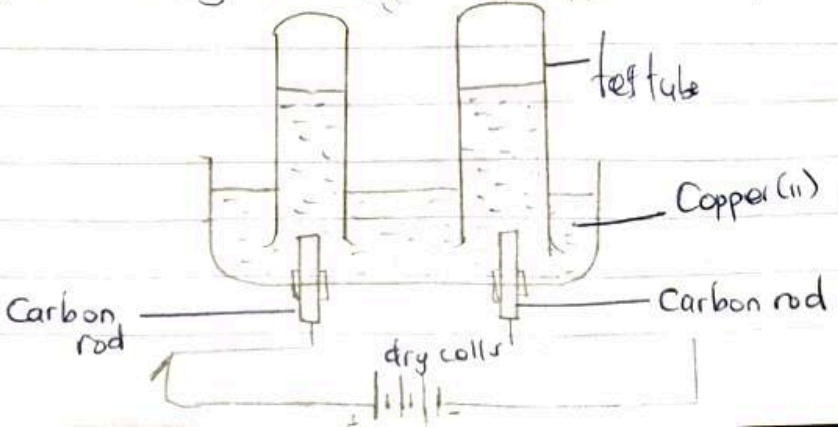
$$H_2O_{(l)} \rightleftharpoons H^+_{(aq)} + OH^-_{(aq)}$$

Forexample, an aqueous solution of sodium chloride, NaCl, contains:

a) cations, which are sodium ions (Na^+) and hydrogen ions (H^+)
b) anions, which are chloride ions (Cl^-) and hydroxide ions (OH^-)

Electrolysis of copper(II) sulphate solution.

Figure showing electrolysis of copper(II) sulphate



A known mass of copper (II) sulphate is dissolved in a known volume of water.
Graphite ~~cells~~ electrodes are then connected to the dry cell and then dipped in a solution of copper (II) sulphate.

Observation
The blue colour of the copper (II) sulphate turns colourless.

Observation at the anode.
Bubbles of a colourless gas.

Observation at the ~~the~~ cathode.
Brown solid

Summary of electrolysis of copper (II) sulphate solution.
Ions present: Cu^{2+}, SO_4^{2-}, H^+, $\bar{O}H_{(aq)}$

Reduction at the cathode
Both Cu^{2+} and H^+ migrate to the cathode but Cu^{2+} are discharged because Cu^{2+} are lower in the electrochemical series.

$$Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$$
(Brown solid)

Reduction at the anode
Both SO_4^{2-} and $\bar{O}H$ migrate to the anode but $\bar{O}H$ are discharged because the OH are lower in the electrochemical series.

$$4\bar{O}H_{(aq)} \longrightarrow O_{2(g)} + H_2O_{(l)} + 4e^-$$
(Colourless gas)

NB:
The resultant solution is acidic because sulphuric acid is formed

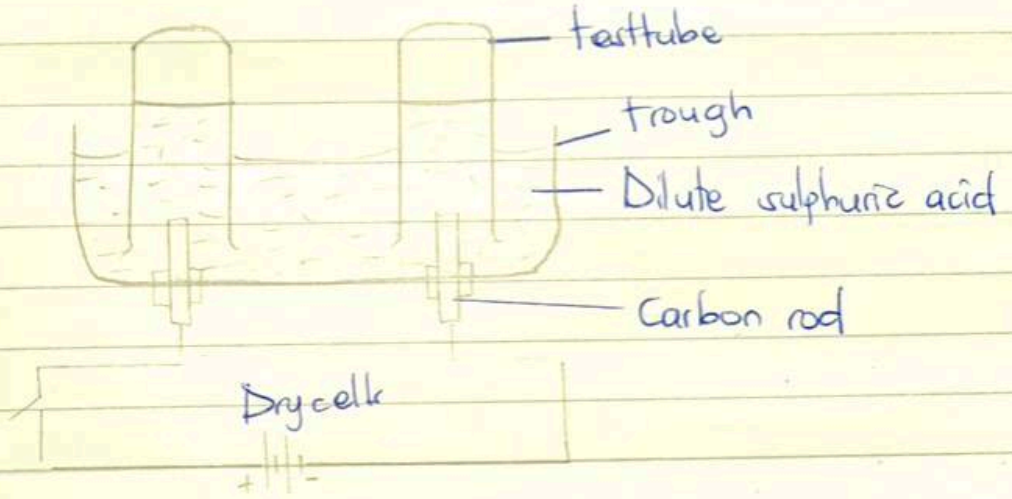
Activity 1.3(e): Electrolysis of dilute sulphuric acid.

What you need

- dry cells
- switch
- carbon electrodes with holders
- connecting wires
- trough
- burning splint
- 2 test tubes
- glowing splint
- 0.5M dilute sulphuric acid.

What to do

1. Fill the trough of the electrolytic cell with 0.5M dilute sulphuric acid until it is half-full.



1. What are the ions present in dilute sulphuric acid?
2a) What did you observe at each of the electrodes?
b) Write ionic equations for the reactions that occured at each of the electrodes.
3. What happened to the colour of the solution at the end of e expt.

Conclusion and Application

1. What can you conclude about the electrolysis of dilute sulphuric acid using inert carbon electrodes
2. State the application of this expt.

Solutions

1. SO_4^{2-}, $OH^-_{(aq)}$, H^+
2a) Anode: Bubbles of a colourless gas
Cathode: Bubbles of colourless gas.
b) Anode: Both sulphate ions and hydroxide ions migrate to the anode but the hydroxide ions are discharged because they are lower in electrochemical series

$$4OH^-_{(aq)} \rightarrow O_{2(g)} + 2H_2O_{(l)} + 4e^-$$

Cathode: Hydrogen ions will be discharged because it is the only positive ion in the solution. $2e^- + 2H^+_{(aq)} \longrightarrow H_{2(g)}$

APPLICATIONS OF ELECTROLYSIS.

Purification of copper

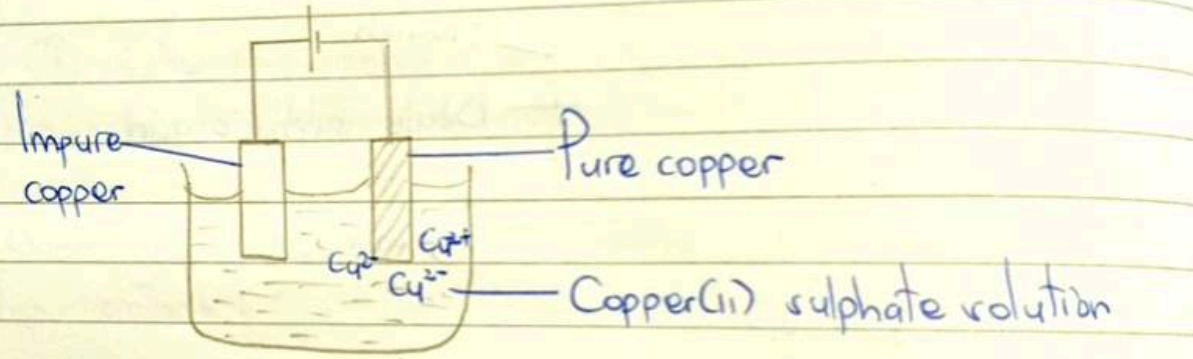
Copper is purified by electrolysis of copper (II) sulphate solution using impure copper as the anode and pure copper as the cathode.

The anode dissolves into the electrolyte to form copper(II) ions to find impurities collect at the bottom of the cell.

$Cu_{(s)} \longrightarrow Cu^{2+}_{(aq)} + 2e^-$

The copper(II) ions migrate to the cathode where they get gain electrons and get deposited as pure copper electrons. metal.

$Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$



Manufacture of sodium hydroxide

Sodium hydroxide is manufactured by electrolysis of brine (concentrated sodium chloride) using carbon anode and flowing mercury cathode.

Electroplating metals

Is the coating of metals with a thin layer of another metal by a process of electrolysis. The metal to be electroplated is used as the cathode while the metal to be used for electroplating is made the anode.

Eg When copper-plating the iron knife, the iron knife is used the cathode while the anode is made of copper. Copper(II) sulphate solution is used as the electrolyte.

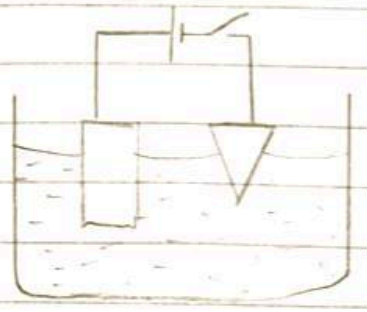
Anode dissolves to form copper(II) ions which migrate to the cathode.

$Cu_{(s)} \longrightarrow Cu^{2+}_{(aq)} + 2e^-$

At the cathode, the copper (II) ions gain electrons and are discharged.

$Cu^{2+}_{(aq)} + 2e^- \longrightarrow Cu_{(s)}$

Copper is deposited on the knife as brown solid



4. Extraction of metals

Metals that are higher in the than carbon in the radioactivity series eg K, Na, Ca, Mg, Al can be extracted from their ores by electrolysis.

The metals are obtained by electrolysis of their electron ores

Assignment 1.1

1. Define the term reducing agent.

A reducing agent is a substance in a redox reaction that loses electrons and so gets oxidised.

2. In each of the following reactions; identify the reducing and oxidising agents;

a) $Mg_{(s)} + Br_{2(l)} \rightarrow MgBr_{2(s)}$

Reducing agent - Magnesium

Oxidising agent - Bromine

v. Good work! Keep it up

b) $2Fe^{3+}_{(aq)} + Zn_{(s)} \rightarrow 2Fe^{2+}_{(aq)} + Zn^{2+}_{(aq)}$

Reducing - Zinc

Oxidising - Iron(III) ions

checked 2/4/2024

c) $2H^+_{(aq)} + Zn_{(s)} \longrightarrow H_{2(g)} + Zn^{2+}_{(aq)}$

Reducing - Zinc

Oxidising - Hydrogen ions

$3CuO_{(s)} + 2NH_{3(g)} \longrightarrow 3Cu_{(s)} + 3H_2O_{(l)} + N_{2(g)}$

Reducing agent - Ammonia gas ✓

Oxidising agent - Copper(II) oxide ✓

$Fe_2O_{3(s)} + 3CO_{(g)} \longrightarrow 2Fe_{(s)} + 3CO_{2(g)}$

Reducing - Carbon monoxide

Oxidising - Iron(III) oxide

$MnO_{4\,(aq)}^{-} + 8H^{+}_{(aq)} + 5Fe^{2+}_{(aq)} \rightarrow Mn^{2+}_{(aq)} + 5Fe^{3+}_{(aq)} + 4H_2O_{(l)}$

Reducing - Iron(III) ions

Oxidising - Permanganante ions ✓

Chapter Summary

a redox reaction is a reaction in which oxidation and reduction occur simultaneously.

a substance is oxidised if it gains oxygen, or loses hydrogen, loses electrons or if its oxidation number increases.

oxidation number is the total number of electrons that a species (atoms or ions) either gains or loses in order to form a chemical bond with another species.

an oxidising agent is a substance that gets oxidised in a redox reaction.

reduction is gaining of electrons, or loss of ~~hydrogen~~ oxygen, or gaining of hydrogen.

electrolysis is a process in which a chemical change, especially decomposition, is brought about by passing an electric current through an electrolytes, and the electrolyte ions move towards the negative and positive electrodes, where they are selectively discharged.

a cathode is a negatively charged electrode by which electrons enter an electrical device.

an anode is a positively charged electrode by which the electrons leave ~~enter~~ an electrical device.

electroplating is the process of coating a layer of a metal onto another metal by electrochemical means. It is most commonly used for decorative purposes or to prevent corrosion of a metal

End-of-Chapter Questions

1a) Copy and complete the following sentences:

i) Oxidation is the loss of electrons, or the gain of ~~oxygen~~ electrons.

ii) Reduction is the gain of hydrogen, or the loss of oxygen.

b) State, with reasons, if the following reactions are redox reactions.

i) $2I^-_{(aq)} + Br_{2(aq)} \rightarrow I_{2(aq)} + 2Br^-_{(aq)}$

ii) $2Ca_{(s)} + O_{2(g)} \rightarrow 2CaO_{(s)}$

iii) $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

2. State whether the underlined substances have been oxidised or reduced:

a) $\underline{2Mg}_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$

b) $2Ag_{(s)} + \underline{Pb^{2+}}_{(aq)} \rightarrow 2Ag^+_{(aq)} + Pb_{(s)}$

c) $2Ni_{(s)} + \underline{Sn^{2+}}_{(aq)} \rightarrow Ni^{2+}_{(aq)} + Sn_{(s)}$

3. When copper(II) oxide dissolves in dilute sulphuric acid, copper(II) sulphate and water are produced.

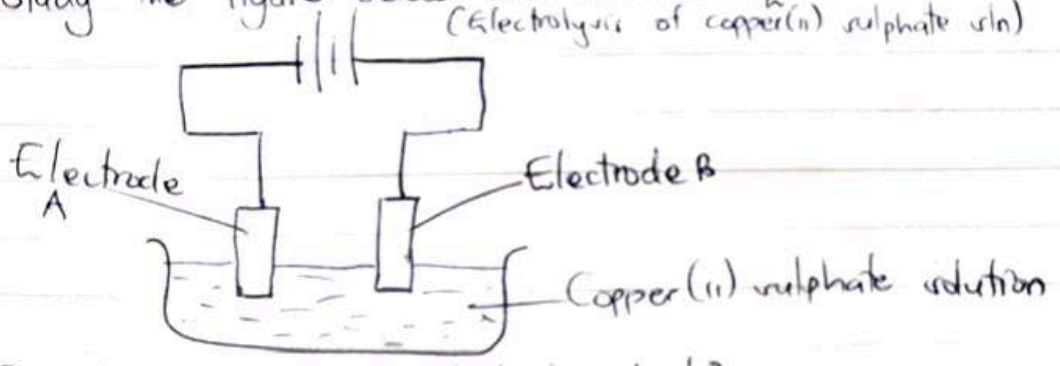
a) Write a balanced chemical equation for the reaction.

b) Discuss the changes in the oxidation numbers of the species involved in this reaction.

c) Is copper oxidised or reduced in the reaction?

4. Study the figure below and answer qtns that follow.

(Electrolysis of copper(II) sulphate soln)



a) Give the names of the electrodes A & B

b) Which electrode is the oxidising electrode?

5 a) What is an electrolyte?

b) Classify the following substances as strong electrolytes, or weak electrolytes, or non-electrolytes: acetic acid, ammonium hydroxide, ammonium chloride, carbon tetrachloride, dilute hydrochloric acid, sodium acetate, dilute sulphuric acid.

Date; 27th March, 2024.

INDUSTRIAL PROCESSES

Main Industries that Produce Useful Chemicals.

Name of product	Industry
Cloth	Textile industry
Steel bars	Steel making industry
Batteries	Electronics industry
Water	Beverages
Cement	Mining industry
Plastics	Plastics industry
fertilizers	Agro-based industries
Sugar	Sugar industry

Assignment 2.1

Complete the table below.

Industry	Product	Class of industry
Mining	limestone	Primary.
Electronics	Cars	Secondary
Pharmaceuticals	Drugs	Primary
Steelbar industry	Steel bar	Secondary

Common Industries

Common product	Main industries	Use of the product
Steel pipes	Steel industry	For construction
Soda and mineral water	Beverage/food industry	For drinking
Cement	Mining industry	It is used for construction
Fertilisers	Fertiliser industry	Applied in soil to increase its fertility.
Soap and detergent	Detergent industry	Are used to remove dirt from clothes
Sanitizers	Chemical industry	Killing germs in the hands
Battery	Electronics	They convert chemical energy to electrical energy
Jelly	Cosmetics	For moisturing the skin.

Day: Wednesday
Date: 3rd April, 2024.

How do the industries affect human welfare?
Jelly industries produce vaseline used to beautify our skins.

PROCESSES OF OBTAINING USEFUL CHEMICALS FROM ROCKS.

Useful Chemicals from Rocks.

There are several useful chemicals in rocks. These chemicals are obtained by use of different chemical process.

Most rocks are composed of naturally occuring inorganic solids that have a crystal structure and a distinct chemical composition. These are known as 'minerals'.

Elements that make up different minerals.

Mineral	Chemical formula	Uses
Silver	Ag	Making jewellery, mirrors, trophies
Copper	Cu	Electric wires, coins, jewellery
Graphite	C	Lead pencils, electrodes, lubricants
Cinnabar	HgS (Mercury(II) sulphide)	Colouring paint, producing mercury
Galena	PbS	Making lead, lead pipes and sheets
Pyrite	FeS_2	Production of sulphur dioxide, sulphuric acide
Halite or rock salt	NaCl	Added in food to make taste, maintaining blood pressure, foodpreservative
Corundum	Al_2O_3	Grinding optical metals, polishing metals.
Cuprite	Cu_2O	Used in making jewellery
Haematite	Fe_2O_3	Producing pigment, production of iron
Calcite	$CaCO_3$	Construction material
Dolomite	$CaMg(CO_3)_2$	Used as an ingredient in production of glass, bricks
Gypsum	$CaSO_4 \cdot 2H_2O$	Used in manufacture of cement
Anhydrite	$CaSO_4$	Used as drying agent in plaster, paint and varnish
Albite	$NaAlSi_3O_3$	Manufacture of glass and ceramics
Olivine	$(Mg, Fe)_2SiO_4$	Added to glass furnaces to remove impurities from the steel to form slug.
Orthoclase	$KAlSi_2O_8$	Manufacture of glass
Quartz	SiO_2	Making watches, oscillators for watches and clocks.

Note:

Rocks usually contain limestone that can be tested for using an acidic solution whereby a rock that contains limestone evolves carbon dioxide. The limestone also known as calcium carbonate.

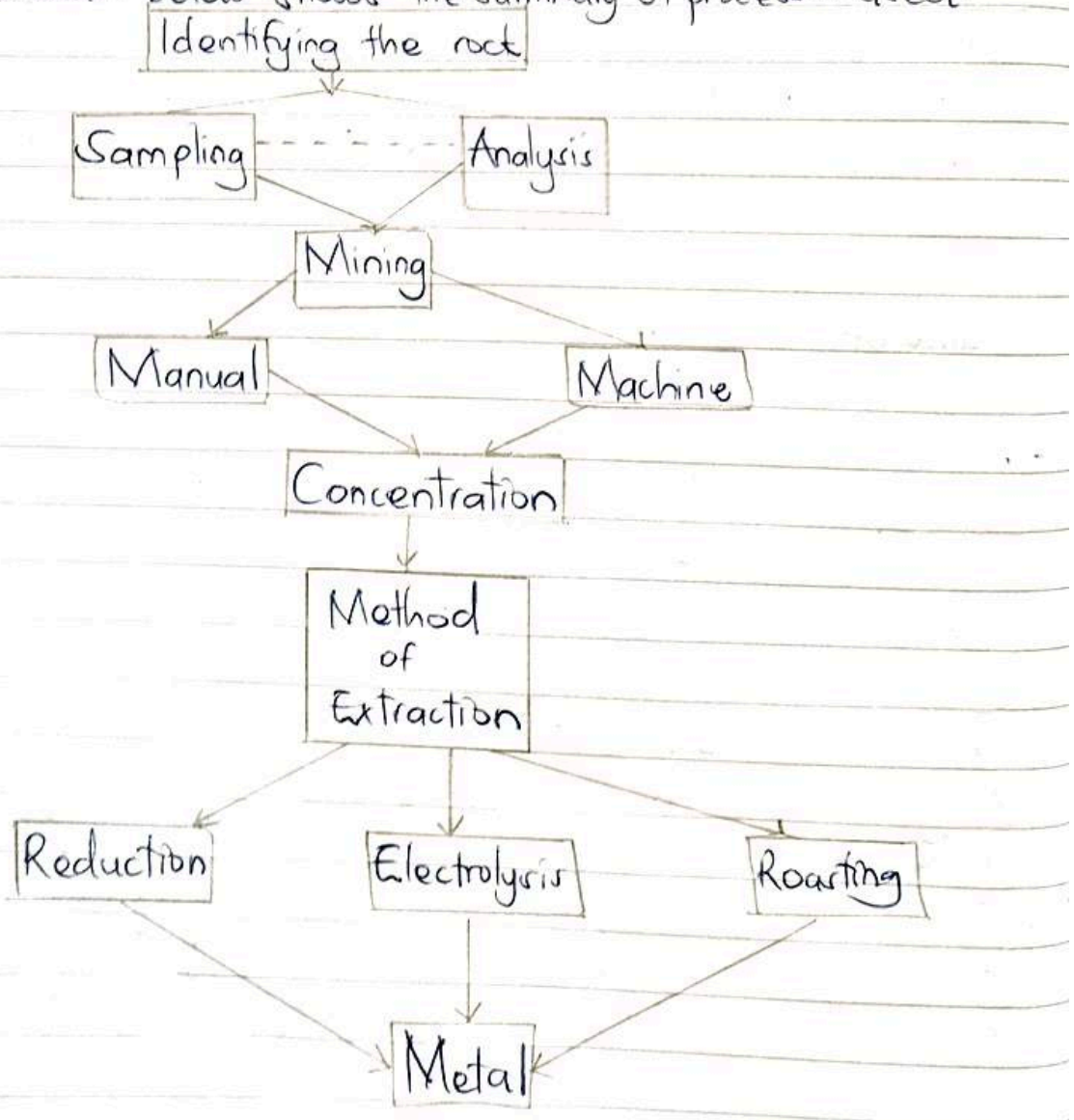
Chalk also contain calcium carbonate and the calcium carbonate can also be tested for using vinegar where carbon dioxide gas is evolved.

$$CH_3COOH_{(aq)} + CaCO_{3(s)} \longrightarrow (CH_3COO)_2Ca_{(aq)} + CO_{2(g)} + H_2O_{(l)}$$

In a similar way, due to presence of dissolved carbon dioxide, rain water is also weakly acidic and can dissolve carbonates in rocks.

Studying Processes Involved in obtaining useful chemicals from rocks.

The flow chart below shows the summary of processes used.



Day: Monday
Date: 8th April, 2024

STUDYING PROCESSES INVOLVED IN OBTAINING USEFUL CHEMICALS FROM ROCKS.

The whole process starts with identifying the rock where the mineral is found.

There is then sampling which helps to obtain the information necessary for economic assessment of the ore.

Analysis is done and this gives information about the ore before massive mining can begin.

After sampling and analysis, mining can then be carried out using manual methods and excavation (machinery) methods

The ore can then be concentrated using methods like Froth floatation, Roasting, Gravity separation.

The ore can then be extracted using a suitable ore for extraction.

Methods of extraction.

Method	Example of metal extracted.
Electrolysis	Sodium, Potassium, aluminium
Chemical reduction	Iron, Zinc
Roasting in air	Zinc, copper
No extraction process	Gold, Silver

Note:

Sampling can be harder machine sampling

Mining methods: Manual mining methods consume more time than excavation method. Also the manual method is risky in terms of accidents than the excavation

Properties considered before concentration.

- Chemical composition of the ore
- Conductivity of the ore
- Solubility of the ore
- Density of the ore