

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.

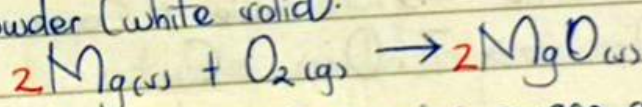
When oxidation and reduction occur simultaneously, the entire process is known as a REDOX reaction.

OXIDATION REACTIONS.

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

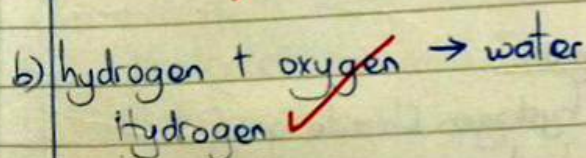
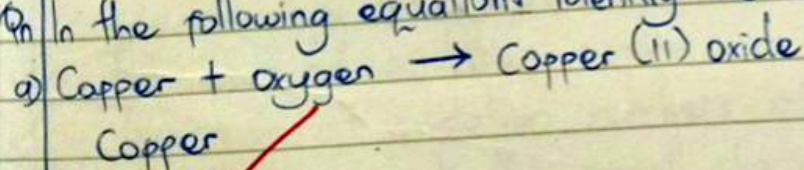
Oxidation as a gain of oxygen.

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

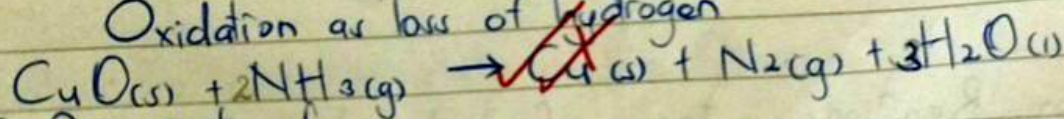


In this reaction, magnesium gains oxygen and therefore it is oxidized. This is an example of an oxidation reaction.

Q. In the following equations identify the substances which are oxidized



Oxidation as loss of hydrogen



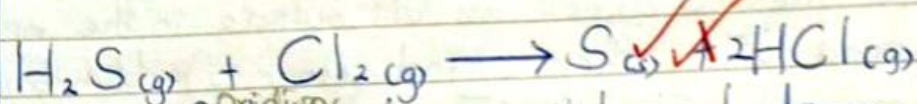
$\text{CuO} \rightarrow$ Reduced

$\text{NH}_3 \rightarrow$ 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 - ^{Oxidiser} Reducer because it loses hydrogen

Cl_2 - ^{Red} Oxidiser because it gains hydrogen

H_2S - Oxidises because it loses hydrogen

Cl_2 - Reduces because it gains hydrogen

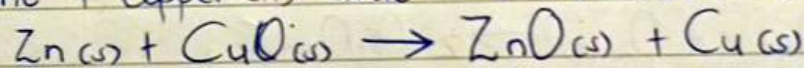
15th February, 2024

REDUCTION REACTIONS.

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

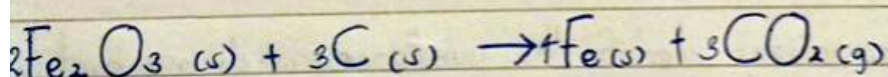
Reduction as loss of oxygen.

E.g. Zinc + Copper (II) oxide $\rightarrow$ Zinc oxide + Copper



Zn - Oxidiser

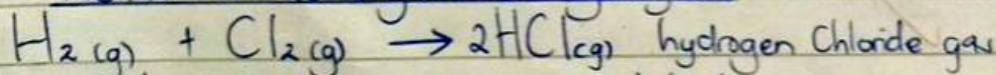
Cu - Oxid Reducer



Fe - Reduced

C - Oxidised

Reduction as a gain of hydrogen.



Cl_2 - Reduced because it has gained hydrogen.

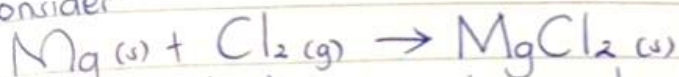
H_2 -

Redox Reactions in terms of electron transfer.

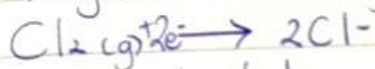
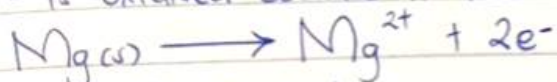
Oxidation - is the loss of electrons

Reduction - is the gain of electrons

Consider

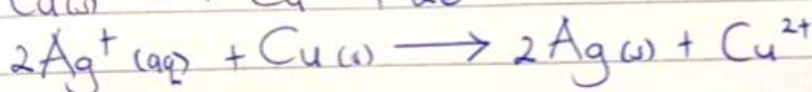
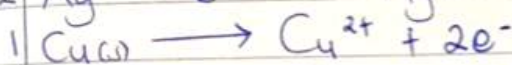
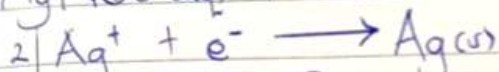
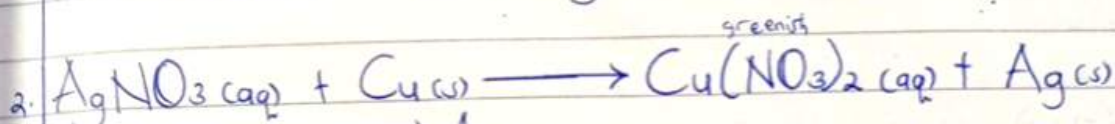


Mg - is oxidised because it loses its electrons



Mg - is oxidised because it lost two electrons

Cl₂ - is reduced because it gained two electrons



21st February, 2024 -

OXIDATION NUMBER (STATE).

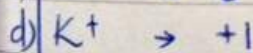
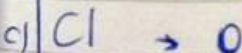
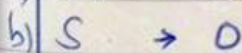
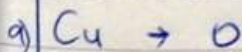
Is the total number of electrons that an electron atom or ion should gain or lose to form a chemical bond

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.



Calculate the overall oxidation state in;

a) CaCO_3

$$\text{Ca} = +2$$

$$\text{C} = +4$$

$$\text{O}_3 = (3 \times -2) = -6$$

Overall oxidation

$$+2 + 4 - 6$$

$$= 0$$

b) MgCl_2

$$\text{Mg} = +2$$

$$\text{Cl}_2 = (-1 \times 2) = -2$$

Overall oxidation

$$+2 - 2 = 0$$

c) H_2O

$$\text{H}_2 = (2 \times +1) = +2$$

$$\text{O} = -2$$

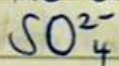
$$\text{Overall oxidation} = +2 - 2$$

$$= 0$$

Calculate the oxidation states of the following.

a) Sulphur in sulphate

Let the oxidation number of sulphur be m



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

$$m = -2 + 8$$

$$m = +6$$

b) Nitrogen in nitrate



Let the oxidation number of nitrogen be k

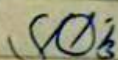
$$k + (-2 \times 3) = -1$$

$$k + (-6) = -1$$

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

$$k = +5$$

c) Sulphur in sulphur trioxide



Let the oxidation of sulphur be x
 $x + 6(-2) = -2$

Day: Thursday
Date: 22nd Feb, 2024.

Calculating oxidation number.

Calculate the oxidation number of nitrogen in each of the following

NO_2

Let the oxidation number be b

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

$$b - 4 = 0$$

$$b = +4$$

e) NH_3

Let the oxidation number be y

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

$$y + 3 = 0$$

$$y = -3$$

b) NO_3^-

Let the oxidation number be m

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

$$m - 6 = -1$$

$$m = +5$$

f) Mg_3N_2

Let the oxidation number be k

$k + l$

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

$$2k + 6l = 0$$

$$\frac{2k}{2} = \frac{-6l}{2}$$

$$k = -3$$

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

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

$$k - 6 = 0$$

$$k = +6$$

Calculate the oxidation state 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.

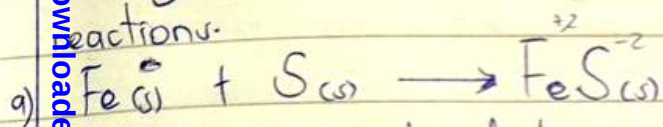
Oxidation Reduction Reactions in terms of increase or decrease in oxidation number.

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

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

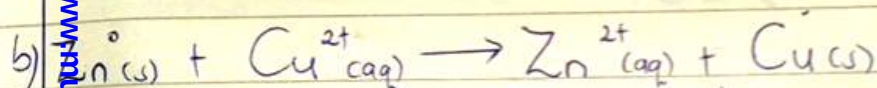
Examples.

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



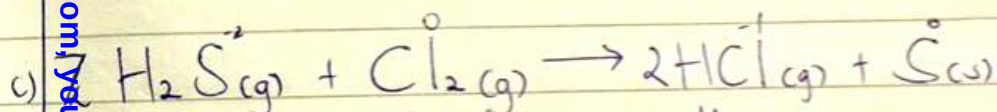
Fe has been oxidised because there is increase in oxidation number

S has been reduced because there is decrease in oxidation number



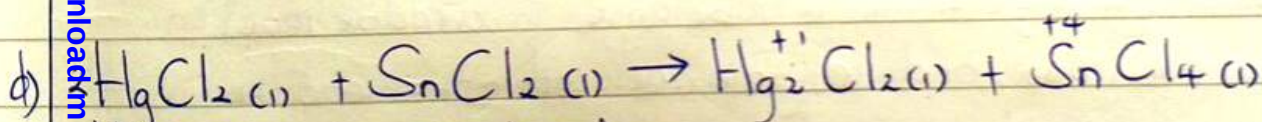
Zn has been oxidised because there is increase in oxidation number.

Cu has been reduced because there is decrease in oxidation number.



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

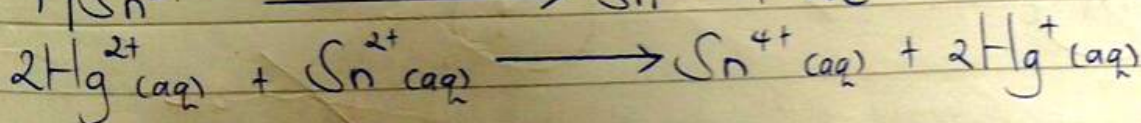
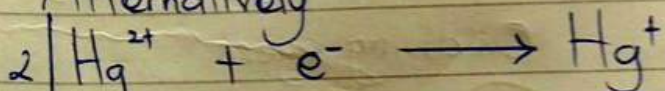
Cl has been reduced



Hg - Has been reduced

Sn - Has been oxidised

Alternatively



5th March, 2024.

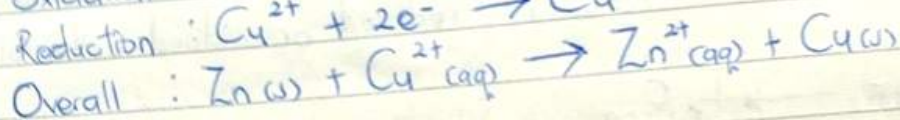
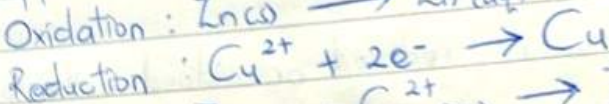
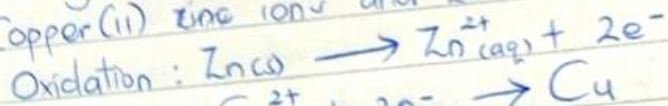
Exploring oxidation and reduction

Wednesday, 6th March, 2024.

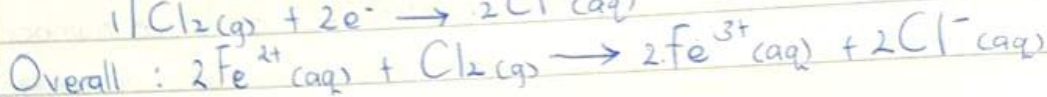
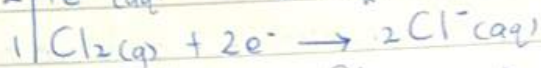
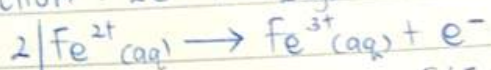
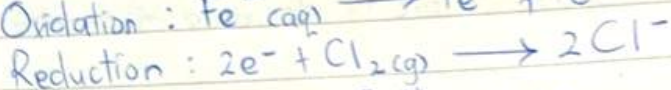
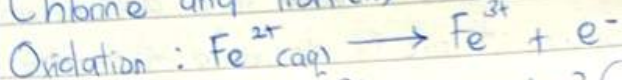
Exploring oxidation and reduction reactions in terms of electron transfer.

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

a) Copper(II) zinc ions and zinc metal



b) Chlorine and Iron(II) ions



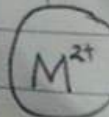
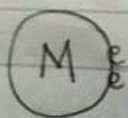
c) Hydrogen peroxide and manganate(VII) ions in acidic medium.

OXIDISING AND REDUCING AGENTS.

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

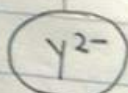
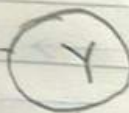
A reducing agent is a substance that in a redox reaction that loses electrons, and so, gets oxidised in the reaction.

Reducing agent



M is oxidised

Oxidising agent



Y is reduced

✓ ok

Oxidising agents

Bromine (Br_2)

Chlorine (Cl_2)

Concentrated sulphuric acid (H_2SO_4)

Nitric acid (HNO_3)

Oxygen (O_2)

Potassium permanganate (KMnO_4)

Potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$)

Hydrogen peroxide (H_2O_2)

Reducing agents

Carbon (C)

Carbon monoxide (CO)

Hydrogen (H_2)

Hydrogen sulphide (H_2S)

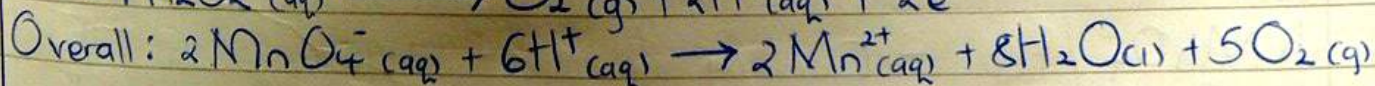
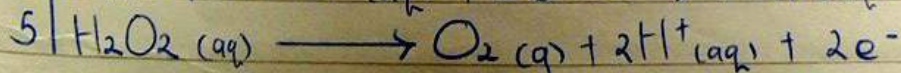
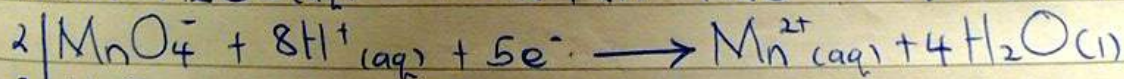
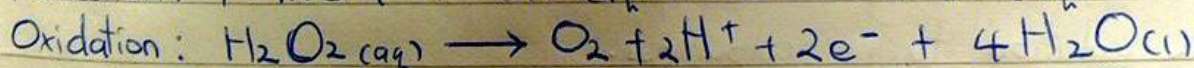
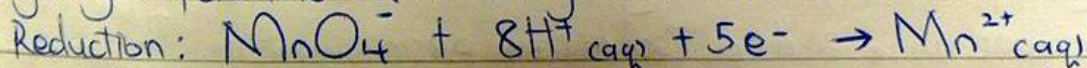
metals

potassium iodide (KI)

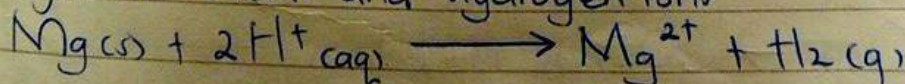
sulphur dioxide (SO_2)

ammonia (NH_3)

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



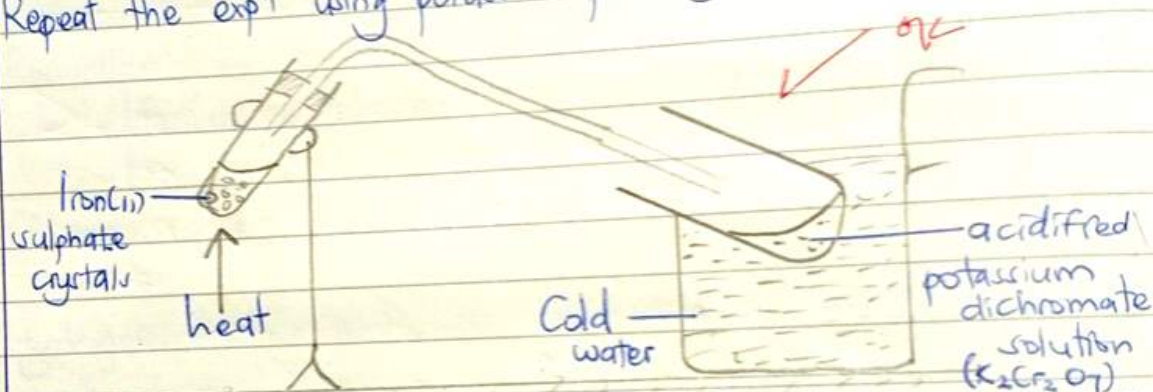
d) Magnesium metal and hydrogen ions



Tuesday, 12th March 2024

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

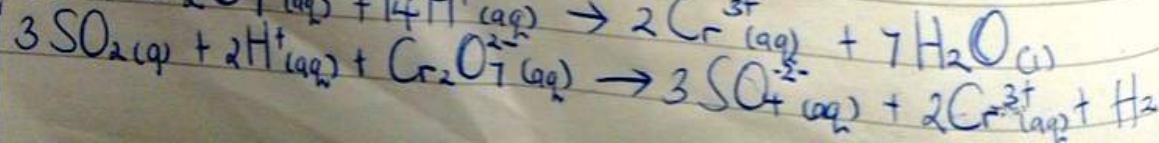
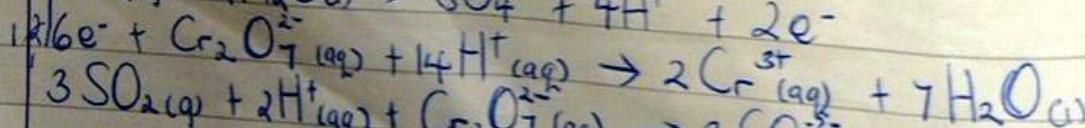
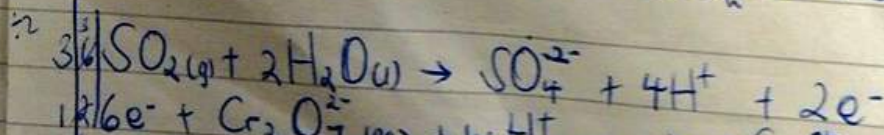
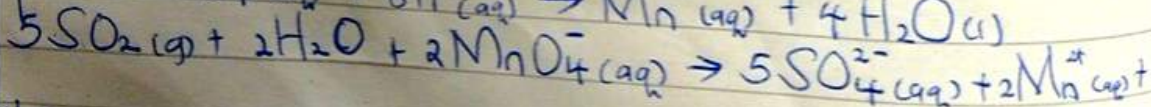
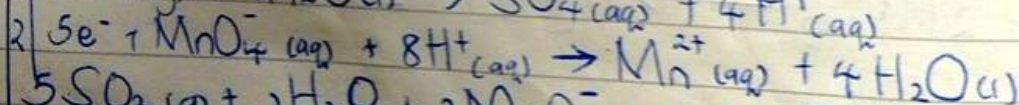
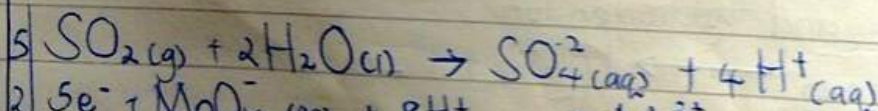
1. Transfer 5cm^3 of potassium dichromate solution into a boiling tube.
2. Add 3cm^3 of dilute sulphuric acid to potassium dichromate solution in a boiling tube.
3. Transfer 6g of iron(II) sulphate crystals into another boiling tube.
4. Hold the boiling tube containing acidified potassium dichromate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



State the observation made using acidified potassium dichromate.
~~Purple solution turns colourless.~~ The ^{an} orange solution.
 The orange solution turns to green.

- ii) Observation made using acidified potassium permanganate soln.
 Purple solution turns colourless.

$\text{KMnO}_4 / \text{H}^+$ - Oxidising
 $\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}^+$ - Oxidising



Conclusion:

$\text{SO}_2(\text{g})$ is a reducing agent

$\text{KMnO}_4 / \text{K}_2\text{Cr}_2\text{O}_7$ in acid medium are oxidising agents.

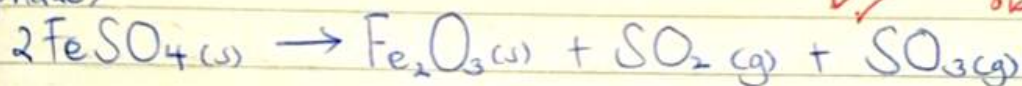
Observation

(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)



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 cell in which a thin layer of metal is deposited onto an electrically conductive 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.

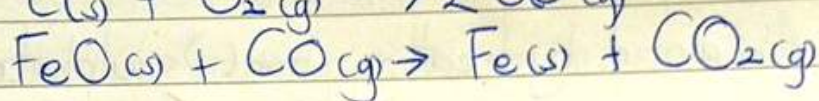
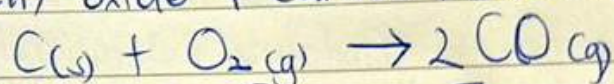
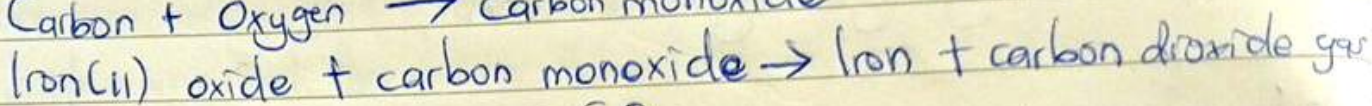
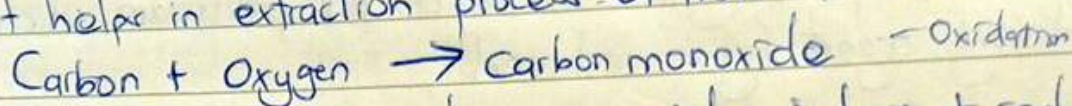
Element	Ore	Importance of the ore
Iron	Magnetite (Fe_3O_4) Haematite (Fe_2O_3)	Used in making iron bars.
Zinc	Zinc blende (ZnS)	For holding since it is an insulator.
Aluminium	Bauxite (Al_2O_3)	For making saucepans
Copper	Copper pyrites (CuFeS_2)	Used for making copper wires

Importances of ores.

- The ores are used to make finished materials for example 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,



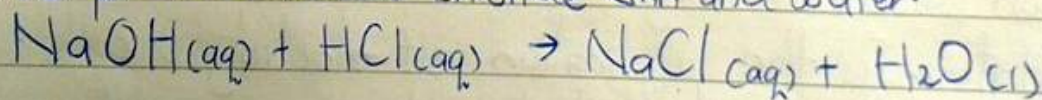
Distinguishing between redox and non-redox reactions

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

Solutions of barium chloride and sodium sulphate react to give insoluble barium sulphate and the solution of sodium chloride.



Sodium hydroxide solution reacts with hydrochloric acid solution to provide produce sodium chloride soln and water.



ELECTROLYSIS

Refers 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. Conductors have free mobile electrons 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 conductors have electrons that are locked up in the covalent bonds and 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 electrolytes that ionise completely in aqueous solution. e.g.
- 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 and are not free to move thus do not conduct electric current.

However in aqueous 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 ($\text{NH}_3(\text{aq})$ or $\text{NH}_4^+ \text{OH}^-$), ethanoic acid (CH_3COOH), Carbonic acid (H_2CO_3)

Non-electrolyte.

Is a solution or molten compound that does not conduct electricity eg paraffin, sugar solution, petrol, ethanol, trichloromethane, tetrachloromethane

Electrodes.

Are terminals where electric current enter and leave the electrolyte. The electrodes are two i.e. anode and cathode respectively.

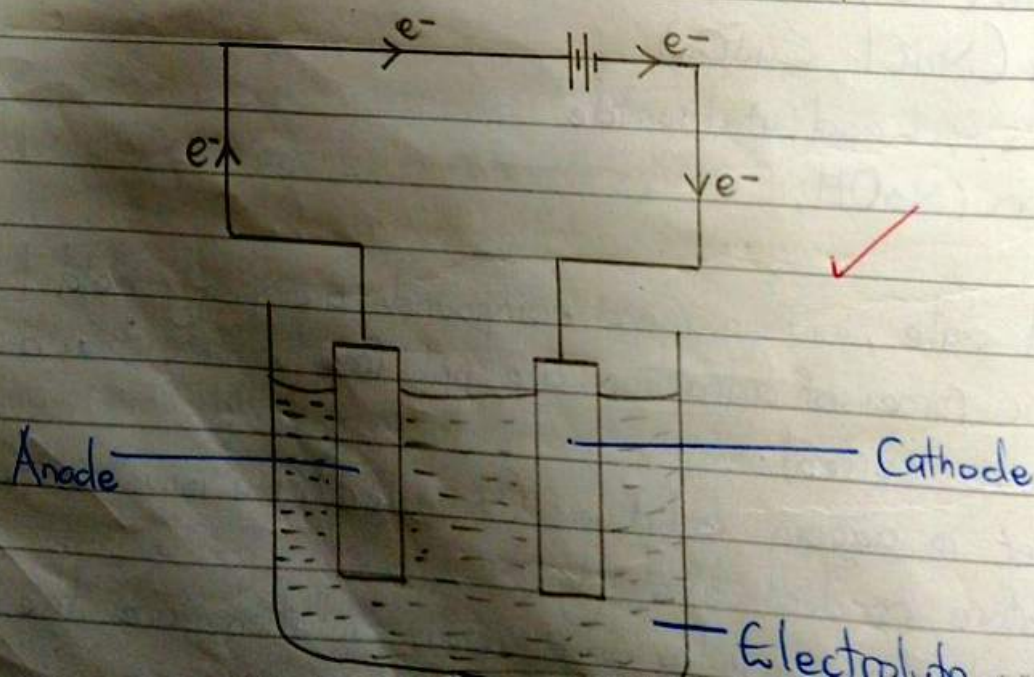
Anode.

Is a positive electrode through which electric current enters the electrolyte.

Cathode.

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

Illustration



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 | - pipe clay triangle | - spatula | - beakers |
| - crucible | - tripod stand | - naphthalene | - lead(II) bromide powder |

What to do

Fill two-thirds of the crucible with lead(II) bromide.

Place the crucible and its contents on a pipe clay triangle on a tripod stand.

Dip the two carbon electrodes into the solid lead(II) bromide and connect the batteries with the connecting wires.

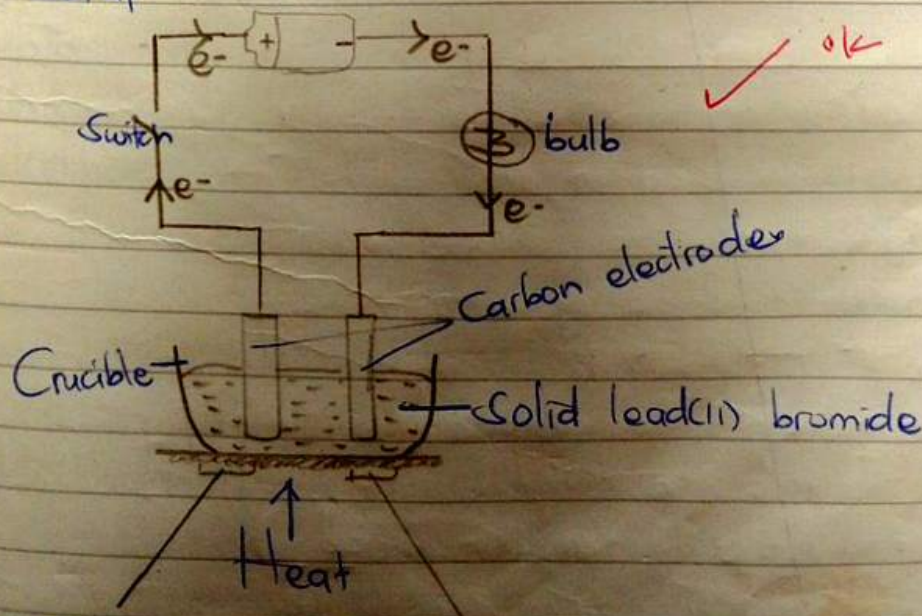
Turn on the switch and check whether the bulb lights up.

Now, heat the lead(II) bromide in the crucible until it melts.

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.

Repeat steps (1) to (6) by replacing solid lead(II) bromide with naphthalene.

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
- glucose solution and powder
- crucible
- weighing balance
- beakers
- carbon electrodes
- pipe clay triangle
- tripod stand
- bulb
- connecting wires
- dry cell
- 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	No observation	No conductivity
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 does not break down into ions.

Conclusion

Electrolytes

- Molten lead(II) bromide
- Aqueous sodium chloride

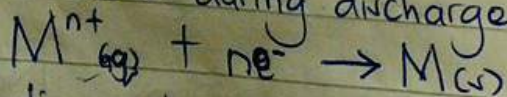
Non-electrolytes

- Glucose
- Naphthalene

PRINCIPLES OF ELECTROLYSIS

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

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



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 preference to one upper in the electrochemical series.

Electrochemical series

Cations

Li^+	Zn^{2+}
K^+	Fe^{2+}
Ca^{2+}	Pb^{2+}
Na^+	H^+
Mg^{2+}	Cu^{2+}
Al^{3+}	Ag^+
Zn^{2+}	
Fe^{2+}	
Pb^{2+}	
H^+	
Cu^{2+}	
Ag^+	

Anions

NO_3^-
SO_4^{2-}
Cl^-
Br^-
I^-
OH^-

Increasing ease of discharge



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 / hydroxyl ions and sodium ions are discharged at the cathode instead of the sodium hydrogen ions.

c) Nature of electrode

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

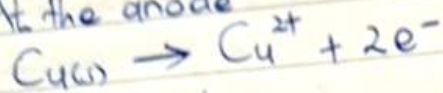
Other electrodes other than graphite determine the ion to be discharged eg during electrolysis of copper(II) sulphate

When platinum electrodes are used:

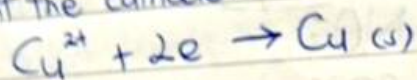
At the anode; hydroxide ions are discharged.
At the cathode; Copper(II) ions discharged.

b) When copper electrodes are used.

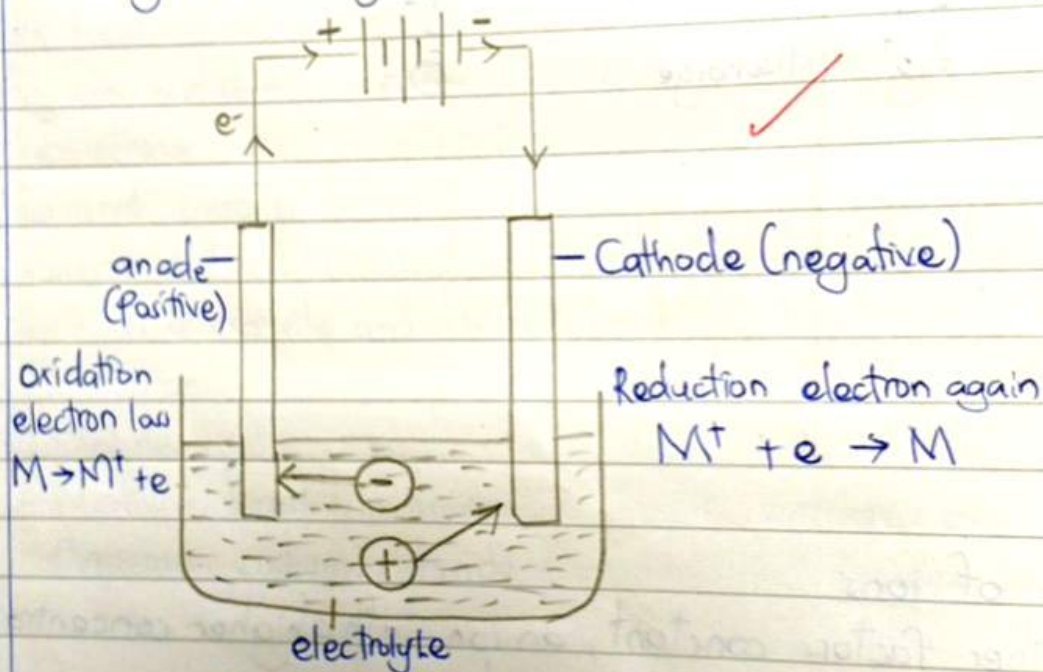
At the anode



At the cathode



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.

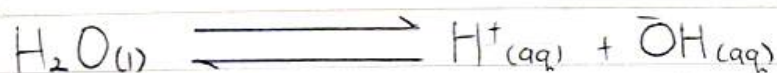
3. Aqueous solution
Molten

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.

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:

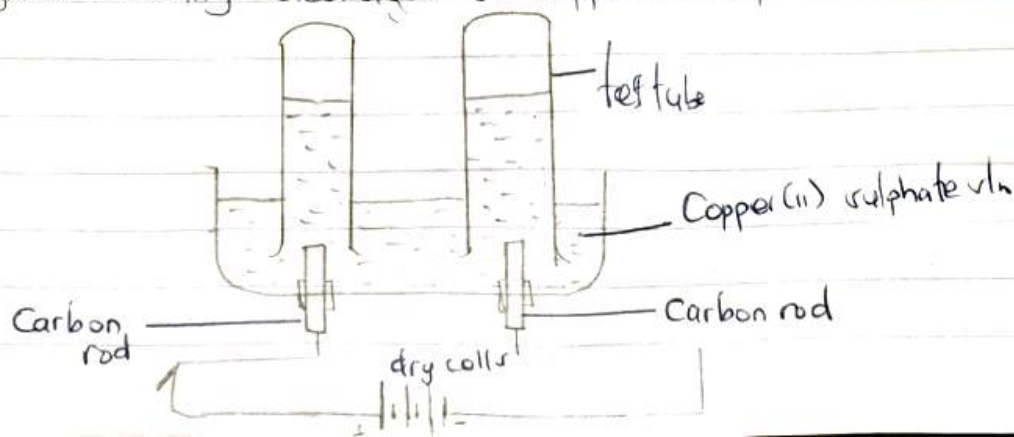


For example, an aqueous solution of sodium chloride, NaCl, contains:

- cations, which are sodium ions (Na^+) and hydrogen ions (H^+)
- 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 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 cathode

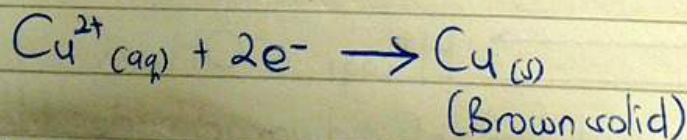
Brown solid

Summary of electrolysis of copper (II) sulphate solution

Ions present: Cu^{2+} , SO_4^{2-} , H^+ , OH^- (aq)

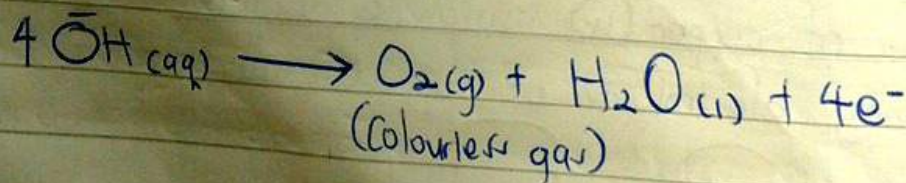
Reduction at the cathode

Both Cu^{2+} and H^+ migrate to the cathode but Cu^{2+} are discharged because $E^\circ_{\text{Cu}^{2+}}$ are lower in the electrochemical series.



Reduction at the anode

Both SO_4^{2-} and OH^- migrate to the anode but OH^- are discharged because the OH^- are lower in the electrochemical series.



NB:

The resultant solution is acidic because sulphuric acid is formed.

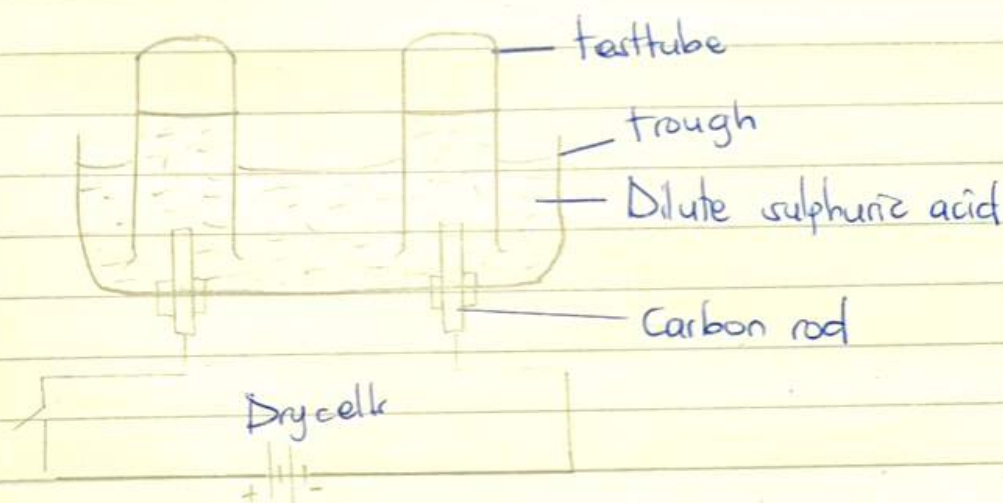
Activity 1.3(e): Electrolysis of dilute sulphuric acid.

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 occurred at each of the electrodes.
3. What happened to the colour of the solution at the end of the 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-} , $\text{OH}^-(\text{aq})$, 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.

$$4\text{OH}^-(\text{aq}) \rightarrow \text{O}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 4\text{e}^-$$

Cathode: Hydrogen ions will be discharged because it is the only positive ion in the solution.

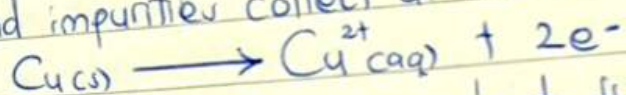
$$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$$

APPLICATIONS OF ELECTROLYSIS.

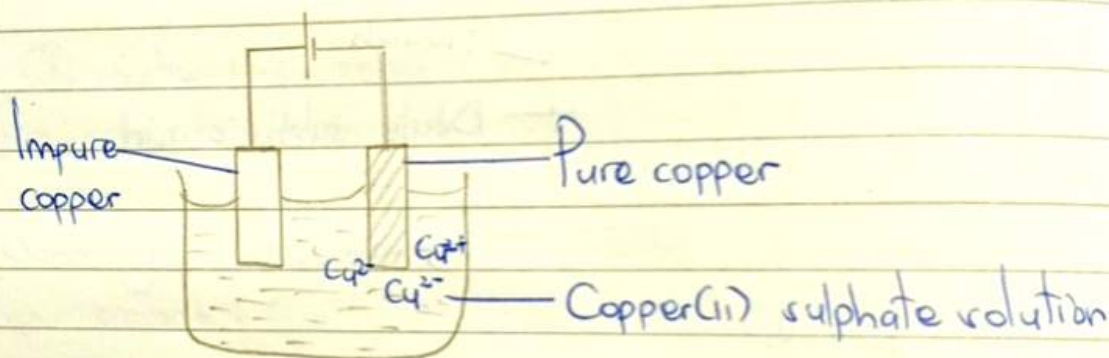
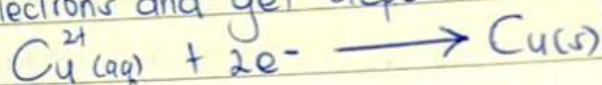
Purification of copper

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 and impurities collect at the bottom of the cell.



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



Manufacture of sodium hydroxide

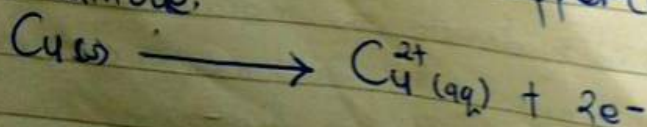
Sodium hydroxide is manufactured by electrolysis of brine (concentrated sodium chloride) using carbon anode and flowing mercury cathode.

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 as the cathode while the anode is made of copper. Copper(II) sulphate solution is used as the electrolyte.

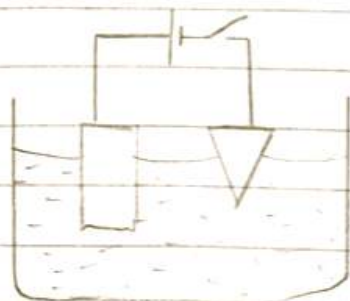
Anode dissolves to form copper(II) ions which migrate to the cathode.



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



Copper is deposited on the knife as brown solid



4. Extraction of metals

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

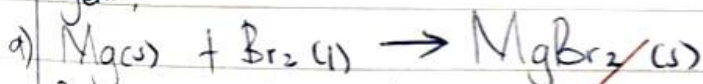
The metals are obtained by electrolysis of their molten ores

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:



Reducing agent - Magnesium

Oxidising agent - Bromine

V. Good work!
Keep it up!
Mumtaz Durrani



Reducing - Zinc

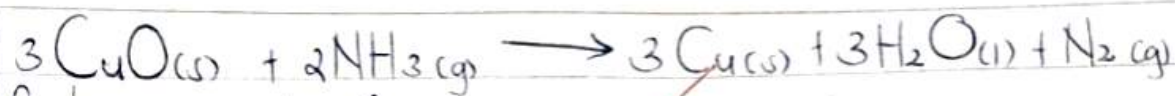
Oxidising - Iron(III) ions

checked
2/4/2024



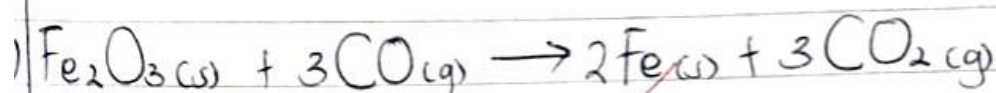
Reducing - Zinc

Oxidising - Hydrogen ions



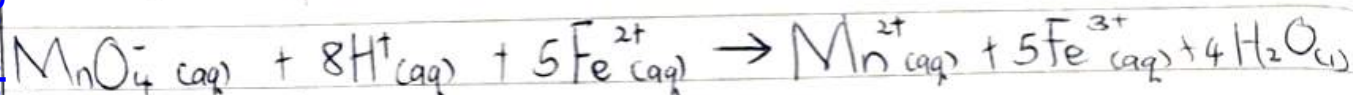
Reducing agent - Ammonia gas ✓

Oxidising agent - Copper(II) oxide ✓



Reducing - Carbon monoxide ✓

Oxidising - Iron(III) oxide



Reducing - Iron(II) ions

Oxidising - Permanganate 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 electrolyte, and the electrolyte's 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 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.

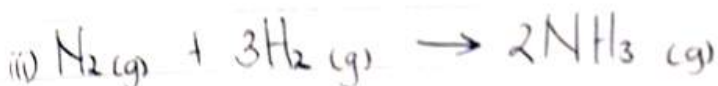
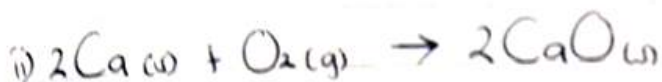
End-of-Chapter Questions

a) Copy and complete the following sentences:

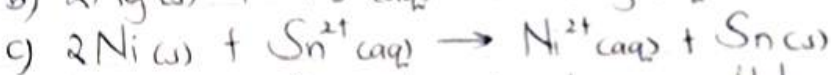
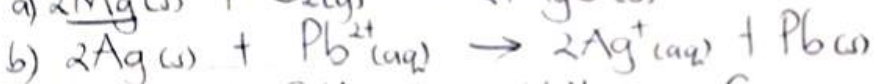
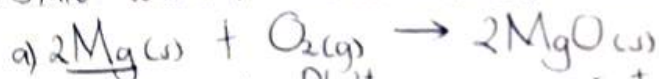
i) Oxidation is the loss of electrons or the gain of oxygen.

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

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



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



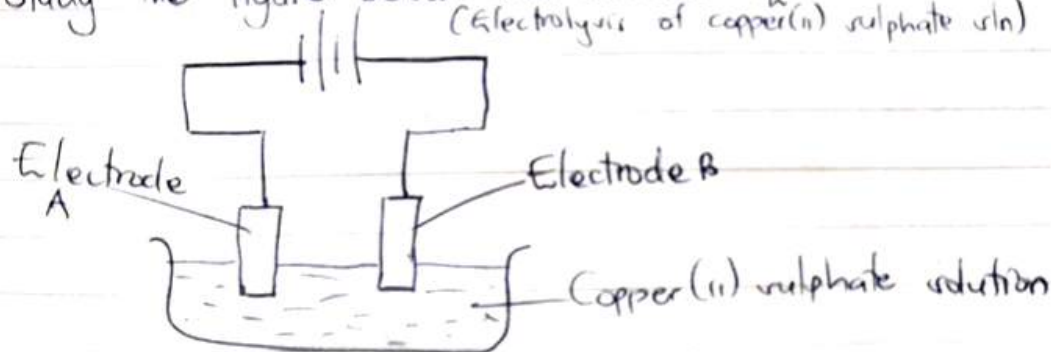
3. When copper(II) oxide dissolves in dilute sulphuric acid, copper(II) sulphate and water are produced.

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 qns 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 electrolyte, or weak electrolyte, or non-electrolyte: 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	Ago-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
Steel bar 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 moisturizing 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 occurring 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	User
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 acid
Halite or rock salt	NaCl	Added in food to make taste, maintaining blood pressure, food preservative
Corundum	Al ₂ O ₃	Grinding optical metals, polishing metals.
Cuprite	Cu ₂ O	Used in making jewellery
Haematite	Fe ₂ O 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 · 2H ₂ O	Used in manufacture of cement
Anhydrite	CaSO ₄	Used as drying agent in plaster, paint and varnish
Albite	NaAlSi ₃ O ₈	Manufacture of glass and ceramics
Olivine	(Mg, Fe) ₂ SiO ₄	Added to glass furnaces to remove impurities from the steel to form slag.
Orthoclase	KAlSi ₃ O ₈	Manufacture of glass
Quartz	SiO ₂	Making watches, oscillators for watches and clocks.

Note:

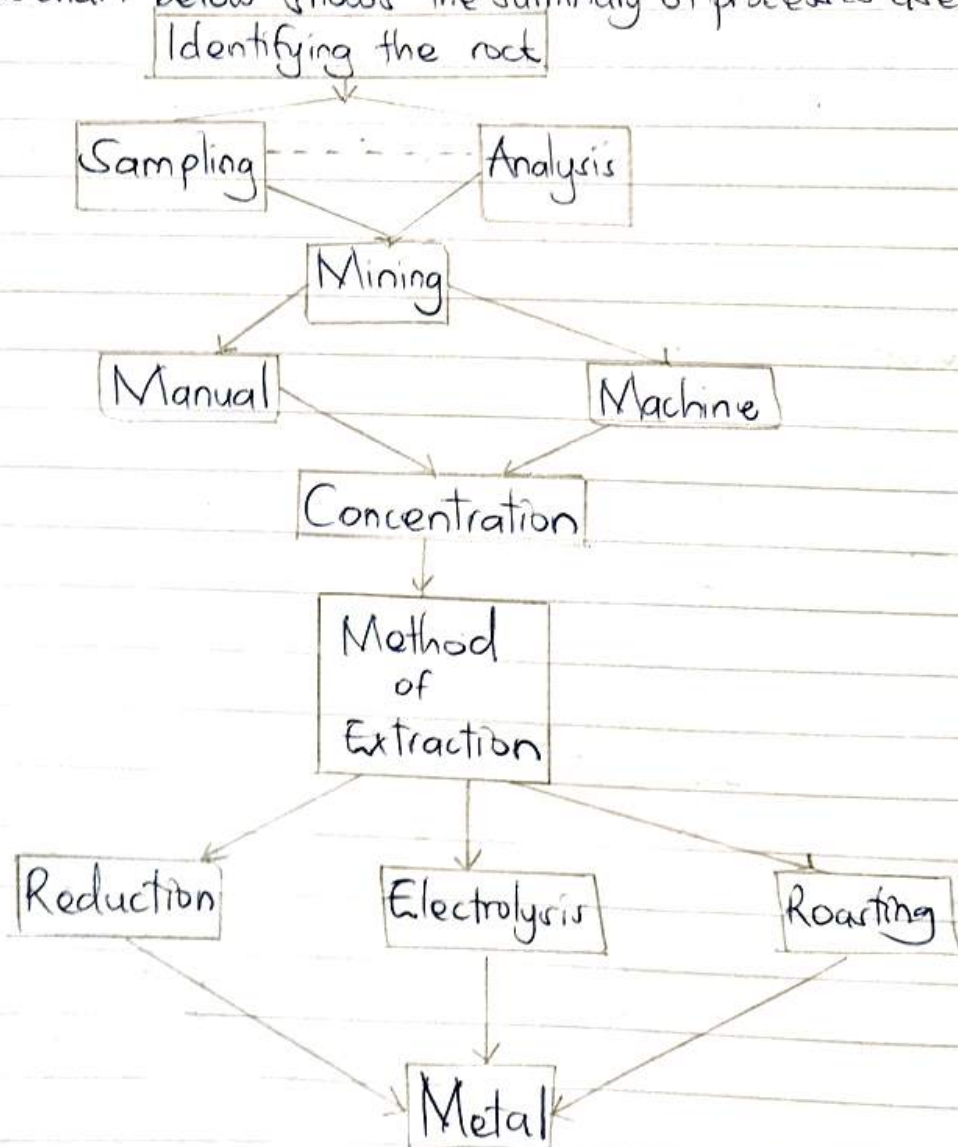
Rocks usually contain limestone that can be tested for using an acidic solution whereby a rock that contains limestone evolves carbon dioxide. The limestone is also known as calcium carbonate.

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



In a similar way, due to presence of dissolved carbon dioxide, rain water is also weakly acidic and can dissolve carbonate 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 hand or 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