

14th December, 2023.

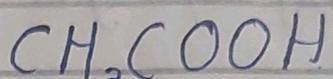
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Thursday

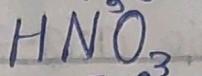
ACIDS AND BASES

ACID

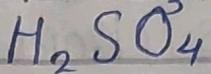
Ethanoic Acid



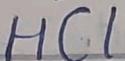
Nitric Acid



Sulphuric Acid

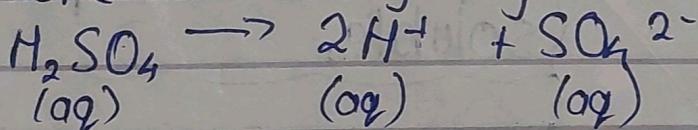
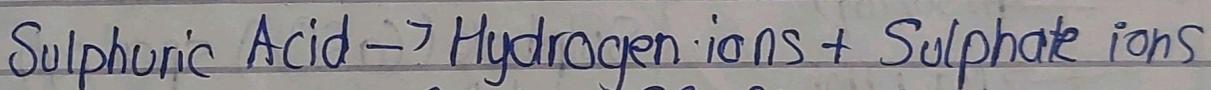
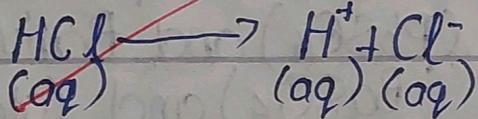
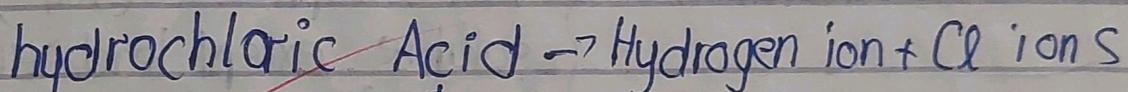


Hydrochloric Acid



"Acid is a substance that produces hydrogen, H⁺ ions, in aqueous solution?"

e.g



"The hydrogen ions that are produced are responsible for the acidic properties of a substance".

Properties of Acids

- ① Acids have sour taste.
- ② Acids dissolve in water to form solutions which can conduct electricity.
- ③ Acids can turn blue litmus paper red.
- ④ Acids react with reactive metals to form salt and hydrogen gas.

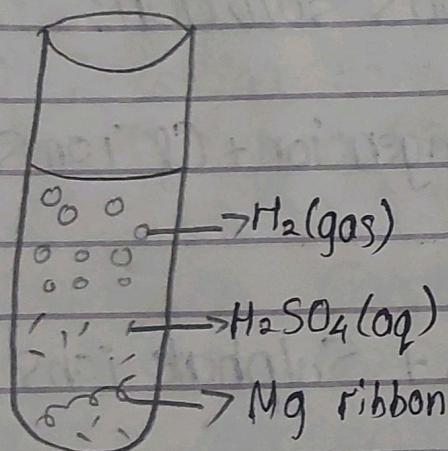
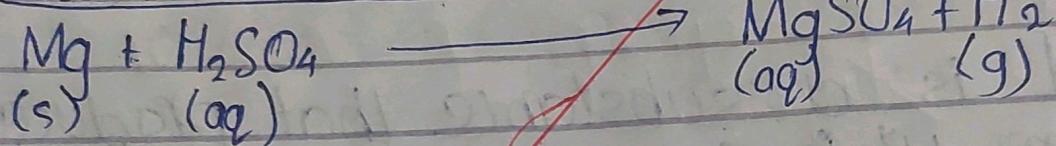
Metal + Acid \rightarrow Salt + Hydrogen
 e.g. When a piece of Magnesium ribbon is added to dilute sulphuric acid, bubbles of hydrogen gas can be seen.

Chemical reaction
 The process in which old bonds break down and new bonds are formed.

Magnesium + Sulphuric acid \rightarrow Magnesium Sulphate + hydrogen gas.] Word equation.

Reactants: Substances that react,

Products formed from reaction



All sulphates (SO_4^{2-}) are soluble except lead sulphate (PbSO_4) and Barium sulphate (BaSO_4) and Calcium Sulphate (CaSO_4) sparingly soluble.

Properties of Acids

④ Acid reacts with reactive metals to form salt and hydrogen gas.

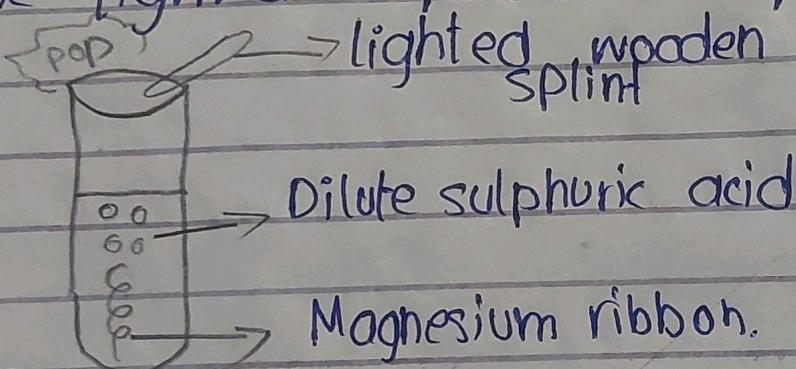
Sulphate salts - Sulphuric Acid - H_2SO_4

Nitrate salts - Nitric Acid - HNO_3

Chloride salts - Hydrochloric Acid - HCl .

Test for hydrogen gas

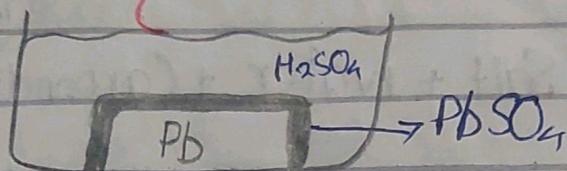
^(test) We can test for hydrogen gas by placing a lighted splint at the mouth of the test tube. ^{Observation} Hydrogen gas extinguishes the lighted splint with pop sound.



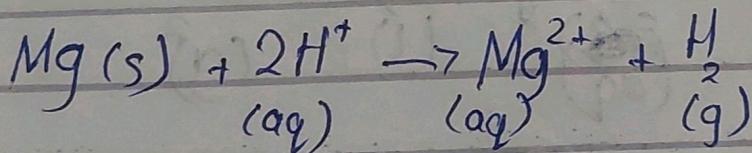
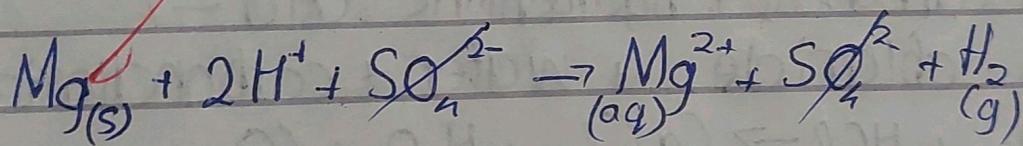
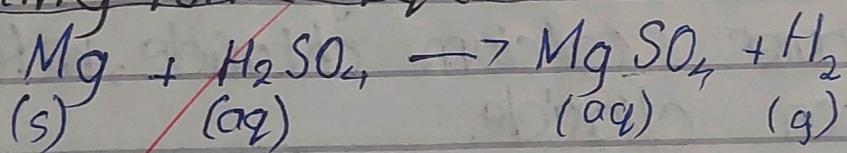
Which metals do not react with acids?

- ★ Not all metals react with acids to give salt and hydrogen gas.
 - Some ~~unreactive~~ metals such as copper and silver when added to dilute acids, they do not react.
 - Lead appears not to react with dilute sulphuric acid and hydro-chloric acid. The
- All chlorides are soluble in water except lead chloride ($PbCl_2$) and silver chloride ($AgCl$)

initial reaction between lead and dilute acid produces a layer lead (II) chloride and lead (II) sulphate. This layer is insoluble in water and quickly forms a coating around the metal. The coating protects the metal from further attack by acid.



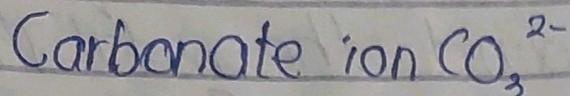
Writing Ionic Equation



Spectator ions

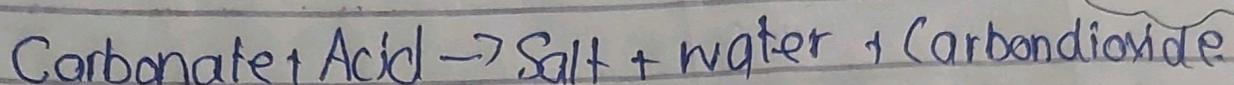
The ions that do not take part in the reaction and remain as such before and after reaction.

⑤ Acids react with carbonates and hydrogen carbonates / bicarbonates to form salt and carbon dioxide.

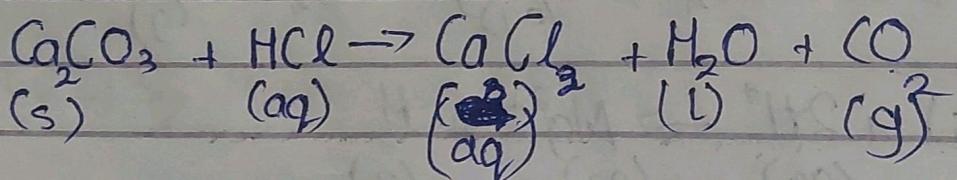
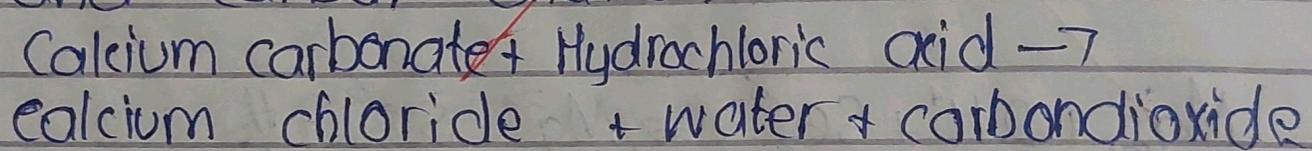


General equation

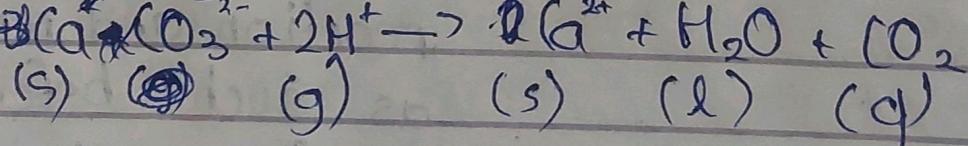
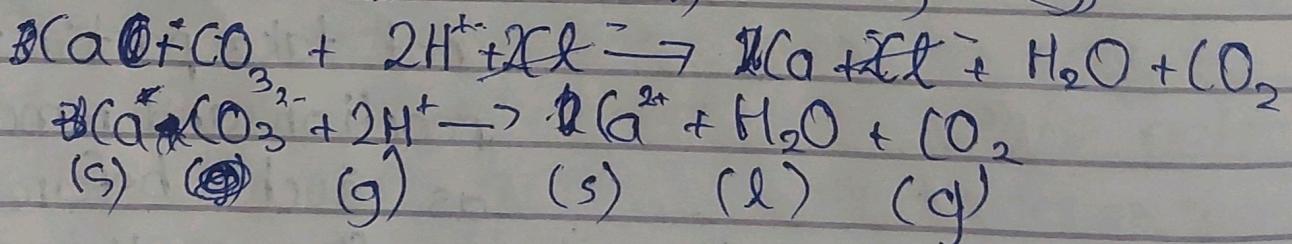
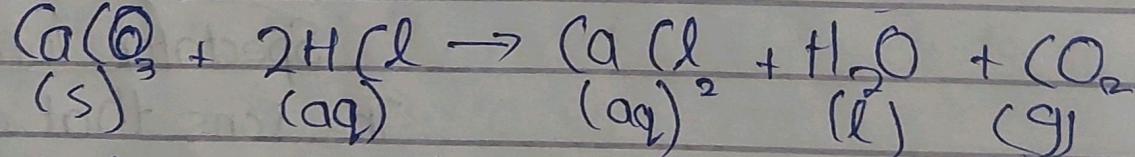
All carbonates
are insoluble in
water except Sodium,
Potassium, ammonium
carbonate Na_2CO_3 ,
 K_2CO_3



For example, reaction between calcium carbonate and dilute hydrochloric acid produces calcium chloride, water and carbon dioxide.

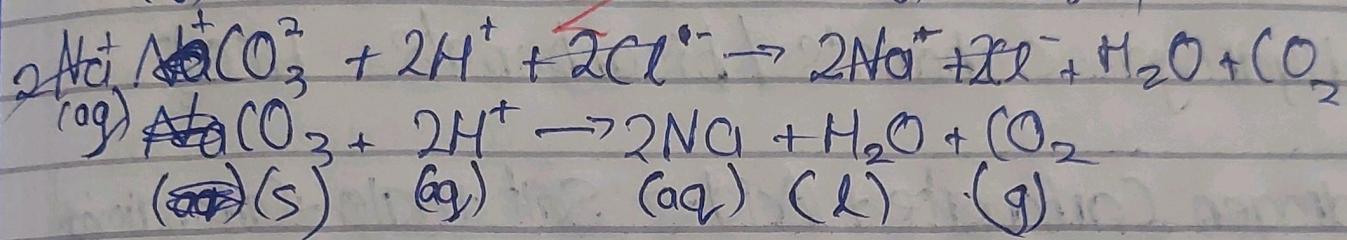
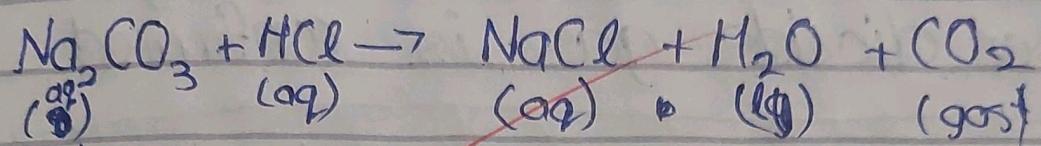


Ionic



Sodium Carbonate and ionic equation

Sodium Carbonate + Hydrochloric acid \rightarrow
Sodium Chloride + water + (carbon dioxide)



Test for carbon dioxide

Test: Carbon dioxide gas produced is passed / bubbled through lime water.

Observation:

The lime water turns milky
Carbon dioxide gas is confirmed.

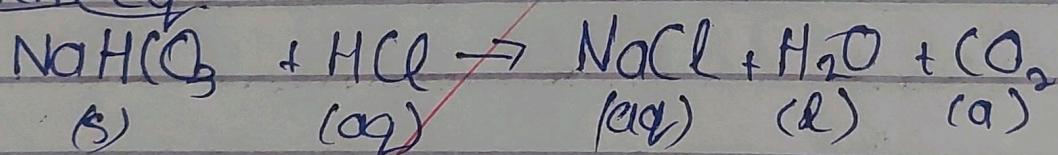
Hydrogen carbonate / bicarbonate HCO_3^{1-}

Hydrogen carbonate + Acid \rightarrow Salt + water + Carbon dioxide.
e.g. sodium carbonate reacts with hydrochloric acid to produce salt, water, and carbon dioxide.

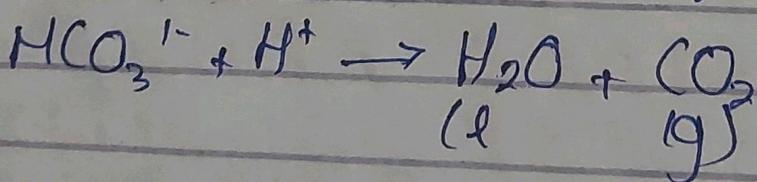
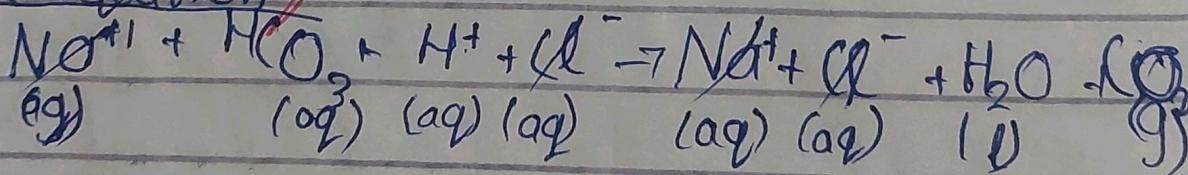
word eq.

Sodium hydrogen carbonate + hydrochloric acid
 \rightarrow Sodium chloride + water + carbon dioxide.

Chem eq.



Ionic equation



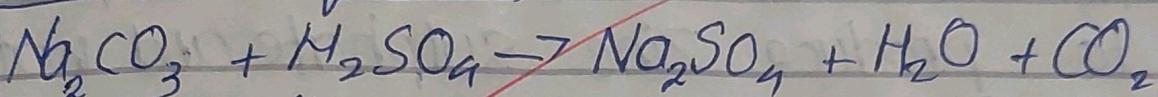
~~State~~

~~sodium~~
~~cation~~ Carbonate reacts with sulphuric acid to produce Sodium sulphate, water and carbon dioxide.

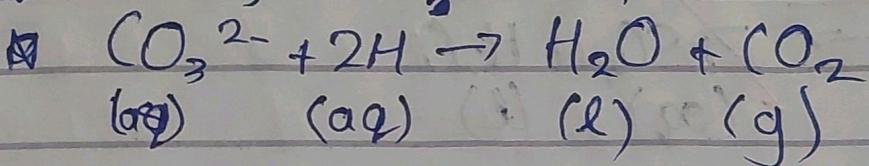
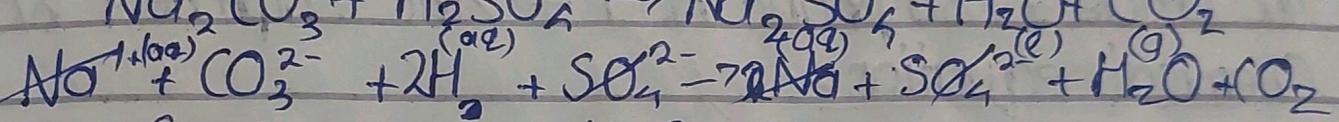
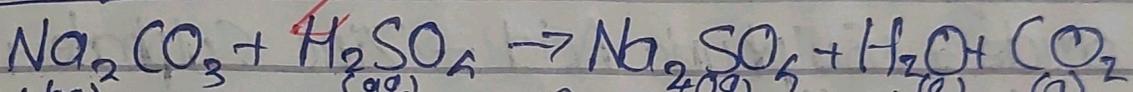
Word equation

Sodium Carbonate + Sulphuric acid \rightarrow Sodium sulphate + water + carbon dioxide.

Chemical equation

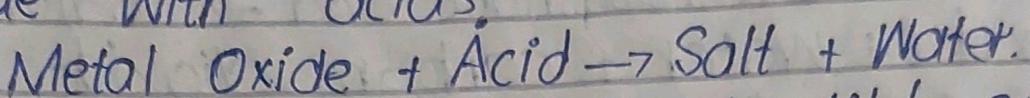


Ionic equation



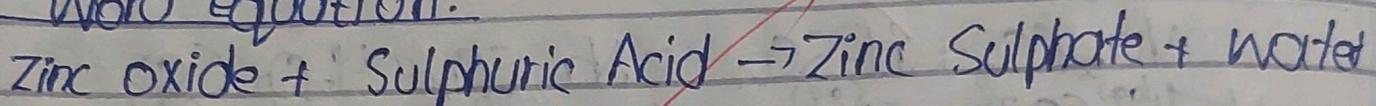
⑥ Acids react with metal oxides and hydroxides to form salt and water only

General equation after reaction of a metal oxide with acids.

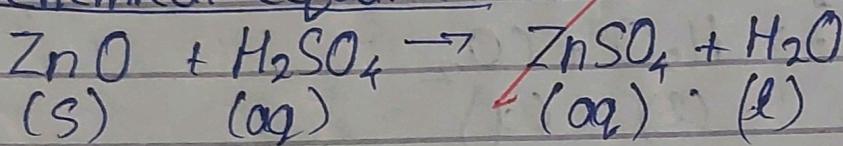


e.g zinc oxide reacts with dilute sulphuric acid to produce zinc sulphate and water.

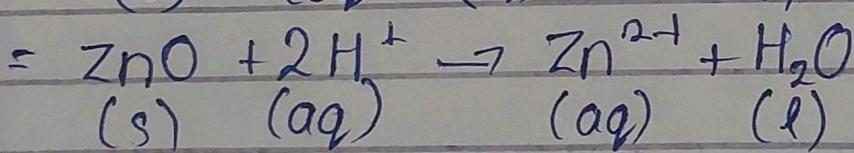
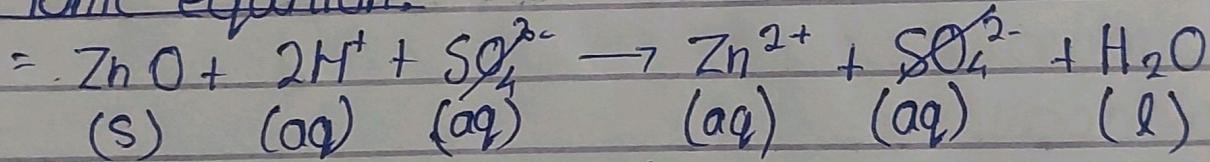
Word equation:



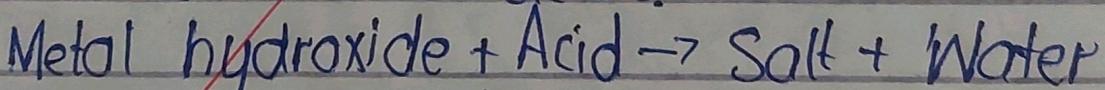
Chemical equation:



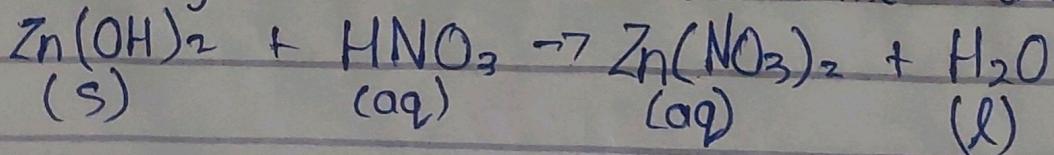
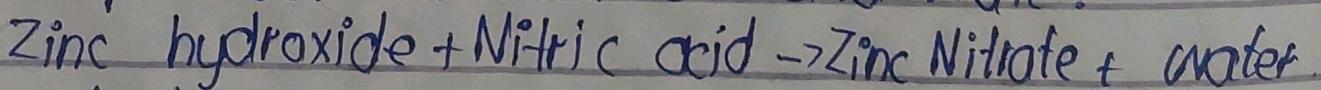
Ionic equation:



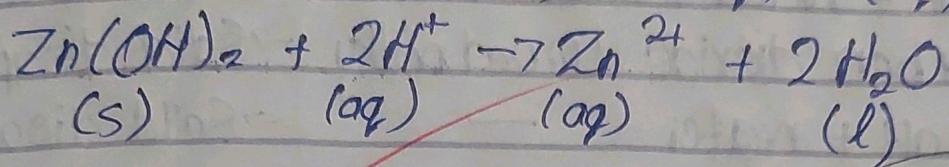
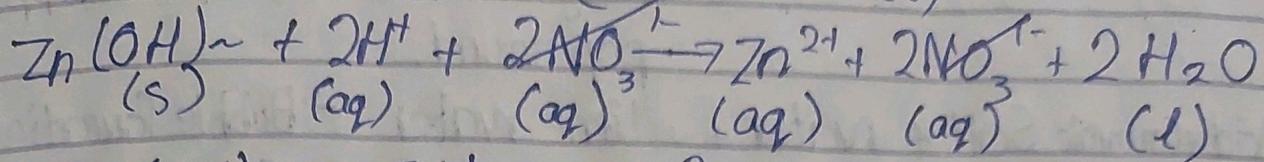
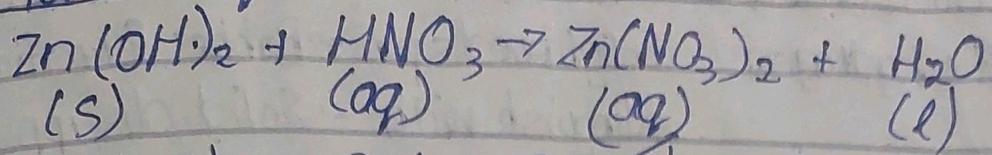
General equation for reaction of metal hydroxides with acids.



e.g Zinc hydroxide reacts with nitric acid to produce Zinc nitrate and water.



Ionic equation.



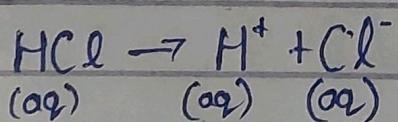
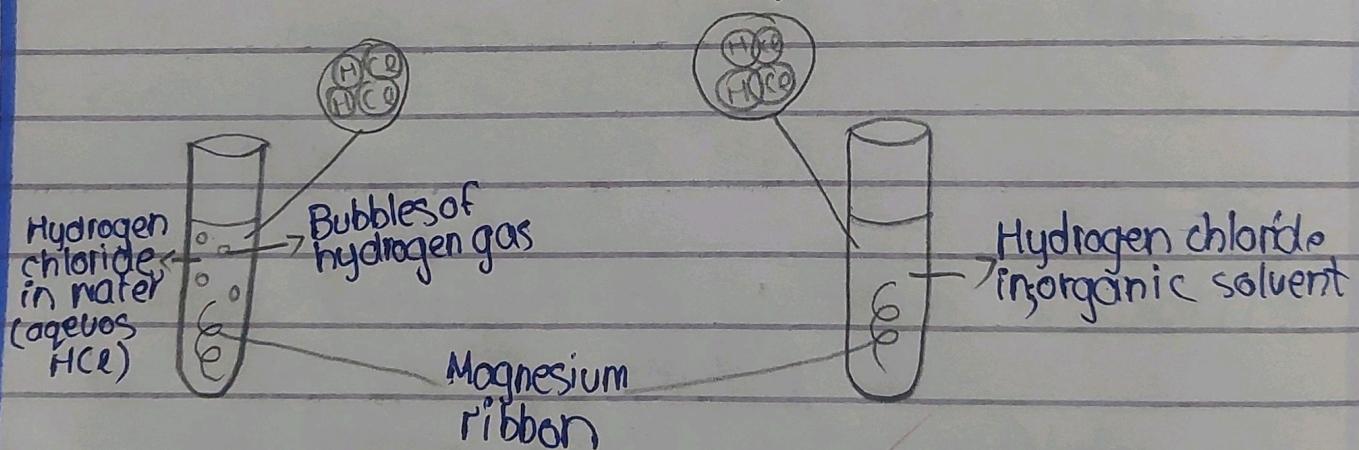
Nitrates

All nitrates are
soluble in
water.

Reactions	Products Formed.	Test	Observable change.
i) Acid + metal	Salt + hydrogen	Enlightened splint extinguish with	→ Bubbles formation → Solid disappear pop sound.
ii) Acid + carbonate	Salt + water + hydrogen carbonate	lime water turned milky.	→ Bubble formation → Solid disappear
iii) Acid + metal oxide + metal hydroxide.	Salt + water	—	→ Solid disappear

Role of water in acids

Acids only display their properties when they are dissolved in water. This is because acids produce hydrogen ions (H^+) only in water. It is the hydrogen ions which give acids their acidic properties.



The hydrogen chloride ionises into hydrogen ions (H^+) and chloride ions (Cl^-) when dissolved in water. The hydrogen ions produced allow acid to react with magnesium.

Hydrogen chloride ionises into hydrogen ions exists as covalent molecules when dissolved in an organic solvent. It does not ionise to produce hydrogen ions (H^+). Since no hydrogen ions are produced, there is no reaction with magnesium.

Uses of Acids

① Sulphuric Acid

a) Manufacture of fertilisers.

→ It is the important starting material for the production of Ammonium Sulphate $(NH_4)_2SO_4$ and super phosphate, the active ingredients in fertilization.

b) Manufacture of detergents.

→ Concentrated Sulphuric acid is used in the manufacture of detergents to convert hydrocarbons with organic acids. The organic acids are then converted into sodium hydroxide to produce the detergent.

c) As battery acid in cars

→ Dilute sulphuric acid is used in car batteries. It reacts with lead plates and lead (IV) oxide plates in the battery to generate electrical energy which is used to get the car engine running.

Uses of other Acids

② Hydrochloric acid

Hydrochloric acid is used to clean impurities such as rust and scale from metal and aluminium alloys.

③ Ethanoic acid

Ethanoic acid is used in vinegar to act as food preservative and flavour enhancer.

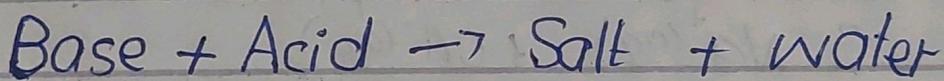
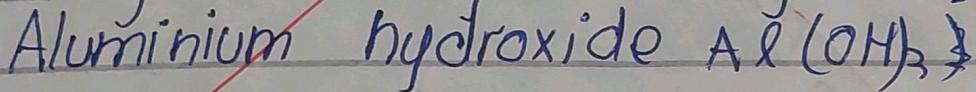
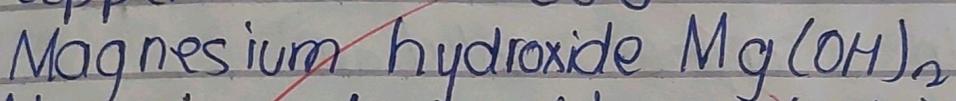
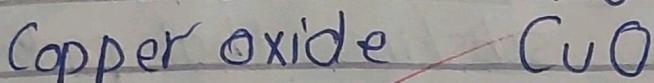
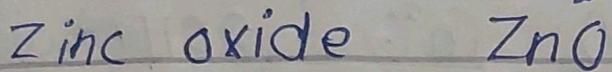
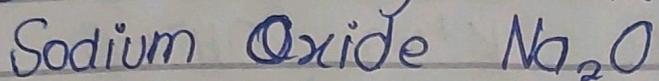
④ Phosphoric acid

This acid is added to foods and beverages to give them a sour taste.

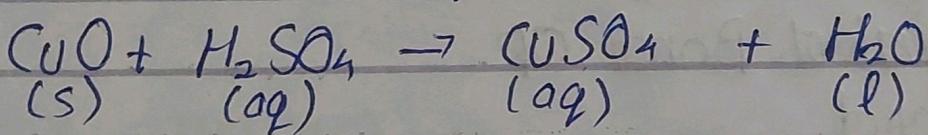
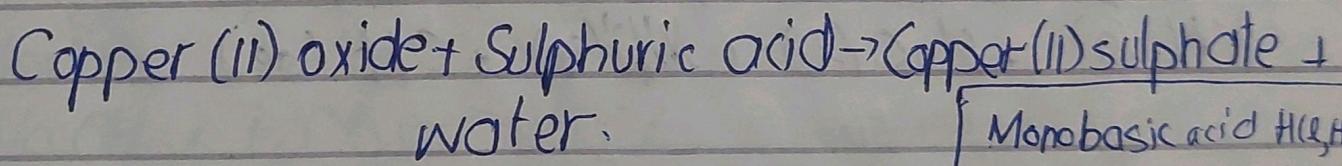
Bases and Alkalies

Bases:

Base is any metal oxide or hydroxide that reacts with an acid to produce salt and water only. This means that a base contains Oxide O^{2-} or hydroxide ion OH^- . e.g

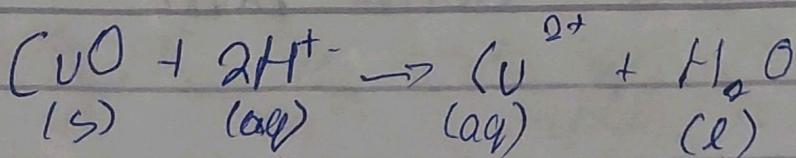
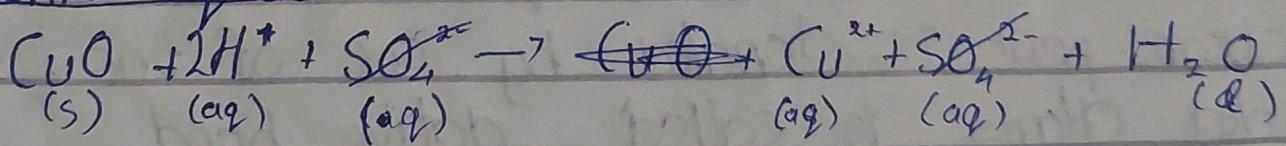


e.g



Monobasic acid HCl, HNO_3
Diabasic acid H_2SO_4
Triabasic acid H_3PO_4

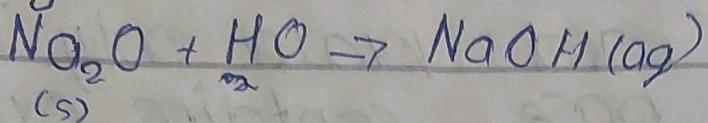
Ionic equation.



Alkali: a special class of bases

An Alkali is a base that is soluble in water.

e.g. sodium oxide



sodium hydroxide NaOH $\text{Na}^{+}\text{(aq)}$ $\text{OH}^{-}\text{(aq)}$

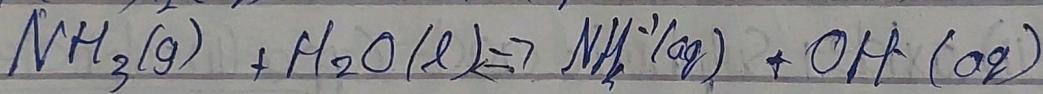
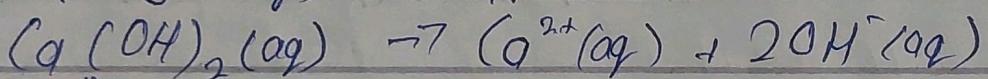
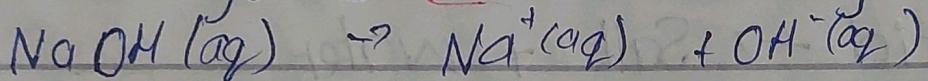
Potassium hydroxide KOH $\text{K}^{+}\text{(aq)}$ $\text{OH}^{-}\text{(aq)}$

Calcium hydroxide Ca(OH)_2 $\text{Ca}^{2+}\text{(aq)}$ $2\text{OH}^{-}\text{(aq)}$

"An alkali is a substance that produces OH^{-} ions in aqueous solution"

e.g.

Sodium hydroxide \rightarrow Sodium ions + hydroxide ions



Coordinate Covalent Bond OR

Dative bond

The covalent bond in which the shared electron pair is donated by one of the bonded atoms is called dative bond.

Properties of Alkali

- ① Alkalies have a bitter taste and feel soapy.
 - ② Alkalies turn red litmus blue.
 - ③ Alkalies react with acids to produce salt and water only.
- Alkali + Acid \rightarrow Salt + water

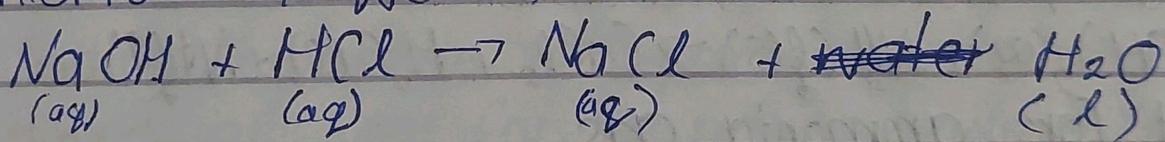
Neutralization reaction

In neutralization reaction, hydrogen ions (H^+) from acid react with hydroxide ions (OH^-) from alkalies to produce water.

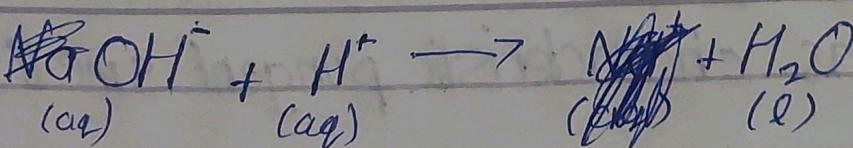
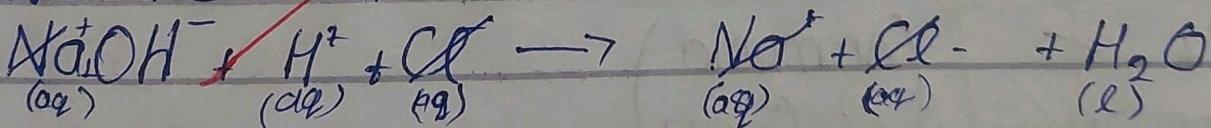
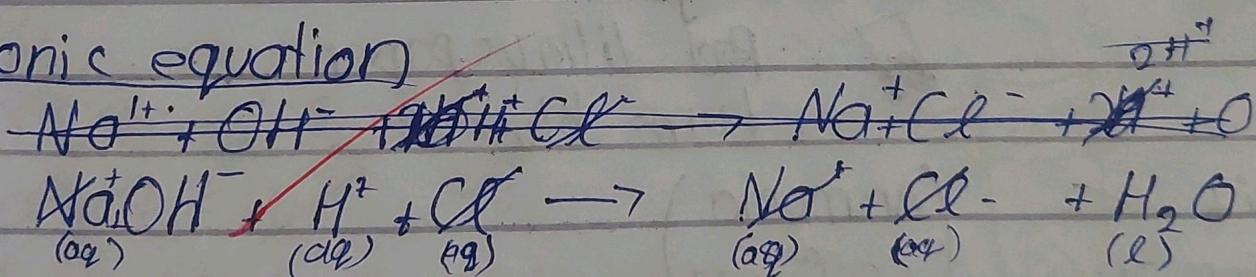


e.g.

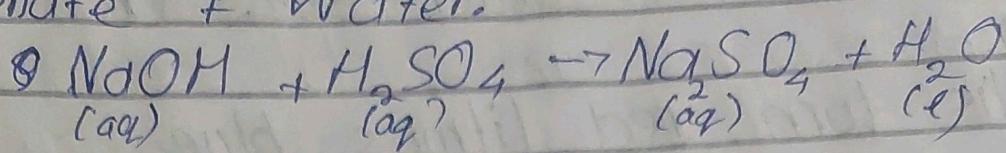
Sodium hydroxide + Hydrochloric acid \rightarrow Sodium chloride + water,



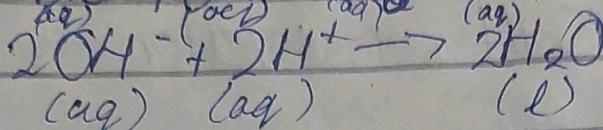
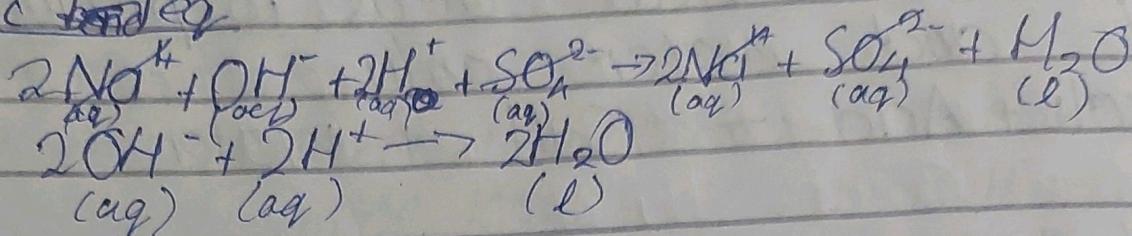
Ionic equation



Sodium hydroxide + Sulphuric acid \rightarrow Sodium sulphate + water.



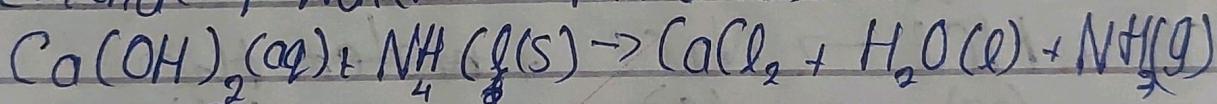
Ionic eq



④ Alkalies, when react with Ammonium salts give off ammonia gas.

Alkali + Ammonium salt \rightarrow Salt + water + Ammonia (g)

Calcium hydroxide + Ammonium Chloride \rightarrow Calcium chloride + water + Ammonia.



Test for ammonia gas.



Red litmus paper
turns blue

Alkali +

Ammonium salt

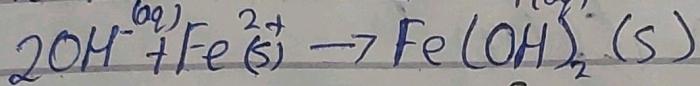
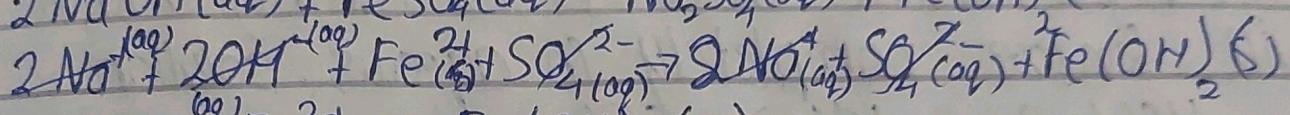
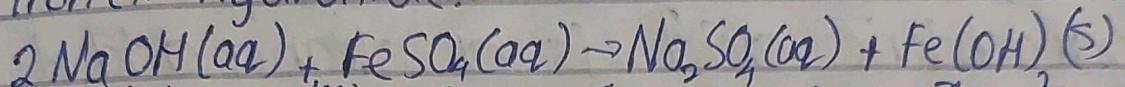
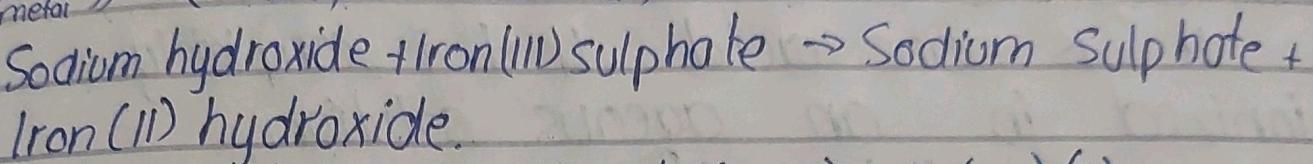
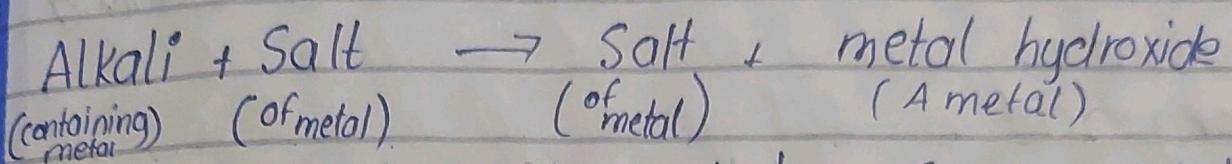
(Ammonia)
Confirmed

\rightarrow Ammonia has characteristic pungent smell.

Test

\rightarrow It will turn moist red litmus paper blue.

⑤ Alkalies react with a solution of metal salt to give another metal salt and metal hydroxide.



Uses of Bases / Alkalies

- 1) a) ~~Magnesium oxide~~ is used as antacid for relieving ~~gastric~~ pain.
b) ~~Magnesium oxide~~ is also used for making refractory bricks.
- 2) Sodium hydroxide and potassium hydroxide are used for the making Materials that can tolerate high temperature of soap.
- 3) Calcium hydroxide is used to reduce acidity in soil.
- 4) Ammonia solution is used to make fertilizer.

Strength and Concentration

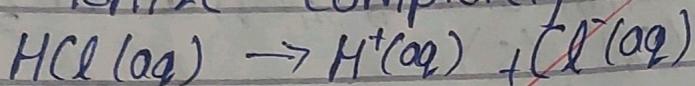
Strong and weak acids:

The term strength refers to how easily an acid or alkali ionizes when dissolved in water.

Strong acids:

It is an acid that is completely ionized in an aqueous solution.

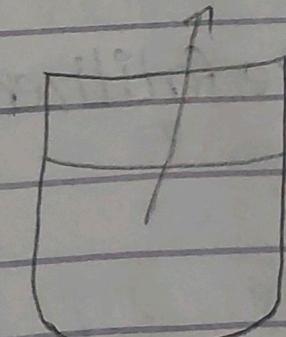
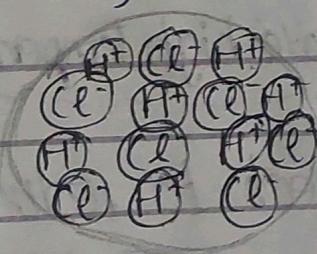
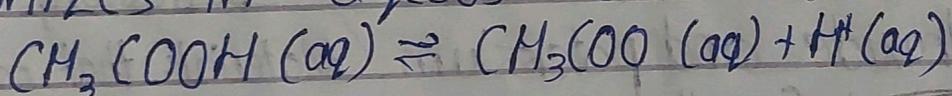
e.g. hydrochloric acid is a strong acid, it will ionize completely in aqueous solution.



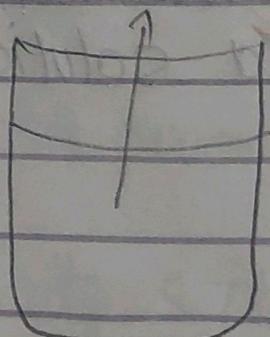
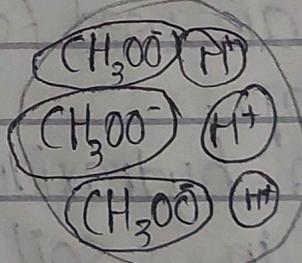
Weak acid:

An acid that partially ionizes in an aqueous solution e.g.

ethanoic acid is a weak acid, it partially ionizes in aqueous solution.



Aqueous HCl



Aqueous CH₃COOH

Solution

"A homogeneous mixture of two or more substances? e.g. → Salt dissolved in water
→ Acid dissolved in water.

Components of solution

i) Solute

"Relatively smaller in amount?
OR

"The component that is dissolved?"

ii) Solvent

"Relatively larger in amount?
OR

"The component that dissolves any substance in itself?

e.g. Aqueous solution of sugar.

Sugar — Solute

Water — Solvent

Concentration

The quantity of solute in the solution is called its concentration.

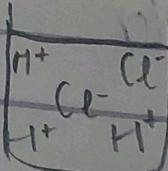
Dilute Solution:

The solution which contains relatively smaller amount of solute.

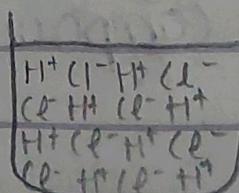
Concentrated Solution:

The solution that contains relatively larger amount of solute.

Dilute Aqueous HCl



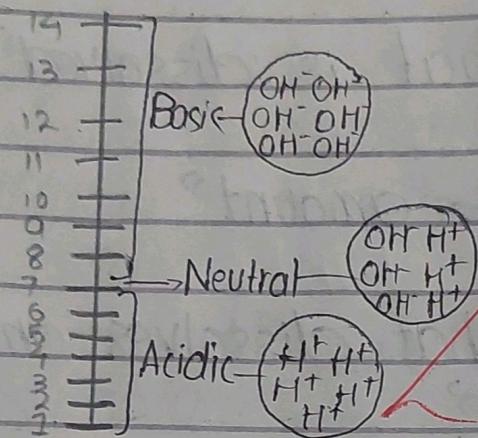
Concentrated Aqueous HCl



The PH Scale

It is a set of number from 0 to 14 which is used to indicate whether a solution is acidic, neutral, or basic.

- Acids have PH values of less than 7.
- Alkalies have PH greater than 7.
- a neutral solution has PH value of exactly 7.



pH and concentration of Hydrogen Ions (H^+)

- An acid with lower value is more acidic. It has higher concentration of Hydrogen ions.
- An alkaline solution with a higher pH value is more alkaline. It has higher concentration of hydrogen ions.

$$\text{pH} \downarrow = (\text{H}^+) \uparrow$$

$$\text{pH} \uparrow = (\text{H}^+) \downarrow$$

How can we measure pH of a solution?

pH of a given solution can be determined by,

- Chemical compound called an indicator.

- PH Sensor attached to a data logger.
- PH meter.

Universal Indicator

→ Universal indicator contains a mixture of dyes. It comes in the form of a solution or PH paper. It gives different colors in solutions of different PH.

Indicator

Methyl Orange

Litmus

Bromothymol Blue

Phenolphthalein

Acidic Solution

red

red

Yellow

colourless

Basic Solution

yellow

blue

blue

Pink

Importance of PH

Our blood is slightly alkaline as it has a PH of about 7.4. When a person is given an injection, the substance being injected must have a PH of almost 7.4. If the PH of blood is changed by one unit e.g. 8.3, the person would die.

Why is PH of soil important?

The PH of soil can vary from 4 to 8 depending upon the type of soil. It is important to control the PH of soil, because this affects the growth and the development of plants.

→ Most plants will not grow if the pH of soil is below 5 or above 9.

→ Most plants grow best when the soil is neutral to slightly acidic.

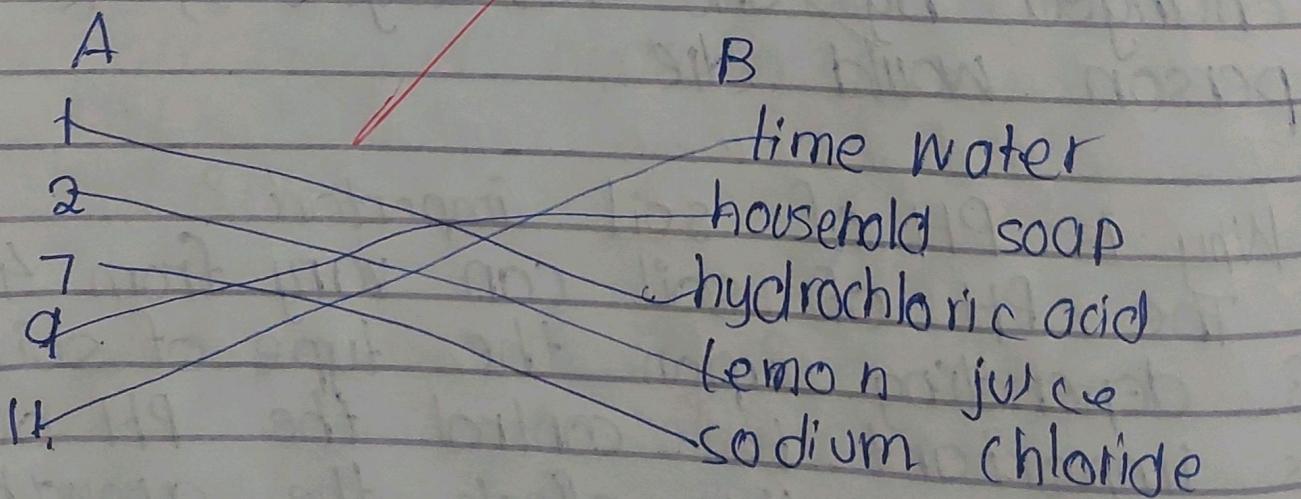
How can we control the pH of soil?

Chemicals are often added to the soil to adjust its pH. If the soil is too acidic then it can be treated with bases such as quick lime (calcium oxide) or slaked lime (calcium hydroxide).

This is known liming of soil. The bases react with the acids in the soil and raise the pH so that plants grow healthier.

However

Adding too much base will make the soil too alkaline and unstable for plant growth.



Oxides

"The binary compounds of oxygen with other elements".

Bi - two

e.g.

Carbo**n** monoxide CO

H_2SO_4 not oxid.

Carbon dioxide CO_2

Hydrogen Oxide H_2O

Nitrogen dioxide SO₂

Calcium oxide (CaO)

Types of oxides

① Acidic oxides

"Most oxides of Non-metals are acidic oxides"

→ Most acidic oxides dissolve in water to form acids.

→ e.g. Sulphur dioxide dissolve in water to form Sulphurous acid.

$$\rightarrow \text{SO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{SO}_3(\text{aq}) \text{ Sulphurous acid}$$

$$\rightarrow \text{SO}_2(\text{g}) + \text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{SO}_4(\text{aq})$$

$$\rightarrow \text{SO}_3 \text{ (g)} + \text{H}_2\text{O (l)} \quad \text{Sulphur trioxide} \quad \text{Sulphuric acid}$$

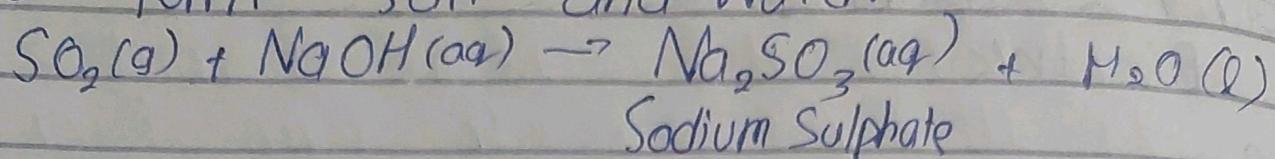
$$\rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\ell) \rightarrow \text{H}_2\text{CO}_3(\text{aq})$$

CO_2 (Carbon dioxide) (carbonic acid.)

$$\rightarrow \text{P}_4\text{O}_{10}^{(s)} + \text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_4 \text{ (aq)}$$

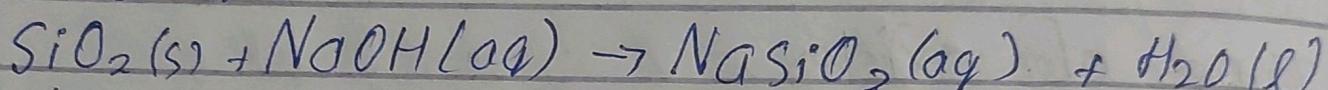
(Phosphorus(V) oxide) Phosphoric acid.

- Acidic oxides do not react with acids
- However acidic oxides react with alkalis to form salt and water.



Is silicon dioxide an acidic oxide?

- It does not dissolve in water
- But reacts with concentrated alkaline sodium hydroxide to form sodium silicate and water.

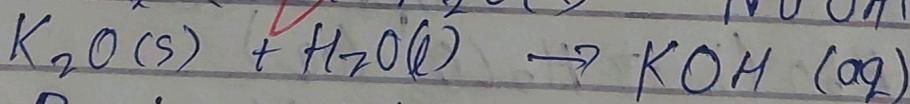
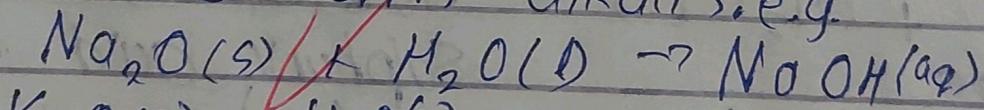


Hence silicon dioxide is acidic oxide.

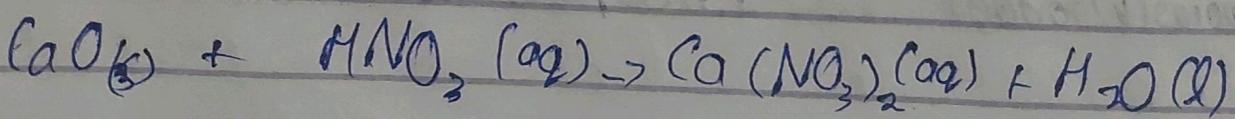
② Basic oxides

"Oxide of most metals are basic oxides."

- Most basic oxides are insoluble in water
- A few oxides such as sodium oxide and potassium oxide dissolve in water to form alkalis. e.g.



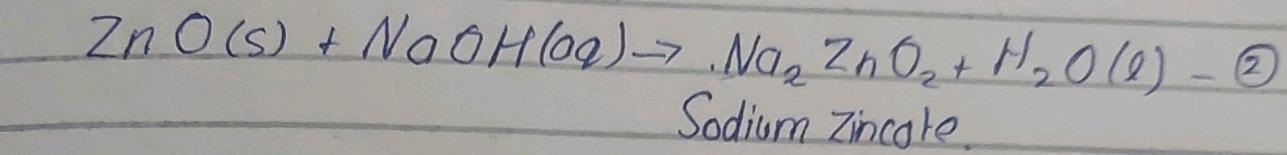
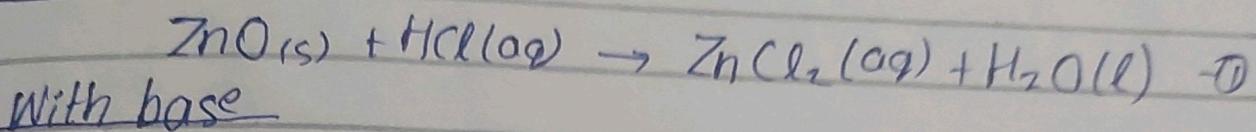
- Basic Oxides are solids at room temperature. They react with acids to form salt and water.



③ Amphoteric Oxides

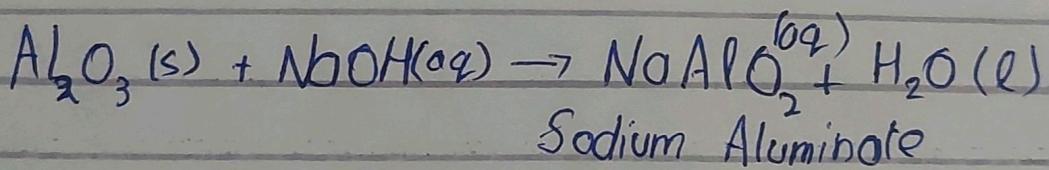
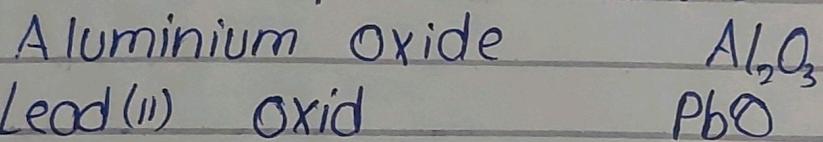
These are the metallic oxides that react with both acids and bases to form salt and water.

→ Zinc oxide is an amphoteric oxide.



In reaction ① ZnO acts as base while in reaction ② it acts as an acid.

Other amphoteric oxides:



④ Neutral Oxides

Some non-metals form oxides that are neither acidic nor basic. They are insoluble in water?

e.g. Water - H_2O

Good
to

Carbon Monoxide - CO

Nitric Oxide - NO

Glau
18/01/2021