

## Gases: Preparation & Tests

Describe how the following gases are prepared:

*Carbon Dioxide*

*Hydrogen*

*Oxygen*

Give equations.

Describe tests for the following gases:

*Oxygen*

*Ammonia*

*Carbon Dioxide*

*Chlorine*

*Hydrogen*

*Sulfur Dioxide*

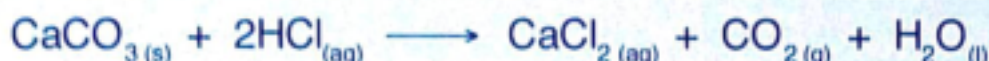
## Tests for Water

State two tests for water. Give equations.

## Gas Preparation:

### Carbon Dioxide:

React calcium carbonate (marble chips) with dilute hydrochloric acid:



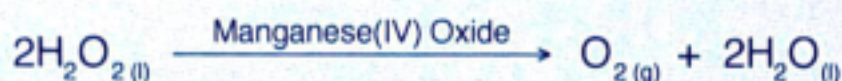
### Hydrogen:

React zinc with dilute hydrochloric acid:



### Oxygen:

Mix hydrogen peroxide with manganese(IV) oxide (which acts as a catalyst):



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## Gas Tests:

**Oxygen:** relights a glowing splint

**Ammonia:** turns damp red litmus paper **blue**

**Carbon Dioxide:** turns limewater milky

**Chlorine:** bleaches (i.e. turns white) damp litmus paper

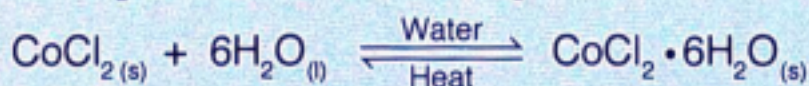
**Hydrogen:** burns with a squeaky 'pop' when lit with a lighted splint

**Sulfur Dioxide:** decolourises filter paper which has been dipped into purple acidified potassium manganate(VII)

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## Tests for Water:

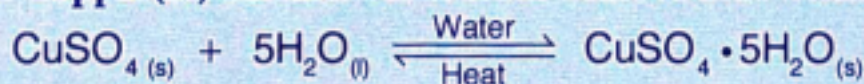
**Cobalt Chloride Paper:** Turns from blue to pink when water is added:



Blue

Pink

**Anhydrous Copper(II) Sulfate:** Turns from white to blue when water is added:



White

Blue

## Chemical Tests: Anions

Describe how to test for the following ions:

*Chloride*

*Bromide*

*Iodide*

*Carbonate*

*Sulfate*

*Nitrate*

*Sulfite*

Give equations for the first five tests.

## Halide ions:

- Acidify with dilute nitric acid
- Add silver nitrate solution

### *Positive results:*

Chloride ions, $\text{Cl}^-$	White precipitate	$\text{Ag}_{(\text{aq})}^+ + \text{Cl}_{(\text{aq})}^- \longrightarrow \text{AgCl}_{(\text{s})}$
Bromide ions, $\text{Br}^-$	Cream precipitate	$\text{Ag}_{(\text{aq})}^+ + \text{Br}_{(\text{aq})}^- \longrightarrow \text{AgBr}_{(\text{s})}$
Iodide ions, $\text{I}^-$	Yellow precipitate	$\text{Ag}_{(\text{aq})}^+ + \text{I}_{(\text{aq})}^- \longrightarrow \text{AgI}_{(\text{s})}$

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## Carbonate ions ( $\text{CO}_3^{2-}$ ):

- Add dilute hydrochloric acid

### *Positive result:*

Carbon dioxide produced (effervescence).  $\text{CO}_2$  turns limewater cloudy.



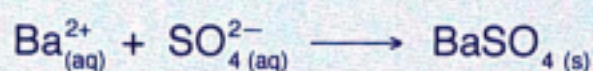
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## Sulfate ions ( $\text{SO}_4^{2-}$ ):

- Acidify with dilute hydrochloric acid
- Add barium nitrate solution

### *Positive result:*

White precipitate of (insoluble) barium sulfate produced:



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## Nitrate ions ( $\text{NO}_3^-$ ):

- Add sodium hydroxide solution followed by small pieces of aluminium foil
- Warm gently

*Positive result:* Ammonia gas is given off (this turns damp red litmus paper **blue**)

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## Sulfite ions ( $\text{SO}_3^{2-}$ ):

- Acidify with dilute hydrochloric acid
- Warm gently

*Positive result:* Sulfur dioxide gas ( $\text{SO}_2$ ) produced.  $\text{SO}_2$  decolourises filter paper which has been dipped into purple acidified potassium manganate(VII).

## Chemical Tests: Cations

Describe how to do flame tests.  
State the resulting flame colours for the following:

*Lithium ions*                      *Sodium ions*  
*Potassium ions*                *Copper(II) ions*

Describe how to test for the following ions:

*Copper(II)*  
*Iron(II)*  
*Iron(III)*  
*Chromium(III)*  
*Calcium*  
*Zinc*  
*Aluminium*

Describe how to test for *Ammonium* ions.

## Flame Tests for Metal ions:

- Dip a loop of **nichrome wire** in hydrochloric acid
- Dip the loop of wire in the unknown compound
- Hold the loop of wire in a hot Bunsen burner flame

**Positive results (flame colours):**

Lithium ions, Li <sup>+</sup>	Red
Sodium ions, Na <sup>+</sup>	Orange/yellow
Potassium ions, K <sup>+</sup>	Lilac
Copper(II) ions, Cu <sup>2+</sup>	Blue-green

## Precipitation Tests for Metal ions:

- Add a few drops of sodium hydroxide or ammonia solution
- Use colour of precipitate formed to identify metal ions present
- Add **excess** sodium hydroxide or ammonia – certain precipitates will redissolve

**Positive results:**

	with Sodium Hydroxide	with Ammonia
Copper(II) ions, Cu <sup>2+</sup>	Light blue precipitate Insoluble in excess	Light blue precipitate Soluble in excess (gives dark blue solution)
Iron(II) ions, Fe <sup>2+</sup>	Green precipitate Insoluble in excess	Green precipitate Insoluble in excess
Iron(III) ions, Fe <sup>3+</sup>	Red-brown precipitate Insoluble in excess	Red-brown precipitate Insoluble in excess
Chromium(III) ions, Cr <sup>3+</sup>	Green precipitate Soluble in excess	Grey-green precipitate Insoluble in excess
Calcium ions, Ca <sup>2+</sup>	White precipitate Insoluble in excess	No precipitate, or very slight white precipitate
Zinc ions, Zn <sup>2+</sup>	White precipitate Soluble in excess	White precipitate Soluble in excess
Aluminium ions, Al <sup>3+</sup>	White precipitate Soluble in excess	White precipitate Insoluble in excess

## Ammonium ions (NH<sub>4</sub><sup>+</sup>):

- Add sodium hydroxide solution
- Warm gently

**Positive result:** Ammonia gas released, which turns damp red litmus paper **blue**



## Acids and Bases

Define *Acid*, *Base* and *Alkali*.

Which ions are responsible for making a solution acidic or alkaline?

Name 4 common acids and 4 common bases.  
Give their formulae.

Explain the difference between:  
*Strong Acids*, *Weak Acids*, *Strong Bases* & *Weak Bases*

What are the hazards of working with acids and bases?

## Definitions:

\***Acid:** A proton ( $H^+$ ) donor

\***Base:** A proton ( $H^+$ ) acceptor

**Alkali:** A soluble base

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## Ions:

**Acidic** solutions contain  $H^+$  ions (hydrogen ions)

**Alkaline** solutions contain  $OH^-$  ions (hydroxide ions)

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## Common Acids:

Hydrochloric acid	HCl
Sulfuric acid	$H_2SO_4$
Nitric acid	$HNO_3$
Ethanoic acid	$CH_3COOH$

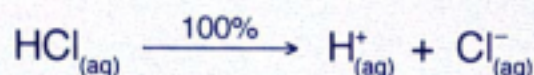
## Common Bases:

Sodium Hydroxide	NaOH
Potassium Hydroxide	KOH
Calcium Hydroxide	$Ca(OH)_2$
Ammonia	$NH_3$

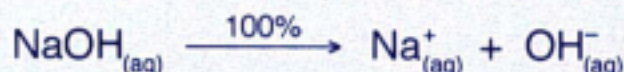
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## Strong Acids and Bases:

- **Strong acids dissociate completely** into ions when dissolved in water  
e.g. hydrochloric acid, sulfuric acid, nitric acid

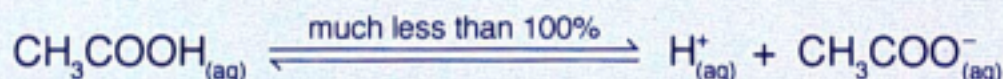


- **Strong bases dissociate completely** into ions when dissolved in water  
e.g. sodium hydroxide, potassium hydroxide, calcium hydroxide

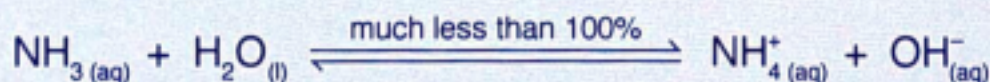


## Weak Acids and Bases:

- **Weak acids do not dissociate completely** into ions when dissolved in water  
e.g. ethanoic acid



- **Weak bases do not dissociate completely** into ions when dissolved in water  
e.g. ammonia solution



## Hazards:

**Strong** acids and bases are corrosive (they can eat away metals, skin and cloth)



## Reactions of Acids & Bases

Give equations for the reactions of acids with:

*Bases*

*Metals*

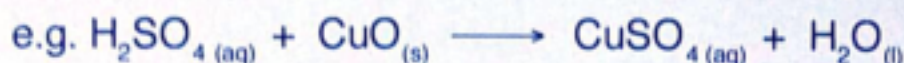
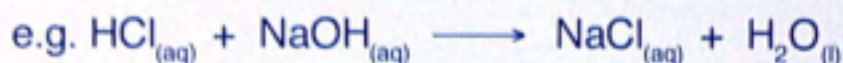
*Carbonates*

Give an equation for the reaction of a base with an ammonium salt.

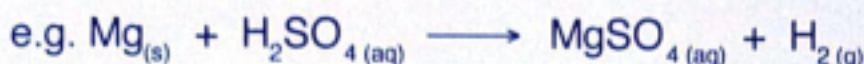
Give an equation to show how an insoluble salt can be produced.

Which salts are soluble?

## Acid + Base:



## Acid + Metal:



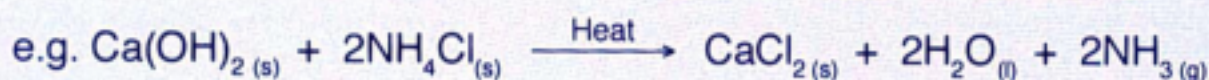
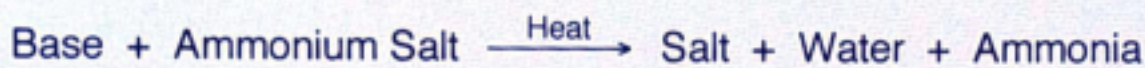
*Metals which form insoluble salts will not usually react with acids because a layer of the salt forms on the surface of the metal, preventing any more metal from reacting*

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## Acid + Carbonate:



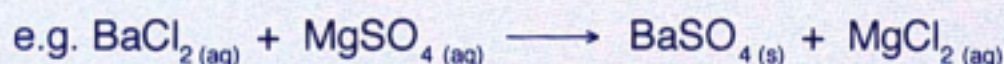
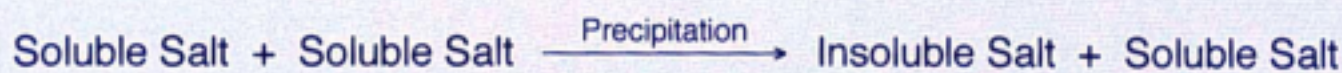
## Base + Ammonium Salt:



*This reaction is used to make ammonia in the lab*

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## Making Insoluble Salts:



## Soluble Salts

- All sodium, potassium & ammonium salts
- All nitrates
- Chlorides *except* silver & lead chlorides
- Sulfates *except* calcium, barium & lead sulfates

*All other salts are insoluble*

## pH & Neutralisation

Explain the pH Scale.

List 3 indicators with their colours in acidic, neutral and alkaline solutions.

What is *Neutralisation*? Give an ionic equation.

Give an agricultural use for neutralisation.

Which bases could you use for this?

## Oxides

Explain what is meant by

*Acidic Oxides*

*Basic Oxides*

*Amphoteric Oxides*

*Neutral Oxides.*

Give examples of each.

## pH Scale:

A measure of acidity or alkalinity on a scale of 1 to 14:

1 = most acidic      7 = neutral      14 = most alkaline

pH values can be determined using **Universal Indicator (UI)**

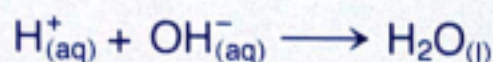
## Indicators:

Indicator	Acid	Neutral	Alkali
Universal Indicator	Red - Orange - Yellow	Green	Blue - Purple
Litmus	Red	Purple	Blue
Methyl Orange	Red	Orange	Yellow

## Neutralisation:

Neutralisation occurs when acids and bases react together:

Hydrogen ions + Hydroxide ions  $\longrightarrow$  Water



## Reducing Soil Acidity:

Acidic soil can be neutralised with a base, e.g.

- crushed limestone (calcium carbonate,  $\text{CaCO}_3$ )
- lime (calcium oxide,  $\text{CaO}$ )
- slaked lime (calcium hydroxide,  $\text{Ca}(\text{OH})_2$ )

*Crops do not grow well if soil is too acidic*

## Oxides:

Type of Oxide	Properties	Examples
<b>Acidic Oxides</b>	React with bases (dissolve in water to produce acids)	Most <b>non-metal oxides</b> , e.g. <ul style="list-style-type: none"><li>• Carbon Dioxide, <math>\text{CO}_2</math></li><li>• Sulfur Dioxide, <math>\text{SO}_2</math></li><li>• Phosphorus Pentoxide, <math>\text{P}_2\text{O}_5</math></li></ul>
<b>Basic Oxides</b>	React with acids	<b>Metal oxides</b> , e.g. <ul style="list-style-type: none"><li>• Magnesium Oxide, <math>\text{MgO}</math></li><li>• Iron(III) Oxide, <math>\text{Fe}_2\text{O}_3</math></li><li>• Copper(II) Oxide, <math>\text{CuO}</math></li></ul>
<b>Amphoteric Oxides</b>	React with both acids and bases	<ul style="list-style-type: none"><li>• Aluminium Oxide, <math>\text{Al}_2\text{O}_3</math></li></ul>
<b>Neutral Oxides</b>	Do not react with acids or bases	<ul style="list-style-type: none"><li>• Carbon Monoxide, <math>\text{CO}</math></li><li>• Dinitrogen Oxide, <math>\text{N}_2\text{O}</math></li></ul>

## Limestone

Give the chemical name and formula of *Limestone*.

Give equations for the *Thermal Decomposition of Limestone* and the *Slaking of Lime*.

Give uses for *Limestone*, *Lime* and *Slaked Lime*.

**Name:**

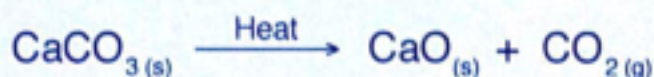
Calcium carbonate

**Formula:** $\text{CaCO}_3$ 

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**Thermal Decomposition of Limestone:**

Calcium Carbonate  $\xrightarrow{\text{Heat}}$  Calcium Oxide + Carbon Dioxide



Calcium Oxide,  $\text{CaO}$ , is referred to as **Lime**

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**Slaking Lime:**

Calcium Oxide + Water  $\longrightarrow$  Calcium Hydroxide



Only a small amount of water is added, so the calcium hydroxide does not dissolve.

Solid Calcium Hydroxide is referred to as **Slaked Lime**.

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**Uses:****Limestone:**

- Making iron (extracting it from iron ore)
- Making cement

**Lime /Slaked Lime:**

- Neutralising acidic soil (to make it better for growing plants)
- Neutralising acidic industrial waste products (e.g. flue gas desulfurisation)