8 ACIDS, BASES & SALTS

YOUR NOTES

CONTENTS:

8.1 ACIDS, BASES & OXIDES

8.1.1 THE CHARACTERISTIC PROPERTIES OF ACIDS & BASES

Properties of Acids

Properties of acids

- Acids have pH values of below 7, have a sour taste and are corrosive
- In acidic conditions, blue litmus paper turns **red** and methyl orange **indicator** turns **red**
- Acids are substances that can neutralise a base, forming a salt and water
- When acids react, they will lose electrons to form positively charged **hydrogen ions** (H^+)
- The presence of H+ ions is what makes a solution acidic

Example: Hydrochloric Acid

$$HCl\,(aq) \rightarrow H^+\,(aq) + Cl^-\,(aq)$$

Typical reactions of acids

Acids and metals

- Only metals **above hydrogen** in the reactivity series will react with dilute acids
- When acids react with metals they form a salt and hydrogen gas:

$$\text{Acid} + \text{Metal} \rightarrow \text{Salt} + \text{Hydrogen}$$

Examples of Reaction Between Acids and Metals:

ACID	NAME OF PRODUCTS	EQUATION FOR REACTION
HYDROCHLORIC ACID	METAL CHLORIDE AND HYDROGEN	$M + 2HCL \longrightarrow MCL_2 + H_2$
SULFURIC ACID	METAL SULFATE AND HYDROGEN	$M + H_2SO_4 \longrightarrow MSO_4 + H_2$

8 ACIDS, BASES & SALTS

YOUR NOTES

8.1.1 THE CHARACTERISTIC PROPERTIES OF ACIDS & BASES cont...

Acids with Bases (Alkalis)

- Metal **oxides** and metal **hydroxides** can act as **bases**
- When they react with acid, a **neutralisation** reaction occurs
- Acids and bases will react together in a neutralisation reaction and produce a **salt** and **water**:

Acid + Base → Salt + Water

Examples of Reaction Between Acids and Bases:

ACID	NAME OF PRODUCTS	EQUATION FOR REACTION
HYDROCHLORIC ACID	METAL CHLORIDE AND WATER	$MOH + HCL \rightarrow MCL + H_2O$
SULFURIC ACID	METAL SULFATE AND WATER	$MO + H_2SO_4 \rightarrow MSO_4 + H_2O$
NITRIC ACID	METAL NITRATE & WATER	$M(OH)_2 + 2HNO_3 \rightarrow M(NO_3)_2 + 2H_2O$

Acids with Metal Carbonates

- Acids will react with metal carbonates to form the corresponding metal salt, carbon dioxide and water:

Acid + Metal Carbonate → Salt + Carbon Dioxide + Water

Examples of Reaction Between Acids and Bases:

ACID	NAME OF PRODUCTS	EQUATION FOR REACTION
HYDROCHLORIC ACID	METAL CHLORIDE, CARBON DIOXIDE AND WATER	$MCO_3 + 2HCL \rightarrow MCL_2 + CO_2 + H_2O$
SULFURIC ACID	METAL SULFATE, CARBON DIOXIDE AND WATER	$MCO_3 + H_2SO_4 \rightarrow MSO_4 + CO_2 + H_2O$
NITRIC ACID	METAL NITRATE, CARBON DIOXIDE AND WATER	$MCO_3 + 2HNO_3 \rightarrow M(NO_3)_2 + CO_2 + H_2O$

8 ACIDS, BASES & SALTS

YOUR NOTES

8.1.1 THE CHARACTERISTIC PROPERTIES OF ACIDS & BASES cont...

Properties of Bases

Properties of bases

- Bases have pH values of above 7
- A base which is water soluble is referred to as an **alkali**
- In basic (alkaline) conditions red litmus paper turns **blue** and methyl orange indicator turns **yellow**
- Bases are substances which can neutralise an acid, forming a salt and water
- Bases are usually **oxides** or **hydroxides** of metals
- When alkalis react, they gain electrons to form negative hydroxide ions (OH–)
- The presence of the OH– ions is what makes the aqueous solution an alkali

Example: Sodium Hydroxide

$$NaOH\,(s) \rightarrow Na^{+}\,(aq) + OH^{-}\,(aq)$$

Typical reactions of bases

Bases and acids

- When they react with an acid, a neutralisation reaction occurs
- Acids and bases react together in a neutralisation reaction and produce a salt and water:

$$Acid + Base \rightarrow Salt + Water$$

Examples of Reaction Between Bases and Acids:

ACID	NAME OF PRODUCTS	EQUATION FOR REACTION
HYDROCHLORIC ACID	METAL CHLORIDE AND WATER	$MOH + HCL \rightarrow MCL + H_2O$
SULFURIC ACID	METAL SULFATE AND WATER	$MO + H_2SO_4 \rightarrow MSO_4 + H_2O$
NITRIC ACID	METAL NITRATE & WATER	$M(OH)_2 + 2HNO_3 \rightarrow M(NO_3)_2 + 2H_2O$

Alkalis and ammonium salts

- Ammonium salts undergo **decomposition** when warmed with an alkali
- Even though ammonia is itself a weak base, it is very **volatile** and can easily by displaced from the salt by another alkali
- A salt, water and ammonia are produced

Example:

$$NH_4Cl + NaOH \rightarrow NaCl + H_2O + NH_3$$

8.1.1 THE CHARACTERISTIC PROPERTIES OF ACIDS & BASES cont...

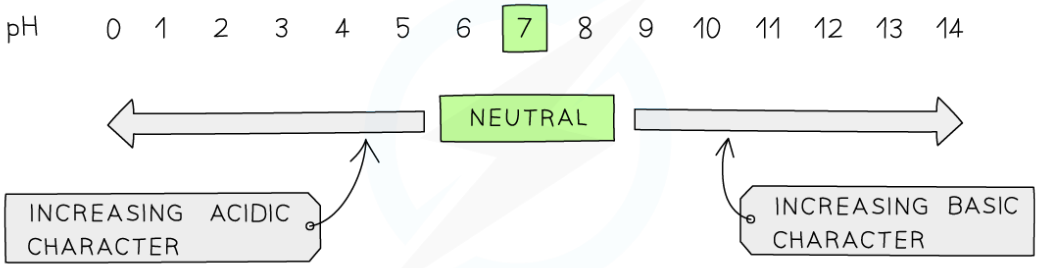
YOUR NOTES

- This reaction is used as a chemical test to confirm the presence of the ammonium ion (NH_4^+)
- Alkali is added to the substance with gentle warming followed by the test for ammonia gas using damp red litmus paper
- The litmus paper will turn from **red** to **blue** if ammonia is present.

Neutrality & Relative Acidity & Alkalinity

The pH scale

- The pH scale is a numerical scale which is used to show how **acidic** or **alkaline** a solution is
- It goes from 1 – 14 (extremely acidic substances can have values of below 1)
- All acids have pH values of **below** 7, all alkalis have pH values of **above** 7
- The **lower** the pH then the more acidic the solution is
- The **higher** the pH then the more alkaline the solution is
- A solution of pH 7 is described as being **neutral** e.g. water



The pH scale showing acidity, neutrality and alkalinity

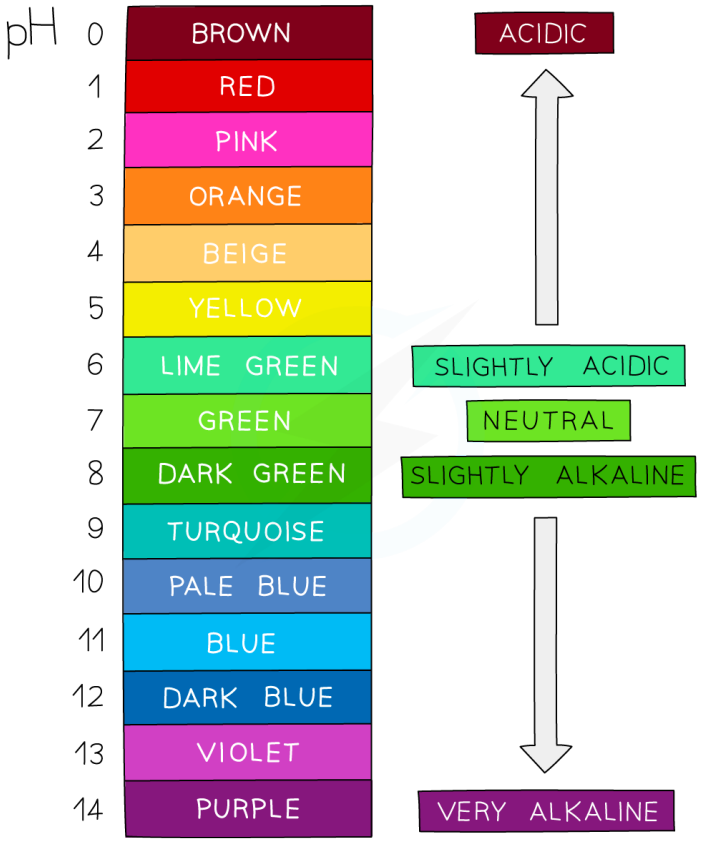
Universal indicator

- Universal indicator is a mixture of different **indicators** which is used to measure the pH
- A drop is added to the solution and the colour is matched with a colour chart which indicates the pH which matches specific colours.

8 ACIDS, BASES & SALTS

8.1.1 THE CHARACTERISTIC PROPERTIES OF ACIDS & BASES cont...

YOUR NOTES



The pH scale with the Universal Indicator colours which can be used to determine the pH of a solution

The importance of pH and soil acidity

- Soil pH is analysed to indicate the **acidity** or **alkalinity** of soil
- Most plants favour a pH value of between **5.5** and **8**
- Changes in soil which cause a pH to be outside this range adversely affect plant processes resulting in reduced **growth** and **crop yield**
- Soils may become acid from **acid rain**, overuse of **fertilisers** which contain ammonium salts or by the excessive breakdown of organic matter by bacteria
- Crushed or powdered limestone (calcium carbonate) or lime (calcium oxide) or slaked lime (calcium hydroxide) is added to neutralise the excess acidity in the soil
- The addition process must be carefully monitored though, as if added in excess, further damage could be done if the pH goes too high

8 ACIDS, BASES & SALTS

8.1.1 THE CHARACTERISTIC PROPERTIES OF ACIDS & BASES cont...

YOUR NOTES

EXTENDED ONLY

Proton Transfer & Weak & Strong Acids & Bases

Proton transfer in acids and bases (Alkalis)

Proton transfer

- The earlier definition of an acid and a base can be extended
- In terms of proton transfer, we can further define each substance in how they interact with protons

Acids

- Acids are **proton donors** as they ionize in solution producing protons, H^+ ions
- These H^+ ions make the aqueous solution acidic

Bases (Alkalis)

- Bases (alkalis) are **proton acceptors** as they ionize in solution producing OH^- ions which can accept protons
- These OH^- ions make the aqueous solution alkaline

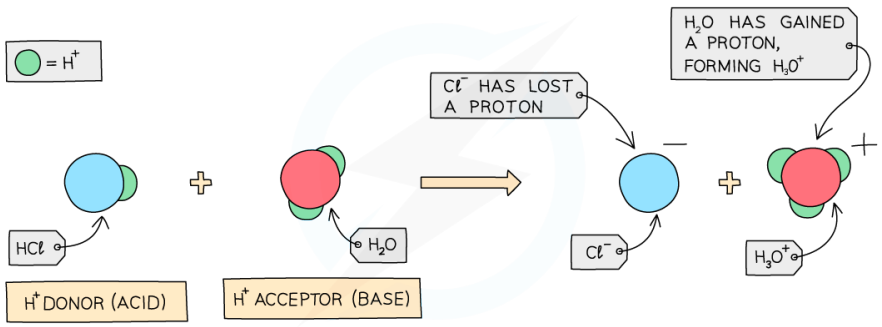


Diagram Showing the Role of Acids and Bases in the Transfer of Protons

Strong acids and bases

- Acids and alkalis can be either **strong** or **weak**, depending on how many ions they produce when dissolved in water
- Strong acids and bases **ionize completely** in water, producing solutions of **very low pH** for an acid or **very high** pH for a base
- Strong acids include HCl and H_2SO_4 and strong bases include the Group I hydroxides

8 ACIDS, BASES & SALTS

8.1.1 THE CHARACTERISTIC PROPERTIES OF ACIDS & BASES cont...

YOUR NOTES

EXTENDED ONLY

Proton Transfer & Weak & Strong Acids & Bases

- Weak acids and bases
- Weak acids and bases **partially** ionize in water and produce pH values which are closer to the **middle** of the pH scale
- Weak acids include organic acids such as ethanoic acid, CH_3COOH and weak bases include aqueous ammonia
- For both weak acids and bases, there is usually an equilibrium set-up between the molecules and their ions once they have been added to water
- Example of a weak acid: propanoic acid

$$CH_3CH_2COOH \rightleftharpoons H^+ + CH_3CH_2COO^-$$

- Example for a weak base: aqueous ammonia

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

- In both cases the equilibrium lies to the **left**, indicating a high concentration of intact acid / base molecules, with a low concentration of ions in solution

Effect of concentration on strong and weak acids and alkalis

- A concentrated solution of either an acid or a base is one that contains a **high number** of acid or base **molecules** per dm^3 of solution
- It does not necessarily mean that the acid or base is strong though, as it may be made from a weak acid or base which does not dissociate
- For example a dilute solution of HCl will be more acidic than a concentrated solution of ethanoic acid, since most of the HCl molecules **dissociate** but very few of the CH_3COOH do.

EXAM TIP

In acid-base chemistry, the terms **strong** and **weak** refer to the ability to dissociate and produce H^+/OH^- ions.

If referring to concentration when answering a question, then the words concentrated or **dilute** should be used.

8 ACIDS, BASES & SALTS

8.1.2 TYPES OF OXIDES

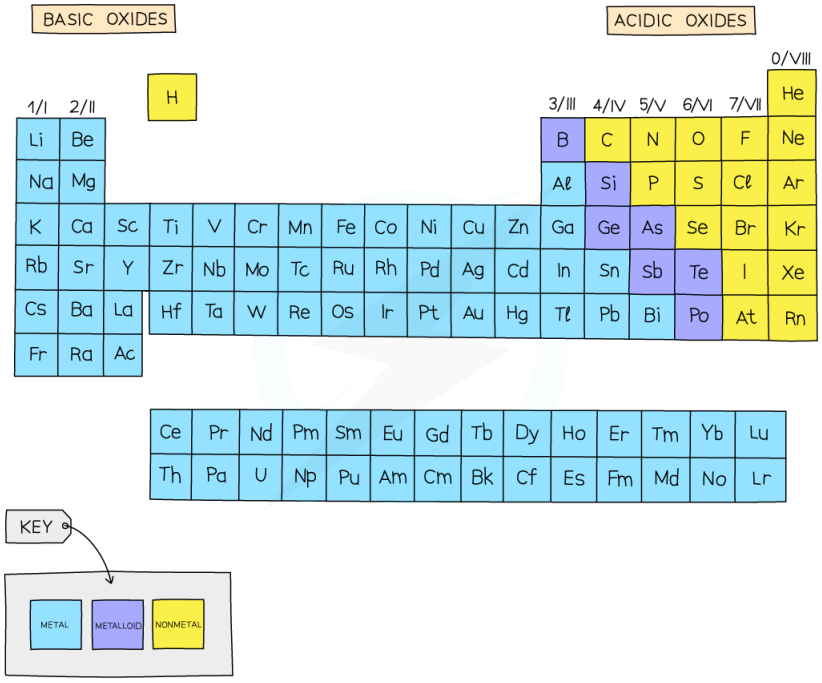
YOUR NOTES

Classifying Oxides

Types of oxide

Acid and basic oxides

- Acidic and basic oxides have different properties and values of pH
- The difference in their pH stems from whether they are bonded to a **metal** or a **nonmetal** element
- The metallic character of the element influences the acidic or alkaline behaviour of the molecule



Metals form basic oxides and hydroxides while nonmetals form acidic oxides

Acidic oxides

- Acidic oxides are formed when a **nonmetal** element combines with oxygen
- They react with bases to form a salt and water
- When dissolved in water they produce an **acidic** solution with a **low** pH
- Common examples include SO_2 and SiO_2

Basic oxides

- Basic oxides are formed when a **metal** element combines with oxygen
- They react with acids to form a salt and water
- When dissolved in water they produce a **basic** solution with a **high** pH
- Common examples include NaOH, KOH and $Ca(OH)_2$

8 ACIDS, BASES & SALTS

8.1.2 TYPES OF OXIDES cont...

YOUR NOTES

EXTENDED ONLY

Neutral & Amphoteric Oxides

Neutral oxides

- Some oxides do not react with either acids or bases and thus are said to be **neutral**
- Examples include N_2O, NO and CO

Amphoteric oxides

- Amphoteric oxides are a curious group of oxides that can behave as **both acidic** and **basic**, depending on whether the other reactant is an acid or a base
- In both cases a salt and water is formed
- Two most common amphoteric oxides are **zinc** oxide and **aluminum** oxide
- The **hydroxides** of both of these elements also behave amphoterically
- Example of aluminium oxide behaving as a base:

$$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$$

- Example for an aluminium oxide behaving as an acid:

$$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$$

> NOW TRY SOME EXAM QUESTIONS

8 ACIDS, BASES & SALTS

EXAM QUESTIONS

YOUR NOTES

QUESTION 1

A student is provided with an unmarked beaker containing a colourless solution and asked to identify it. The student decides to perform a series of reactions with the solution and record the observations.

Which of these observations is not indicative of an acid?

A The solution causes blue litmus to turn red.

B On heating and the addition of copper oxide, the solution turns blue.

C On the addition of ammonium carbonate, a colourless, pungent gas is released.

D On the addition of a piece of magnesium, effervescence was produced and the magnesium piece 'disappeared' after a few minutes.

QUESTION 2

Which of the following statements is not correct?

A Ammonia is released when a base reacts with an ammonium salt.

B Neutralisation occurs when an acid and an alkali react together.

C Carbon dioxide is released when an acid and a carbonate react together.

D The higher the pH of a solution, the higher its acidity.

8 ACIDS, BASES & SALTS

EXAM QUESTIONS

YOUR NOTES

QUESTION 3

Which of the following properties is not indicative of a base?

A Carbon dioxide is released when it reacts with a carbonate.

B A salt is formed on reaction with an acid.

C Ammonia is released on reaction with an ammonium salt.

D Universal indicator paper turns blue when placed in an alkaline solution.

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8 ACIDS, BASES & SALTS

YOUR NOTES

8.2 SALTS & CHEMICAL ANALYSIS

8.2.1 PREPARATION OF SALTS

Preparation, Separation & Purification of Salts

Salts

- A salt is a compound that is formed when the **hydrogen atom** in an acid is replaced by a **metal**
- For example if we replace the H in HCl with a potassium atom, then the salt potassium chloride is formed, KCl
- Salts are an important branch of chemistry due to the varied and important uses of this class of compounds
- These uses include fertilisers, batteries, cleaning products, healthcare products and fungicides

Naming salts

- The name of a salt has two parts
- The first part comes from the **metal**, **metal** oxide or **metal** carbonate used in the reaction
- The second part comes from the **acid**
- The name of the salt can be determined by looking at the reactants
- For example hydrochloric acid always produces salts that end in chloride and contain the **chloride** ion, Cl^-
- Other examples:
  - **Sodium** hydroxide reacts with hydro**chloric** acid to produce sodium chloride
  - **Zinc** oxide reacts with **sulf**uric acid to produce **zinc sulfate**

Preparing salts

- Some salts can be extracted by mining but others need to be prepared in the laboratory
- There are two key ideas to consider when preparing salts:
  - Is the salt being formed **soluble** or **insoluble** in water?
  - Is there **water of crystallisation** present in the salt crystals?

8 ACIDS, BASES & SALTS

8.2.1 PREPARATION OF SALTS cont...

YOUR NOTES

Solubility of the common salts

SALTS	SOLUBLE	INSOLUBLE
SODIUM, POTASSIUM AND AMMONIUM	ALL	NONE
NITRATES	ALL	NONE
ETHANOATES	ALL	NONE
CHLORIDES	MOST ARE SOLUBLE	SILVER AND LEAD (II)
SULFATES	MOST ARE SOLUBLE	BARIUM, CALCIUM AND LEAD (II)
CARBONATES	CARBONATES OF SODIUM, POTASSIUM AND AMMONIUM	MOST ARE INSOLUBLE
HYDROXIDES	HYDROXIDES OF SODIUM, POTASSIUM AND CALCIUM (CALCIUM HYDROXIDE IS SLIGHTLY SOLUBLE)	MOST ARE INSOLUBLE

8 ACIDS, BASES & SALTS

8.2.1 PREPARATION OF SALTS cont...

YOUR NOTES

Preparing soluble salts

Method A: adding acid to a solid metal, base or carbonate

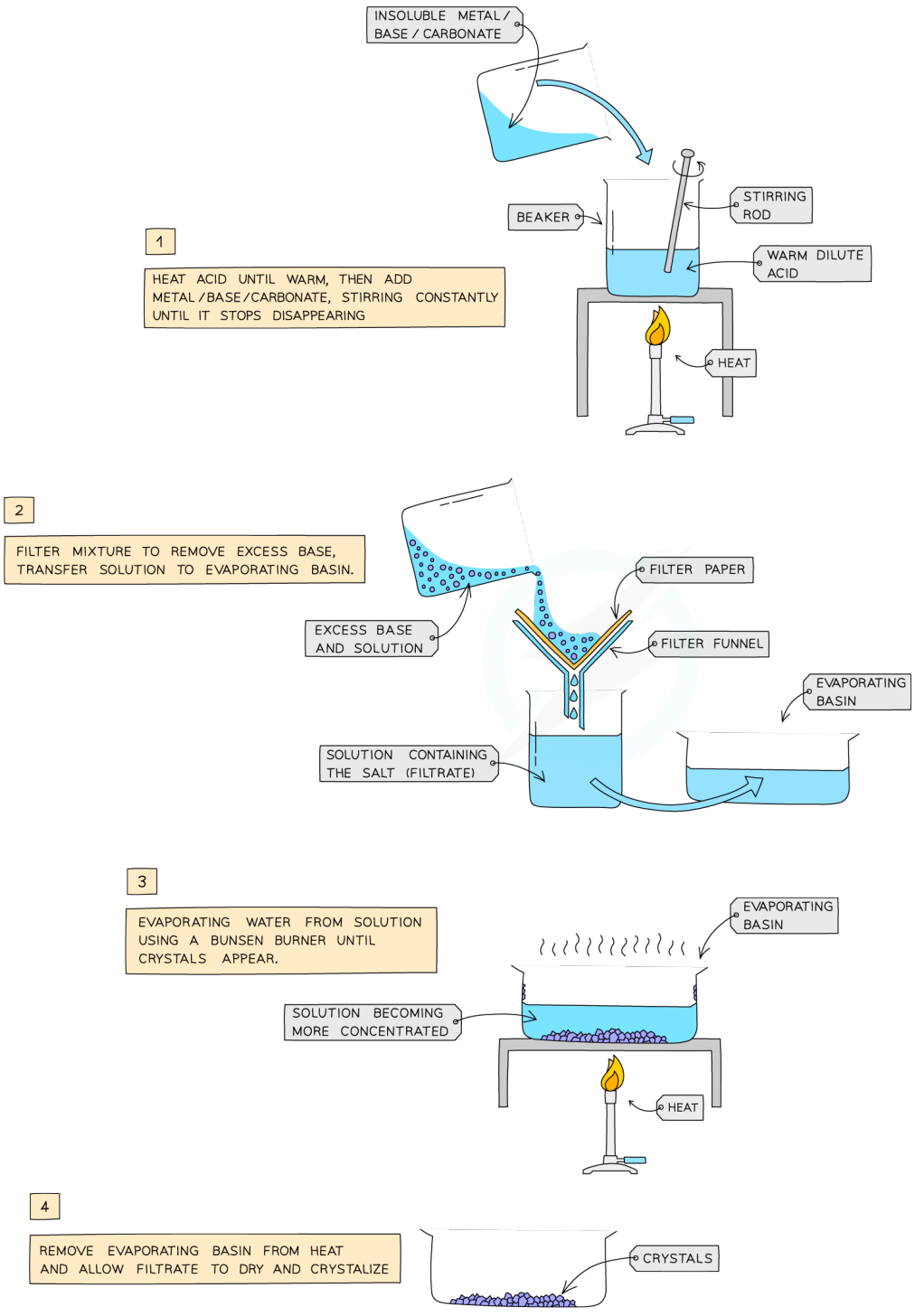


Diagram showing the preparation of soluble salts

8 ACIDS, BASES & SALTS

8.2.1 PREPARATION OF SALTS cont...

YOUR NOTES

Method:

- Add dilute acid into a beaker and heat using a bunsen burner flame
- Add the insoluble metal, base or carbonate, a little at a time, to the warm dilute acid and stir until the base is in excess (i.e. until the base stops disappearing and a suspension of the base forms in the acid)
- Filter the mixture into an evaporating basin to remove the excess base
- Heat the solution to evaporate water and to make the solution saturated
- Check the solution is saturated by dipping a cold, glass rod into the solution and seeing if crystals form on the end
- Leave the filtrate in a warm place to dry and crystallize
- Decant excess solution and allow crystals to dry

Preparation of Pure, Hydrated Copper (II) Sulfate Crystals using Method A

Acid = Dilute Sulfuric Acid **Insoluble Base** = Copper (II) Oxide

Method:

- Add dilute sulfuric acid into a beaker and heat using a bunsen burner flame
- Add copper (II) oxide (insoluble base), a little at a time to the warm dilute sulfuric acid and stir until the copper (II) oxide is in excess (stops disappearing)
- Filter the mixture into an evaporating basin to remove the excess copper (II) oxide
- Leave the filtrate in a warm place to dry and crystallize
- Decant excess solution
- Blot crystals dry

Equation Of Reaction:

$$\underset{CuO\ (s)}{\text{Copper (II) Oxide}} + \underset{H_2SO_4\ (aq)}{\text{Dilute Sulfuric Acid}} \rightarrow \underset{CuSO_4\ (s)}{\text{Copper (II) Sulphate}} + \underset{H_2O\ (l)}{\text{Water}}$$

8 ACIDS, BASES & SALTS

8.2.1 PREPARATION OF SALTS cont...

YOUR NOTES

Method B: reacting a dilute acid & alkali

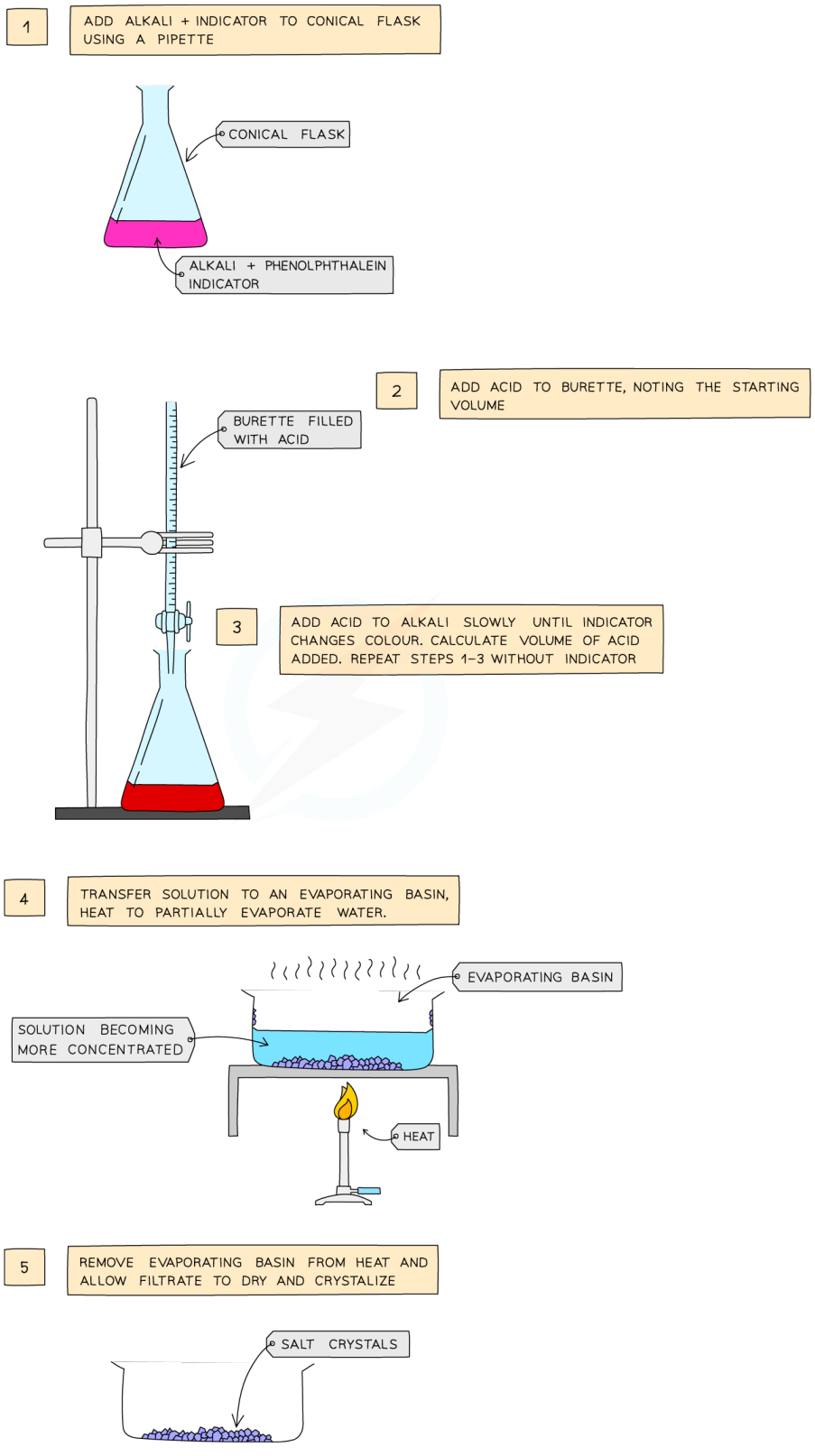


Diagram showing the apparatus needed to prepare a salt by titration

8 ACIDS, BASES & SALTS

8.2.1 PREPARATION OF SALTS cont...

YOUR NOTES

Method:

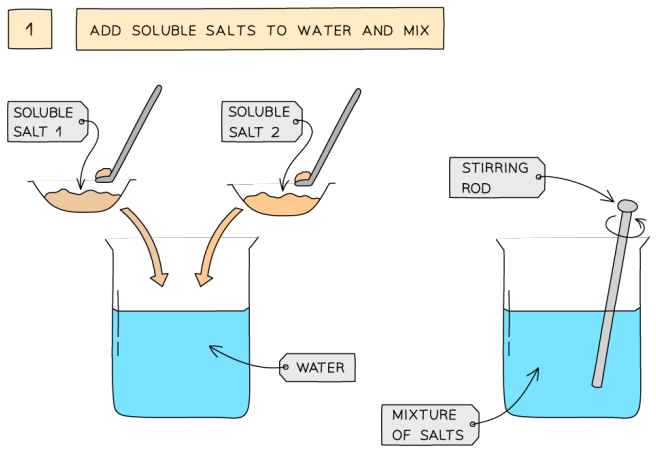
- Use a pipette to measure the alkali into a conical flask and add a few drops of indicator (phenolphthalein or methyl orange)
- Add the acid into the burette and note the starting volume
- Add the acid very slowly from the burette to the conical flask until the indicator changes to appropriate colour
- Note and record the final volume of acid in burette and calculate the volume of acid added (starting volume of acid – final volume of acid)
- Add this same volume of acid into the same volume of alkali without the indicator
- Heat to partially evaporate, leaving a saturated solution
- Leave to crystallise decant excess solution and allow crystals to dry

EXTENDED ONLY

Preparing Insoluble Salts

- Insoluble salts can be prepared using a **precipitation reaction**
- The solid salt obtained is the precipitate, thus in order to successfully use this method the solid salt being formed must be insoluble in water

Using Two Soluble Reactants



8 ACIDS, BASES & SALTS

8.2.1 PREPARATION OF SALTS cont...

YOUR NOTES

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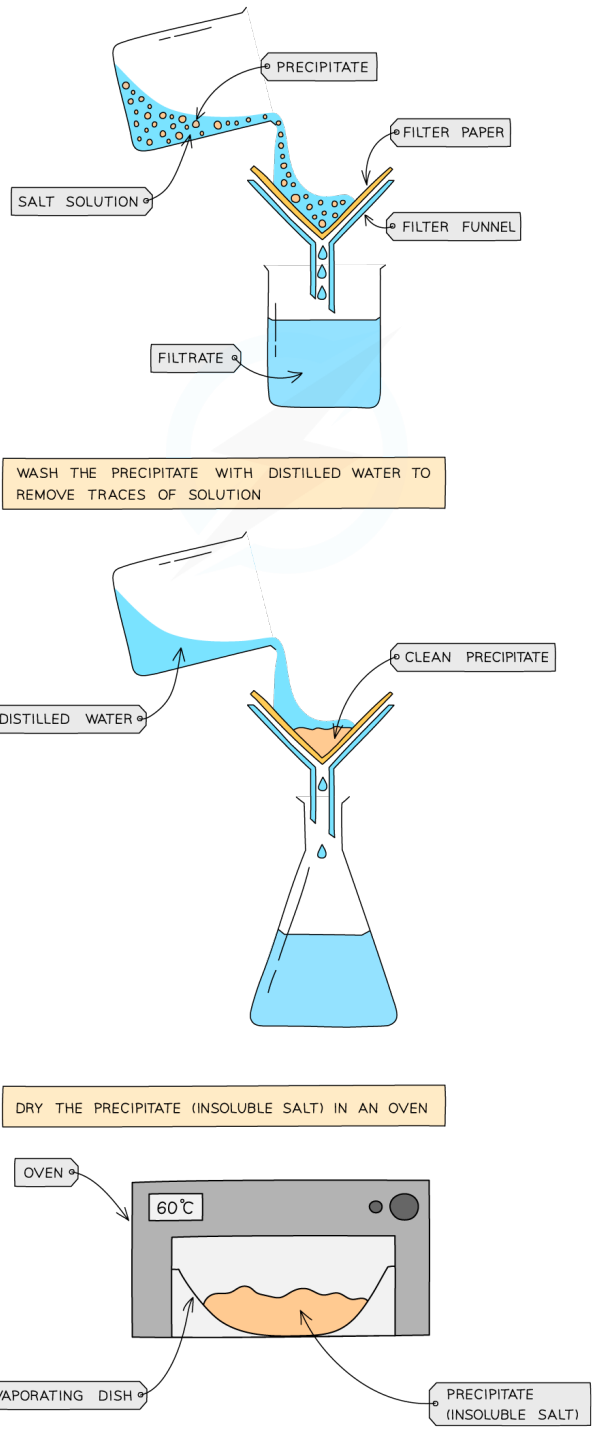


Diagram showing the use of titration to prepare a salt

8 ACIDS, BASES & SALTS

8.2.1 PREPARATION OF SALTS cont...

YOUR NOTES

EXTENDED ONLY cont...

Method:

- Dissolve soluble salts in water and mix together using a stirring rod in a beaker
- Filter to remove precipitate from mixture
- Wash filtrate with water to remove traces of other solutions
- Leave in an oven to dry

Preparation Of Pure, Dry Lead (II) Sulfate Crystals using a precipitation reaction

- **Soluble Salt 1** = Lead (II) Nitrate **Soluble Salt 2** = Potassium Sulfate

Method:

- Dissolve Lead (II) Nitrate and Potassium Sulfate in water and mix together using a stirring rod in a beaker
- Filter to remove precipitate from mixture
- Wash filtrate with water to remove traces of potassium nitrate solution
- Leave in an oven to dry

Equation of Reaction:

Lead (II) Nitrate + Potassium Sulfate → Lead (II) Sulfate + Potassium Nitrate

$Pb(NO_3)_2$ (s) K_2SO_4 (s) $PbSO_4$ (s) $2KNO_3$ (s)

Selecting a Method of Preparation

- When deciding the method of preparation, if is important to first know whether the salt being produced is soluble or insoluble
- If it is **soluble** than it can be prepared using either method (A or B) for preparing a soluble salt
- If it is **insoluble** then it must be prepared using by **precipitation**

8 ACIDS, BASES & SALTS

YOUR NOTES

8.2.2 IDENTIFICATION OF IONS & GASES

Identification of Cations

Test for aqueous cations

- Metal cations in aqueous solution can be identified by the **colour** of the precipitate they form on addition of sodium hydroxide and ammonia
- If only a small amount of NaOH is used then normally the **metal hydroxide** precipitates
- In **excess** NaOH some of the precipitates may dissolve
- A few drops of NaOH is added at first and any colour changes or precipitates formed are noted
- Then the NaOH is added in excess and the reaction is observed again
- The steps are repeated for the test using ammonia solution

EXAM TIP

The ammonia or sodium hydroxide solution must be added very slowly.

If it is added too quickly, and the precipitate is soluble in excess, then you run the risk of missing the formation of the initial precipitate, which dissolves as quickly as it it forms if excess solution is added.

Analysing results

- The table below contains the results for each of the cations included in the syllabus
- If a precipitate is formed from either NaOH or aqueous ammonia then the hydroxide is insoluble in water
- Zinc for example reacts as such:

$$ZnCl_2(aq) + 2NaOH(aq) \rightarrow Zn(OH)_2 + H_2O(l)$$

- Ca^{2+} ions can be distinguished from Zn^{2+} and Al^{3+} as CaOH calcium hydroxide precipitate **does not dissolve** in excess NaOH but both zinc hydroxide and aluminium hydroxide do
- Zn^{2+} ions can be distinguished from Al^{3+} ions as ZnOH **dissolves** in excess aqueous ammonia but $Al(OH)_3$ **does not**
- Most transition metals produce hydroxides with distinctive colours

8 ACIDS, BASES & SALTS

8.2.2 IDENTIFICATION OF IONS & GASES cont...

YOUR NOTES

METAL CATION	EFFECT OF ADDING NaOH	EFFECT OF ADDING AMMONIA SOLUTION
ALUMINIUM (Al^{3+})	WHITE PRECIPITATE, DISSOLVES IN EXCESS NaOH TO FORM A COLOURLESS SOLUTION	WHITE PRECIPITATE, INSOLUBLE IN EXCESS AMMONIA, WHITE PRECIPITATE REMAINS
AMMONIUM (NH^{4+})	AMMONIA PRODUCED IF WARMED	–
CALCIUM (Ca^{2+})	WHITE PRECIPITATE, INSOLUBLE SO REMAINS IN EXCESS NaOH	VERY FAINTLY VISIBLE WHITE PRECIPITATE
CHROMIUM (III) (Cr^{3+})	GREEN PRECIPITATE WHICH FORMS A GREEN SOLUTION IN EXCESS	GREY–GREEN PRECIPITATE, INSOLUBLE IN EXCESS
COPPER (II) (Cu^{2})	LIGHT BLUE PRECIPITATE, INSOLUBLE IN EXCESS	LIGHT BLUE PRECIPITATE, SOLUBLE IN EXCESS TO FORM DARK BLUE COLOUR
IRON (II) (Fe^{2+})	GREEN PRECIPITATE, INSOLUBLE IN EXCESS	GREEN PRECIPITATE, INSOLUBLE IN EXCESS
IRON (III) (Fe^{3+})	RED–BROWN PRECIPITATE, INSOLUBLE IN EXCESS	RED–BROWN PRECIPITATE, INSOLUBLE IN EXCESS
ZINC (Zn^{2+})	WHITE PRECIPITATE, DISSOLVES IN EXCESS TO FORM COLOURLESS SOLUTION	WHITE PRECIPITATE, DISSOLVES IN EXCESS TO FORM COLOURLESS SOLUTION

EXAM TIP

Be sure to distinguish between the term "**colourless**" and "**clear**".

A solution that loses its colour has become colourless.

A clear solution is one that you can see through such as water.

Solutions can be clear **and** have colour e.g. dilute copper sulphate.

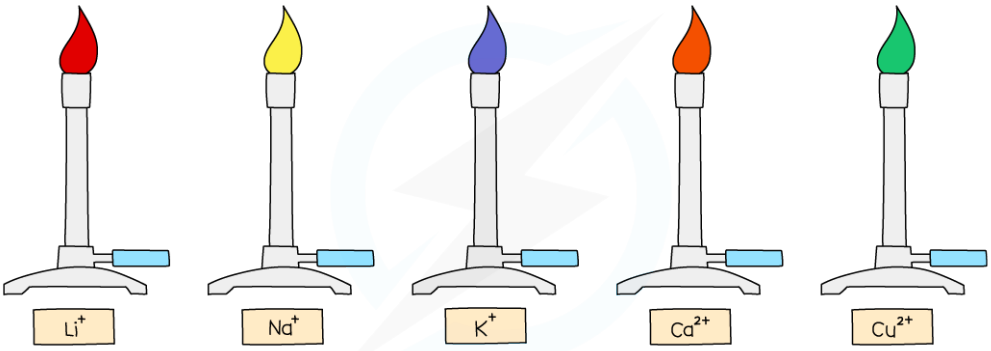
8 ACIDS, BASES & SALTS

8.2.2 IDENTIFICATION OF IONS & GASES cont...

YOUR NOTES

Tests for cations

- The **flame test**
- is used to identify the metal cations by the colour of the flame they produce
- A small sample of the compound is placed on an **unreactive** metal wire such as nichrome or platinum
- The colour of the flame is observed and used to identify the metal



The different coloured flames produced by metal cations during flame tests

CATION	COLOUR OF FLAME
Li^+	RED
Na^+	YELLOW
K^+	LILAC
Ca^{2+}	ORANGE–RED
Cu^{2+}	BLUE–GREEN

8 ACIDS, BASES & SALTS

8.2.2 IDENTIFICATION OF IONS & GASES cont...

YOUR NOTES

Identification of Aqueous Anions

ANION	TEST	RESULT
CARBONATE (CO_3^{2-})	ADD DILUTE ACID AND TEST THE GAS RELEASED	EFFERVESCENCE, GAS PRODUCED IS CO_2 WHICH TURNS LIMEWATER MILKY
CHLORIDE (Cl^-)	ACIDIFY WITH DILUTE NITRIC ACID AND ADD AQUEOUS SILVER NITRATE	WHITE PRECIPITATE FORMED
BROMIDE (Br^-)	ACIDIFY WITH DILUTE NITRIC ACID AND ADD AQUEOUS SILVER NITRATE	CREAM PRECIPITATE FORMED
IODIDE (I^-)	ACIDIFY WITH DILUTE NITRIC ACID AND ADD AQUEOUS SILVER NITRATE	YELLOW PRECIPITATE FORMED
NITRATE (NO_3^{2-})	ADD AQUEOUS NaOH AND ALUMINIUM FOIL, WARM GENTLY AND TEST THE GAS RELEASED	GAS GIVEN OFF IS AMMONIA, HAS A PUNGENT SMELL AND TURNS MOIST RED LITMUS PAPER BLUE
SULFATE (SO_4^{2-})	ACIDIFY WITH DILUTE NITRIC ACID AND ADD AQUEOUS BARIUM NITRATE	WHITE PRECIPITATE FORMED
SULFITE (SO32−)	ADD DILUTE ACID, WARM GENTLY AND TEST THE GAS RELEASED	GAS DECOLOURISES PURPLE ACIDIFIED AQUEOUS POTASSIUM MANGANATE(VII) SOLUTION

EXAM TIP

When it comes to qualitative inorganic analysis, always remember that there will be:

- a test for the metal **cation** part of the molecule
- and another test for the **anion** part.

8 ACIDS, BASES & SALTS

8.2.2 IDENTIFICATION OF IONS & GASES cont...

YOUR NOTES

Identification of Gases

Tests for gases

- Several tests for anions and cations produce **gases** which then need to be tested
- The table below indicates the tests for the gases included in the syllabus

GAS	APPEARANCE OF TEST	TEST	RESULT
AMMONIA (NH_3)	COLOURLESS, PUNGENT SMELL	DAMP RED LITMUS PAPER	TURNS BLUE
CARBON DIOXIDE (CO_2)	COLOURLESS AND ODOURLESS	BUBBLE THROUGH LIMEWATER	LIMEWATER TURNS MILKY/ CLOUDY
CHLORINE (Cl_2)	PALE GREEN, CHOKING SMELL	DAMP BLUE LITMUS PAPER	TURNS RED
HYDROGEN (H_2)	COLOURLESS AND ODOURLESS	HOLD A LIGHTED SPLINT IN MOUTH OF TEST TUBE	BURNS WITH A "SQUEAKY POP" SOUND
OXYGEN (O_2)	COLOURLESS AND ODOURLESS	HOLD A GLOWING SPLINT	SPLINT RELIGHTS
SULFUR DIOXIDE (SO_2)	COLOURLESS, PUNGENT CHOKING SMELL	ADD TO ACIDIFIED AQUEOUS POTASSIUM MANGANATE(VII)	TURNS FROM PURPLE TO COLOURLESS

EXAM TIP

It is easy to confuse the tests for hydrogen and oxygen. Try to remember that:

- a ligHted splint has an **H** for **H**ydrogen, while a gl**O**wing splint has an **O** for **O**xygen.

> NOW TRY SOME EXAM QUESTIONS

8 ACIDS, BASES & SALTS

EXAM QUESTIONS

YOUR NOTES

QUESTION 1

A student wanted to prepare copper(II) sulfate crystals by reacting solid copper(II) oxide to a solution of hot sulfuric acid.

An extract from the method section of the experimental handout is shown below:

Add the copper(II) oxide in small amounts to the hot acid in the reaction flask and stir until it is …..**1**….. When the reaction has gone to completion the copper(II) oxide will no longer …..**2**….., …..**3**….. and …..**4**….. the solution to obtain the copper(II) sulfate crystals.

	1	2	3	4
A	in excess	precipitate	cool	dissolve
B	in excess	dissolve	filter	cool
C	reacting	dissolve	cool	filter
D	reacting	precipitate	filter	cool

QUESTION 2

Which of the following methods to prepare a salt can be achieved using a burette and a pipette?

A Nitric acid and calcium carbonate to prepare calcium nitrate.

B Sulfuric acid and copper(II) oxide to prepare copper(II) sulfate.

C Hydrochloric acid and zinc to prepare zinc chloride.

D Hydrochloric acid and potassium hydroxide to prepare potassium chloride.

8 ACIDS, BASES & SALTS

EXAM QUESTIONS

YOUR NOTES

QUESTION 3

Copper(II) sulfate can be prepared by reacting solid copper(II) carbonate with hot sulfuric acid. The alkali solid is always added in excess.

Why is the solid reactant added in excess?

A To ensure all of the acid reacts.

B To make the reaction go faster.

C To ensure all of the solid reactant has reacted.

D To increase the product yield.

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