CHAPTER 8: SALTS

1. **Salts**
   - A salt is an ionic compound.
   - The anion part comes from the acid while the cation part comes from a base.
   - Example: KCl, KOH(aq) + HCl(aq) → KCl(aq) + H_2O(l)
   - ***A salt is a compound formed when the hydrogen ion. H^+ from an acid is replaced by a metal ion or an ammonium ion, NH_4^+.***

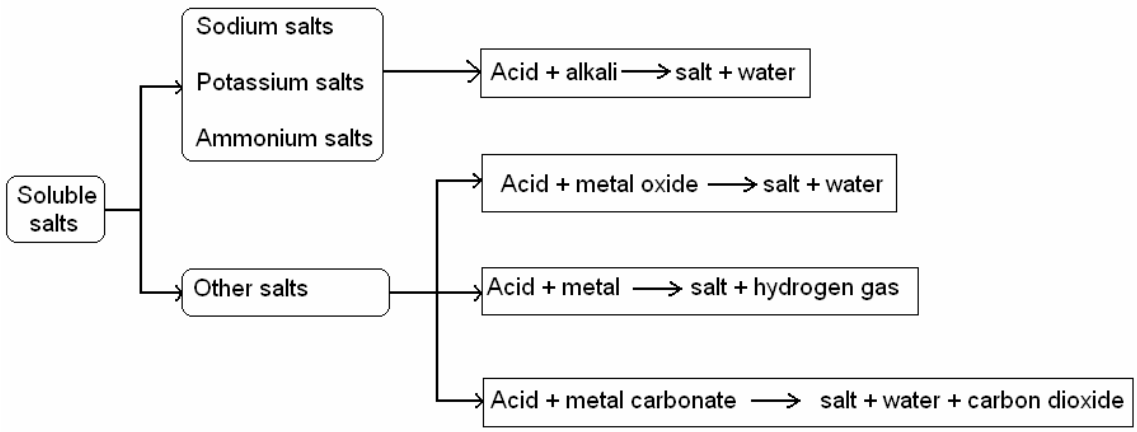
Salts	Soluble	Insoluble
Nitrate salts	- All nitrate salts	-
Carbonate salts	- **P**otassium carbonate, K_2CO_3 - **A**mmonium carbonate, $(NH_4)_2CO_3$ - **S**odium carbonate, Na_2CO_3	- All other carbonate salts
Chloride salts	- All chloride salts **Except →**	- Lead (II) chloride, **Pb**Cl_2 - Silver chloride, **Ag**Cl - Mercury Chloride, **Hg**Cl
Sulphate salts	- All sulphate salts **Except →**	- Lead (II) sulphate, **Pb**S - Barium sulphate, **Ba**SO - Cacium sulphate, **Ca**SO

P **A** **S**

Pb **Ag** **Hg**

Persatuan **Ba**hasa **C**ina

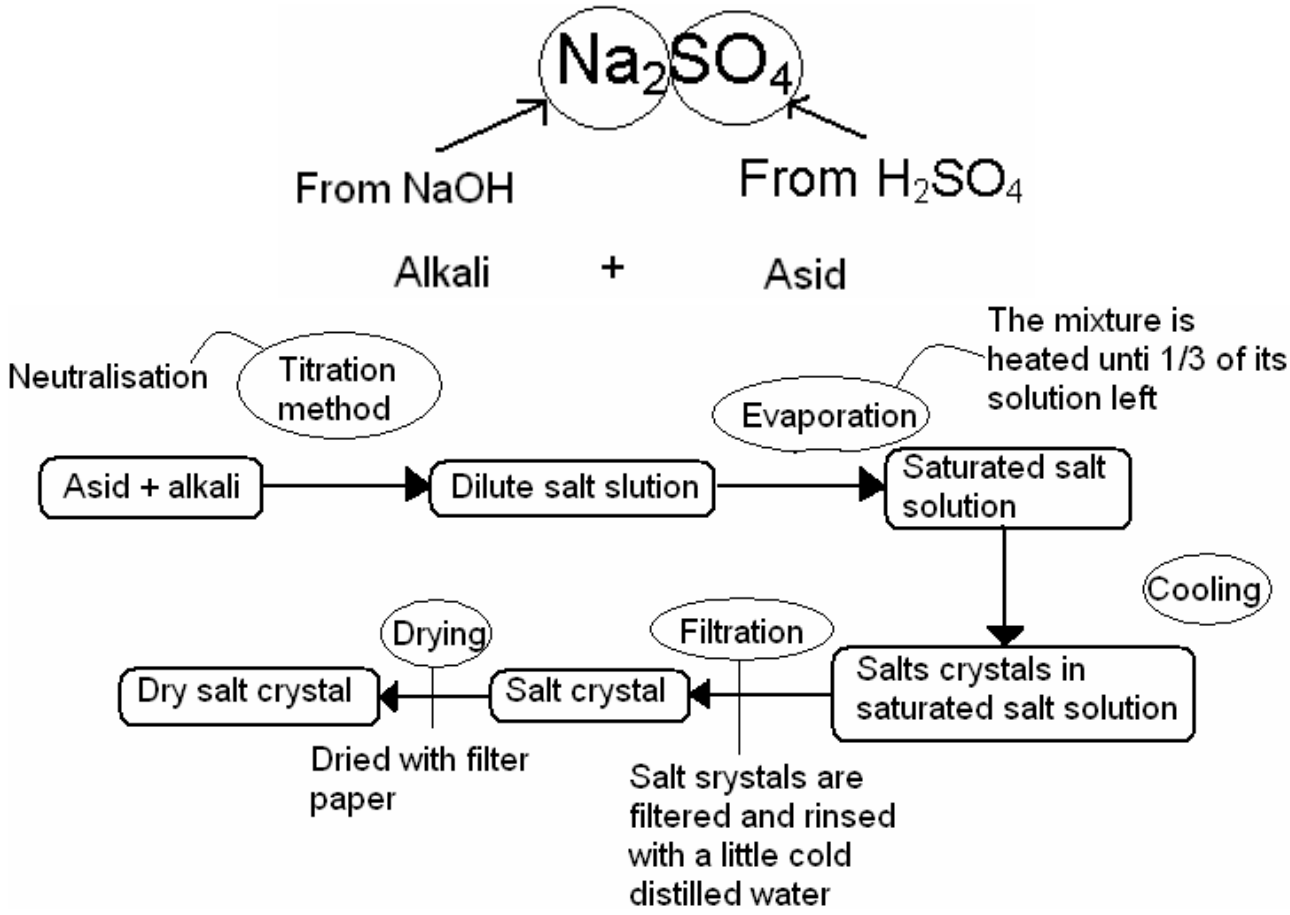
2. **Preparation and purification of soluble salts**



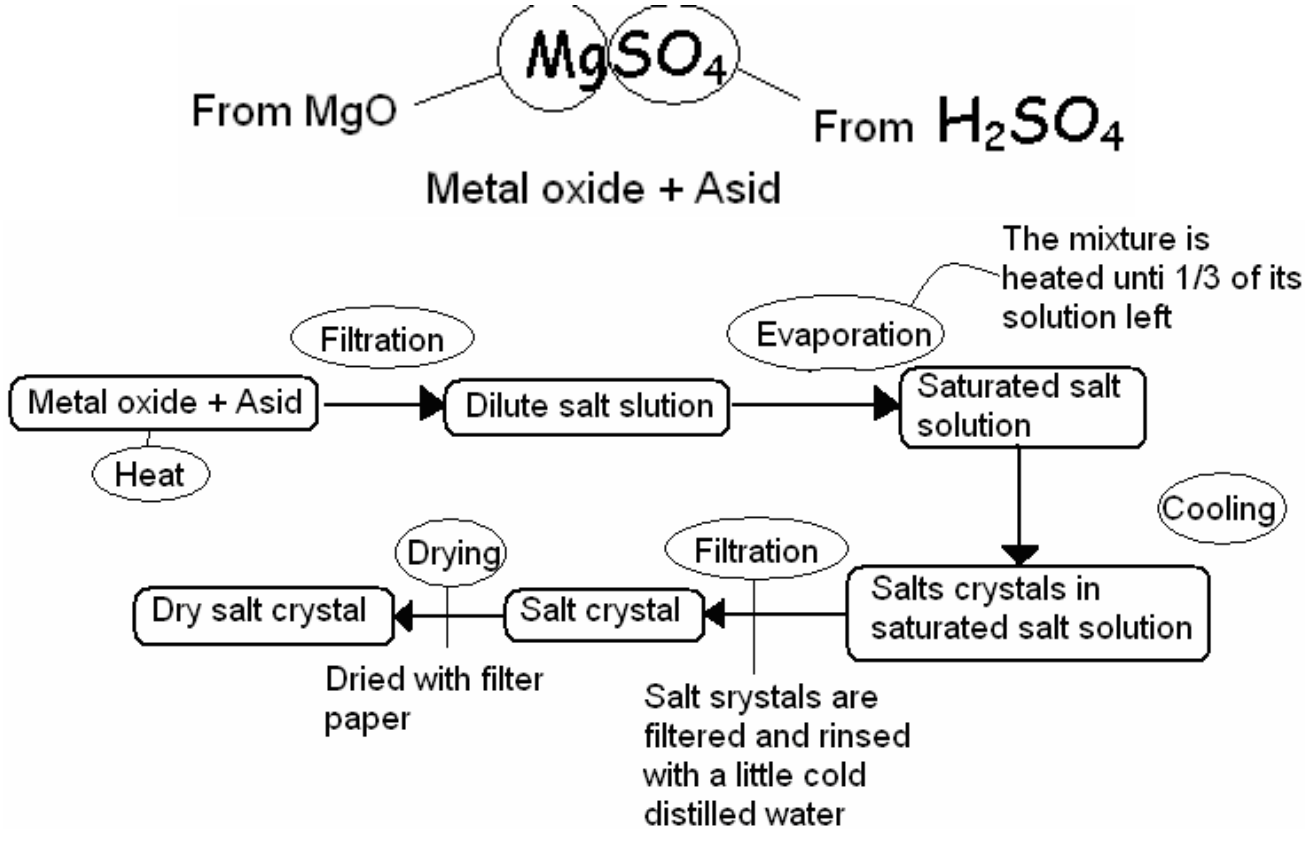
   - The salts formed during preparation of soluble salts contain impurities.
   - These salts need to be purified through a process known as **recrystallisation**.
   - Physical characteristics of crystals:

i. Crystals have fixed geometrical shapes such as a cuboid, rhombic or prism.
ii. Crystals of the same substance have same shapes but may be in different sizes.
iii. Crystals have flat surfaces, straight edges and sharp angles.
iv. Crystals have fixed angles between two neighboring surfaces.

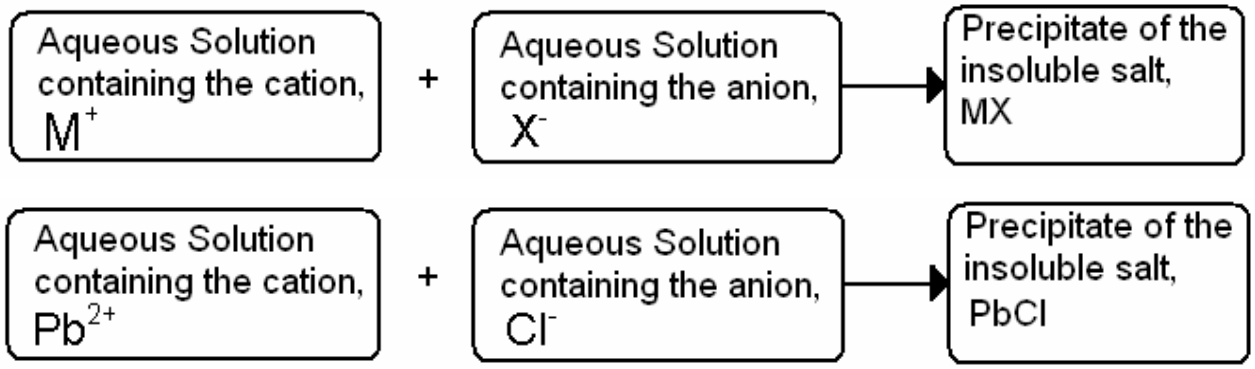
Example 1: Preparation of Soluble Salts → **Na_2SO_4**



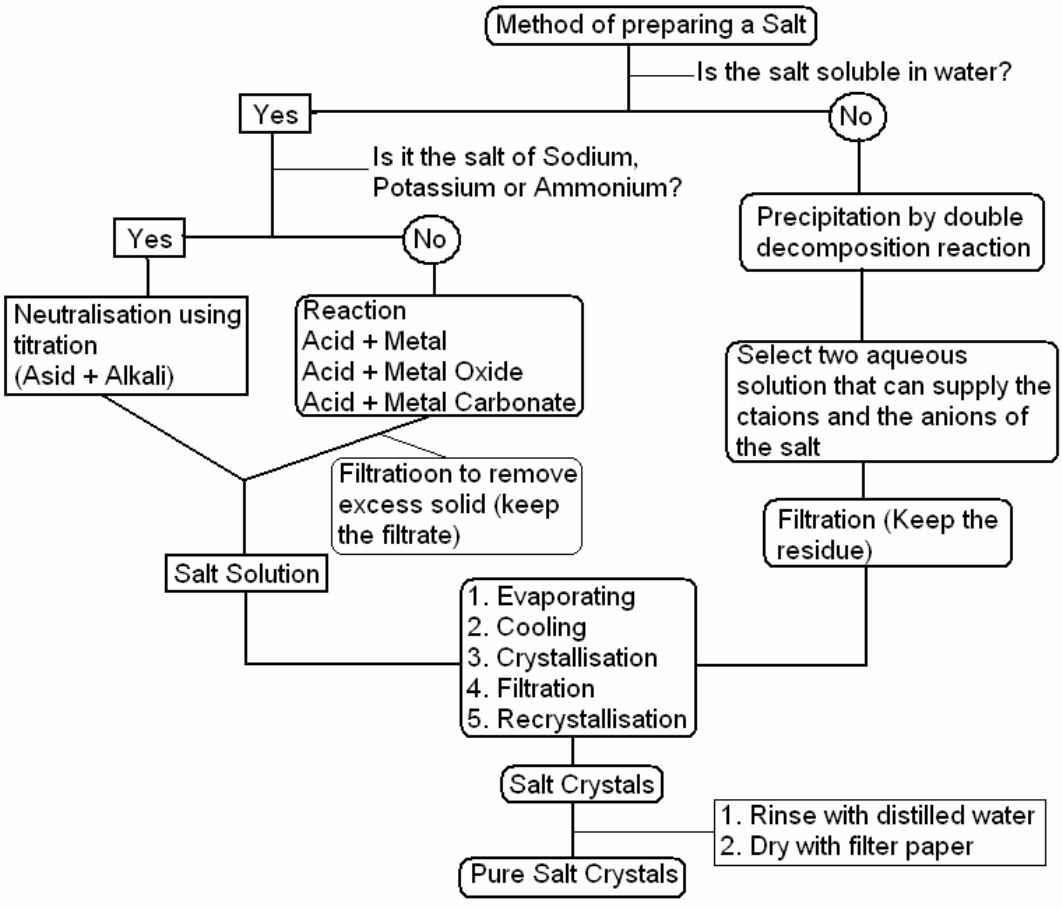
Example 2: Preparation of Soluble Salt → $MgSO_4$



3. **Preparation of insoluble salts**
   - An insoluble salts is prepared through precipitation reaction.
   - Aqueous solutions containing the ions of the insoluble salt are mixed together to from the salt.
   - The insoluble salt is formed as a precipitate and can be obtained by filtration.
   - Example: $BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$
   - Insoluble salts can prepared by double decomposition reaction through precipitation.



4. **Procedure for the selection of the method preparing 1 specified salt.**



5. **Qualitative Analysis of Salts**

- Qualitative analysis is a chemical technique used to determine what substance is present in a mixture but not their quantities.
- In the quantitative analysis of salts, we need to identify the ions that are present in salts.
- This can be done by analyzing their physical and chemical properties.
- Cations and anions in salts can be identified through:
  a) Colour and solubility of the salt
  b) Gas Test
  c) Effect of heat on salt
  d) Confirmatory test for anions
  e) Confirmatory test for cations

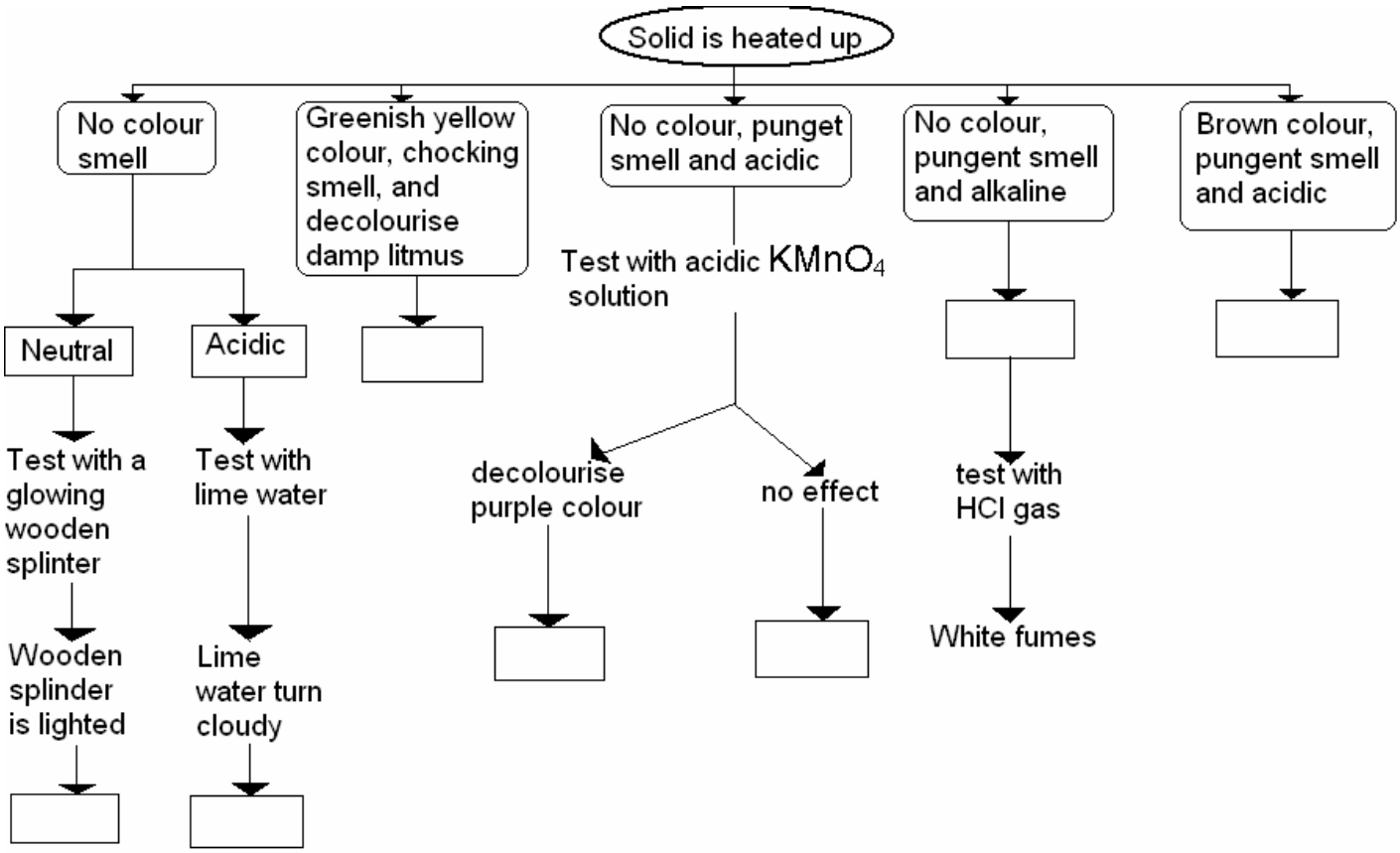
6 **Colour and solubility of the salt**

Cation / anion / salt / compounds which may be present	**Colour**	
	Solid	**Solution**
Salts of Ca^{2+}, Mg^{2+}, Al^{3+}, Pb^{2+}, $NH4^{+}$	White	Colourless
$CuSO_4$ / $Cu(NO_3)_2$	Blue	Blue
$CuCl_2$	Green	Blue
$CuCO_3$	Green	Insoluble
$FeSO_4$ / $Fe(NO_3)_2$ / $FeCl_2$	Green	Green
$Fe(SO_4)_3$ / $Fe(NO_3)_3$ / $FeCl_3$	Brown	Yellow / Browndish-yellow / Brown (depending on concentration)
PbO	Brown when hot and yellow when cooled	Insoluble
CuO	Black	Insoluble
ZnO	Yellow when hot and white when cooled	Insoluble
$PbCl_2$	White	Insoluble in cold water but soluble in hot water
PbI_2	Yellow	Insoluble in cold water but soluble in hot water

7 **Gas Test**

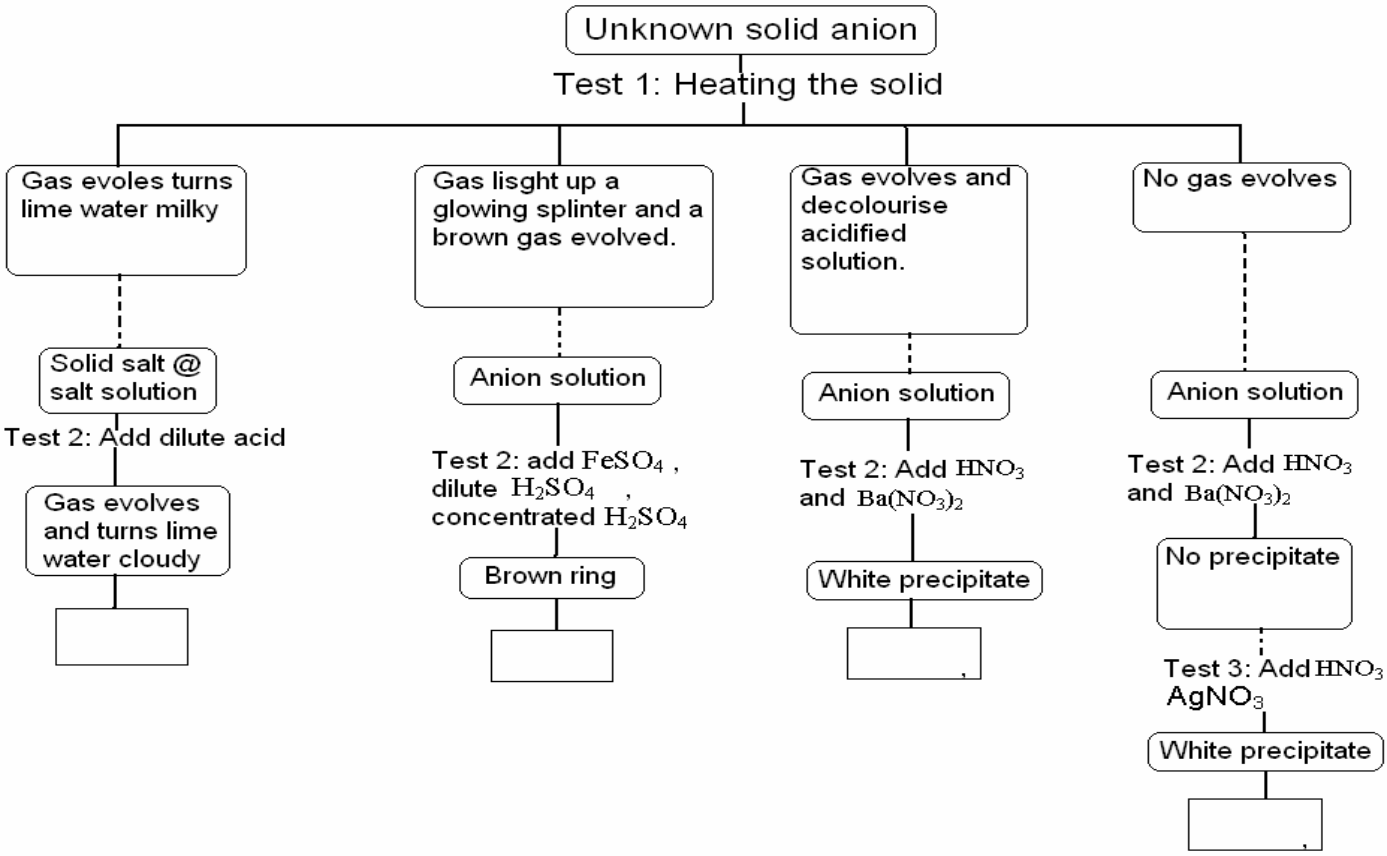
Gas	Colour	Smell	Confirmatory test	Diagram
Oxygen, O_2	Colourless	Odourless	Lights up a glowing wooden splinter	
Hydrogen, H_2	Colourless	Odourless	Produce a 'pop' sound with a lighted wooden splinter	
Carbon dioxide, CO_2	Colourless	Odourless	**Turns limewater cloudy**	
Ammonia, NH_3	Colourless	Pungent smell	a) Turns moist red litmus paper blue b) Produces thick white fumes with hydrogen chloride, HCl gas	
Chlorine, Cl_2	Greenish-yellow	Pungent smell	a) Bleaches moist red litmus paper b) Turns moist blue litmus paper to red and then bleaches it	
Hydrogen Chloride, HCl	Colourless	Pungent smell	Produces thick white fumes with ammonia, NH_3 gas	
Nitrogen dioxide, NO_2	**Brown**	Pungent smell	Turns moist blue litmus paper red	
Sulphur dioxide, SO_2	Colourless	Pungent smell	Bleaches the purple colour of acidified potassium manganate (VII), $KMnO_4$ solution	
Water vapour, H_2O	Colourless	Odourless	a) Turns the white anhydrous copper (II) sulphate, $CuSO_4$ blue b) Turns the blue anhydrous cobalt (II) chloride $CoCl_2$ paper pink.	

Flow Chart for selection of test for gas



8. **Test For Anions**

	ANIONS	TEST
1	Carbonate ion, CO_3^{2-}	- Pour 3 cm^3 of aqueous carbonate solution into a test tube - Add 2 cm^3 hydrochloric acid, HCl - Bubble the gas produced through limewater - **Lime water turned milky**.
2	Chloride ion, Cl^-	- Pour about 2 cm^3 of aqueous chloride solution into test tube - Add 2 cm^3 nitric acid, HNO_3 - Add 2 cm^3 of silver nitrate solution, $AgNO_3$. - **A white precipitate is formed with silver nitrate solution**
3.	Sulphate ion, SO_4^{2-}	- Pour 2 cm^3 of aqueous sulphate solution into test tube - Add 2 cm^3 hydrochloric acid, HCl - Add 2 cm^3 of barium chloride solution, $BaCl_2$. - **A white precipitate is formed with barium chloride solution**
4.	Nitrate ion, NO_3^-	- Pour about 2 cm^3 of aqueous nitrate solution into test tube - Add 2 cm^3 sulphuric acid, H_2SO_4. - Add 2 cm^3 of iron (II) sukphate, $FeSO_4$ solution. Shake to mix well. - Slant the test tube and add slowly concentrated sulphuric acid, H_2SO_4 down the side of the test tube. Do not shake the test tube. - **A brown ring is formed.**



9. **Test for Cations**

Reactions with NaOH solution	Cations	Reactions with NH_3 solution
NH_3 gas evoles when heated	NH_4^+	-
Blue precipitate insoluble in excess NaOH	Cu^{2+}	***Blue*** precipitate insoluble in excess NH_3 (aq) to form a dark blue solution
Green precipitate insoluble in excess NaOH	Fe^{2+}	***Green*** precipitate insoluble in excess NH_3 (aq)
Brown precipitate insoluble in excess NaOH	Fe^{3+}	***Brown*** precipitate insoluble in excess NH_3 (aq)
White precipitate insoluble in excess NaOH	Ca^{2+}	No precipitate forms
White precipitate ***insoluble*** in excess NaOH	Mg^{2+}	White precipitate ***insoluble*** in excess NH_3 (aq)
White precipitate ***soluble*** in excess NaOH	Zn^{2+}	White precipitate ***soluble*** in excess NH_3 (aq)
White precipitate soluble in excess NaOH	Al^{3+}	White precipitate insoluble in excess NH_3 (aq)
White precipitate soluble in excess NaOH	Pb^{2+}	White precipitate insoluble in excess NH_3 (aq)

1 **Confirmation Tests**

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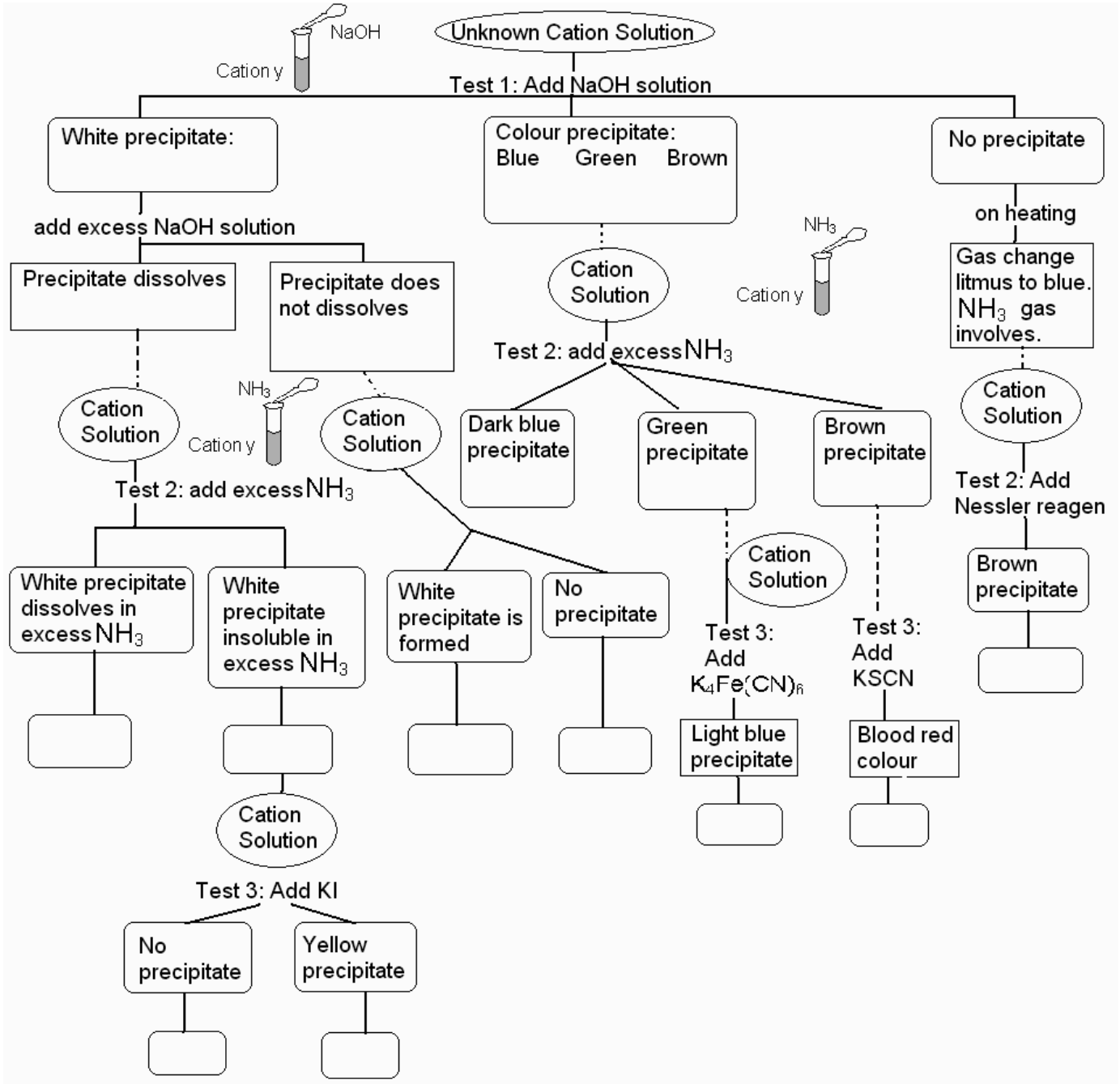
Cations	Confirmatory Test	Observation
Fe^{2+}	- Add acidic potassium manganate (VII) solution, $KMnO_4$ - **Add $K_4Fe(CN)_6$** - Add $K_3Fe(CN)_6$	- Purple colour of solution decolourised - **Light blue precipitate** - Dark blue precipitate
Fe^{3+}	- **Add potassium thicyanate, KSCN** - **Add $K_4Fe(CN)_6$** - Add $K_3Fe(CN)_6$	- **Blood red solution formed** - **Dark blue precipitate** - Greenish brown solution
Pb^{2+}	- **Add potassium iodide solution, KI** - Add potassium chloride solution, KCl - Add potassium sulphate solution, K_2SO_4	- **Yellow precipitate** - White precipitate - White precipitate
NH_4^+	- **Add Nessler reaget**	- **Brown precipitate formed**

11. **Analysis of cations in Salt**



Chemistry Form 4: Chapter 9 Salts

Salts	Salts is a compound
Types of salts	

Types of Salts	Soluble	Insoluble

Salt / Compound	**Solubility in water**	**Salt / Compound**	**Solubility in water**
1. $Cu(NO_3)_2$		11. NH_4Cl	
2. $MgCl_2$		12. $AgNO_3$	
3. $ZnCO_3$		13. $CaCO_3$	
4. $PbSO_4$		14. $BaSO_4$	
5. $CuCl_2$		15. $PbCl_2$	
6. $ZnSO_4$		16. $Al(NO_3)_3$	
7. AgCl		17. $CuCO_3$	
8. Na_2CO_3		18. Na_2SO_4	
9. $BaCO_3$		19. $ZnCl_2$	
10. $Ca(NO_3)_2$		20. $FeSO_4$	

Method	Diagram
To prepare soluble salts by mixing acid with alkali i) Titration ii) Crystallisation iii) Recrystallisation	$HCl(aq) + KOH(aq) \rightarrow KCl(aq) + H_2O(l)$

To prepare soluble salts by mixing acid with an insoluble metal oxide i. Acid + insoluble salt ii. Crystallisation iii. Recrystalisation	$2HNO_3(aq) + CuO(s) \rightarrow Cu(NO_3)_2(aq) + 2H_2O(l)$
To prepare soluble salts by mixing acid with an insoluble metal carbonate i. Acid + insoluble metal carbonate ii. Crystallisation iii. Recrystalisation	$2HCl(aq) + MgCO_3(s) \rightarrow MgCl_2(aq) + CO_2(g) + 2H_2O(l)$

To prepare insoluble salts by precipitation reaction i. mixing solutions ii. Filtering and washing precipitate iii. Drying insoluble salt	$BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$

Gas Tests

Gas	Colour	Smell	Diagram	Confirmatory Test
Oxygen O_2				
Hydrogen H_2				
Carbon dioxide CO_2				
Ammonia NH_3				
Chlorine Cl_2				
Hydrogen chloride, HCl				

Nitrogen dioxide NO_2				
Sulphur dioxide SO_2				
Water vapour H_2O				

Effect of heat on carbonate salts

Carbonate salts	Colour of salt before heating	Colour of residue		Effect on lime water	Chemical equation
		Hot	Cold		
Copper (II) carbonate $CuCO_3$					
Zinc carbonate $ZnCO_3$					
Lead(II) carbonate $PbCO_3$					
Magnesium carbonate $MgCO_3$					
Calcium carbonate $CaCO_3$					
Potassium carbonate K_2CO_3					
Sodium carbonate Na_2CO_3					

Effect of heat on Nitrate salts

Nitrate salts	Colour of salt before heating	Colour of residue		Observation	Chemical equation
		Hot	Cold		
Sodium nitrate $NaCO_3$					
Potassium nitrate KNO_3					
Magnesium nitrate $Mg(NO_3)_2$					
Calcium nitrate $Ca(NO_3)_2$					
Copper (II) nitrate $Cu(NO_3)_2$					
Zinc nitrate $Zn(NO_3)_2$					
Lead(II) nitrate $Pb(NO_3)_2$					
Iron (II) nitrate $Fe(NO_3)_2$					
Iron (III) nitrate $Fe(NO_3)_3$					

Test of Anions

Anion	Activity & Diagram	Observation	Inference
Carbonate ion, CO_3^{2-}			
Chloride ion, Cl^-			
Sulphate ion, SO_4^{2-}			
Nitrate ion, NO_3^-			

Test for Cations

		Observation				
Cation solution	Cation	A liitle sodium hydroxide NaOH	Excess sodium hydroxide NaOH	A little ammonia, NH_3 solution	Excess ammonia NH_3 solution	Confrimatory test
Calcium nitrate $Ca(NO_3)_2$						
Magnesium nitrate $Mg(NO_3)_2$						
Zinc nitrate $Zn(NO_3)_2$						
Aluminium nitrate $Al(NO_3)_3$						
Lead (II) nitrate $Pb(NO_3)_2$						
Copper (II) sulphate $CuSO_4$						
Iron (II) sulphate $FeSO_4$						
Iron (III) chloride $FeCl_3$						