

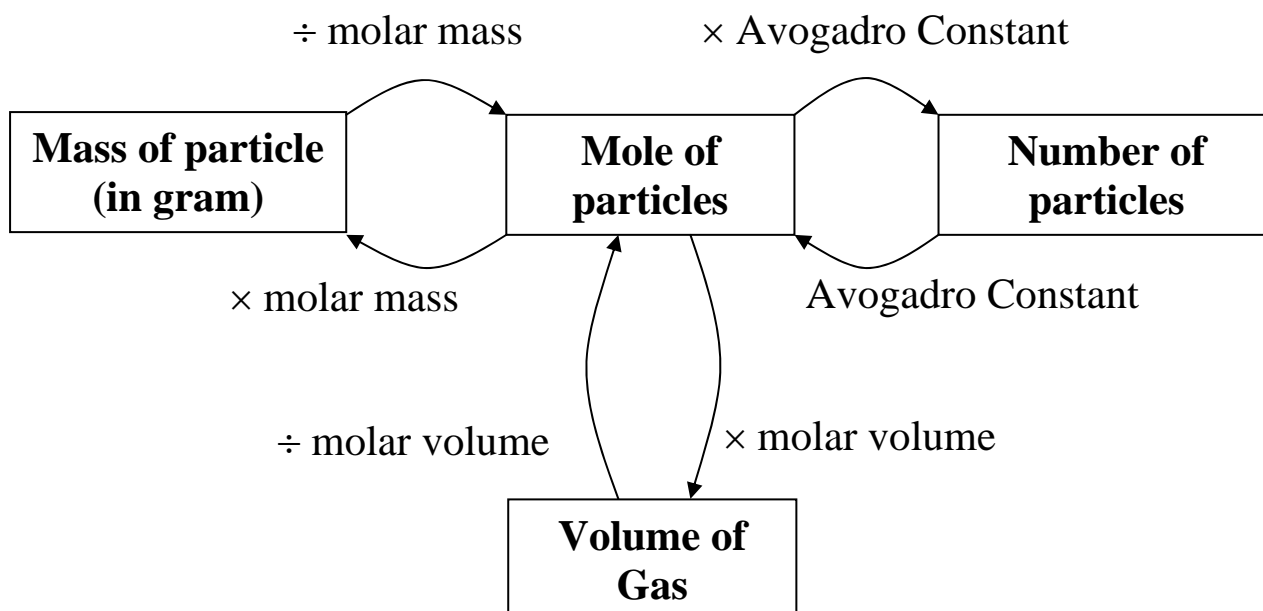
Short Notes: Form 4 Chemistry

Chemical Formulae and Equation

Calculation

<p>For Solid, liquid or gas</p> $\text{number of mole} = \frac{\text{mass of substance}}{\text{molar mass}}$ <p>Molar mass = RAM/RMM/RFM in gram</p>	<p>For gas (only)</p> $\text{number of mole} = \frac{\text{volume of gas}}{\text{molar volume}}$ <p>Molar volume = 24dm³ at room temperature Molar volume = 22.4dm³ at s.t.p.</p>
<p>For Solution</p> $\text{number of mole} = \frac{MV}{1000}$ <p>M = molarity V = Volume of solution in cm³</p>	<p>For quantity of particle(atom,molecule,ion)</p> $\text{number of mole} = \frac{\text{quantity of particle}}{6.02 \times 10^{23}}$

Summary



Chemical Formula

Cation (Positive Ions)

Ion	Symbol	Ion	Symbol	Ion	Symbol
Potassium	K^+	Calcium	Ca^{2+}	Aluminium	Al^{3+}
Sodium	Na^+	Magnesium	Mg^{2+}	Iron (III)	Fe^{3+}
Lithium	Li^+	Zinc	Zn^{2+}	Chromium(III)	Cr^{3+}
Hydrogen	H^+	Barium	Ba^{2+}		
Argentums(I)	Ag^+	Iron (II)	Fe^{2+}		
Mercury(I)	Hg^+	Tin (II)	Sn^{2+}		
Ammonium	NH_4^+	Lead(II)	Pb^{2+}		
		Copper(II)	Cu^{2+}		
		Manganese(II)	Mn^{2+}		

Anion (Negative Ions)

Ion	Symbol	Ion	Symbol	Ion	Symbol
Oxide	O^{2-}	Hydroxide	OH^-	Ethanoate	CH_3COO^-
Fluoride	F^-	Sulphate	SO_4^{2-}	Manganate(VII)	MnO_4^-
Chloride	Cl^-	Nitrate	NO_3^-	Dichromate(VI)	$Cr_2O_7^{2-}$
Bromide	Br^-	Carbonate	CO_3^{2-}	Phosphate	PO_4^{3-}
Iodide	I^-			Thiosulphate	$S_2O_3^{2-}$

Formulae for Certain Molecule

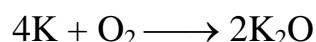
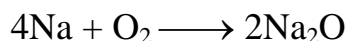
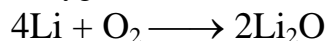
Karbon monoxide	CO	Ammonia	NH_3
Carbon dioxide	CO_2	water	H_2O
Nitrogen monoxide	NO	Hydrogen chloride	HCl
Nitrogen dioxide	NO_2	Tetrachloromethane	CCl_4
Sulphur dioxide	SO_2	Glucose	$C_6H_{12}O_6$
Sulphur trioxide	SO_3	Hydrogen bromide	HBr
Fluorine	F_2	Hydrogen iodide	HI
Bromine	Br_2	Hydrogen sulphide	H_2S
Chlorine	Cl_2	Ethanol	C_2H_5OH
Iodine	I_2	Ethanoic Acid	CH_3COOH

Periodic Table

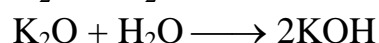
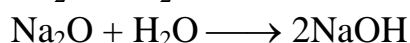
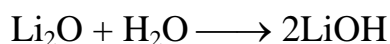
Reaction of Group 1 Elements

1. Reaction with Oxygen

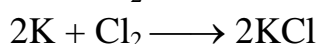
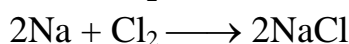
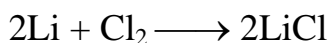
The entire group 1 metal can react with oxygen to form metal oxide.



The metal oxide of group 1 elements can dissolve in water to form alkali (hydroxide) solution

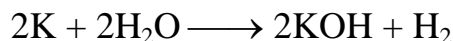
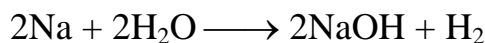
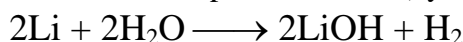


2. Reaction with halogen (Chlorine)



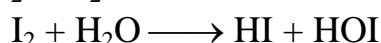
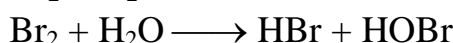
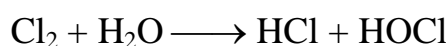
3. Reaction with water

The entire group 1 metal can react with water to produce alkali (hydroxide) solution and hydrogen gas.



Reaction of Group 17 Elements

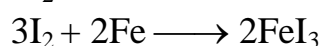
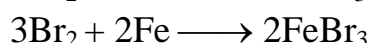
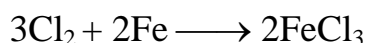
1. React with water



2. React with Sodium Hydroxide



3. React with Iron



Preparation of Chlorine Gas

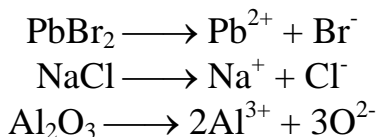


Electrochemistry

Electrolyte

Ionisation of Electrolyte

Ionisation of Molten Compound



Ionisation of Aqueous Solution

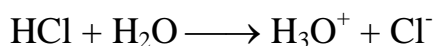
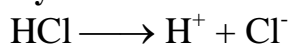
$\text{NaCl} \longrightarrow \text{Na}^+ + \text{Cl}^-$ $\text{H}_2\text{O} \longrightarrow \text{H}^+ + \text{OH}^-$	$\text{HCl} \longrightarrow \text{H}^+ + \text{Cl}^-$ $\text{H}_2\text{O} \longrightarrow \text{H}^+ + \text{OH}^-$	$\text{CuSO}_4 \longrightarrow \text{Cu}^{2+} + \text{SO}_4^{2-}$ $\text{H}_2\text{O} \longrightarrow \text{H}^+ + \text{OH}^-$
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Discharge of Positive Ion	Discharge of Negative Ion
$\text{Na}^+ + \text{e} \longrightarrow \text{Na}$ <p>Observation: Grey deposit is formed.</p> $\text{Al}^{3+} + 3\text{e} \longrightarrow \text{Al}$ <p>Observation: Grey deposit is formed.</p> $\text{Pb}^{2+} + 2\text{e} \longrightarrow \text{Pb}$ <p>Observation: Grey deposit is formed.</p> $\text{Cu}^{2+} + 2\text{e} \longrightarrow \text{Cu}$ <p>Observation: Brown deposit is formed.</p> $\text{Ag}^+ + \text{e} \longrightarrow \text{Ag}$ <p>Observation: Silver deposit is formed.</p> $2\text{H}^+ + 2\text{e} \longrightarrow \text{H}_2$ <p>Observation: Gas bubble is formed. A 'pop' sound is produced when a lighted splinter is placed near the mouth of the test tube.</p>	$2\text{Cl}^- \longrightarrow \text{Cl}_2 + 2\text{e}$ <p>Observation: Bubbles of pungent yellowish green gas are produced. The gas turns moist litmus paper to red and then bleaches it.</p> $2\text{Br}^- \longrightarrow \text{Br}_2 + 2\text{e}$ <p>Observation: Molten electrolyte: Brown colour gas is produced.</p> <p>Aqueous solution: Light brown solution is formed.</p> $2\text{I}^- \longrightarrow \text{I}_2 + 2\text{e}$ <p>Observation: Molten electrolyte: Brown colour gas is produced.</p> <p>Aqueous solution: Light brown solution is formed. The solution turns blue when a few drops of starch solution is added in.</p> $4\text{OH}^- \longrightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}$ <p>Observation: Gas bubble is formed. Gas produces light up a wooden splinter.</p>

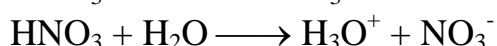
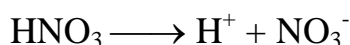
Acid and Base

Ionisation of Acid

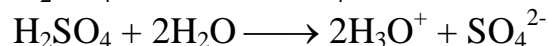
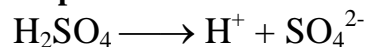
Hydrochloric Acid



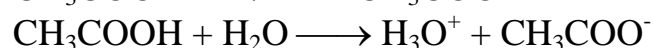
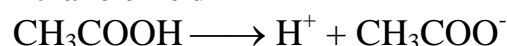
Nitric Acid



Sulphuric Acid



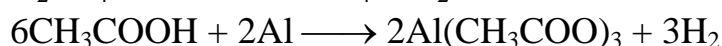
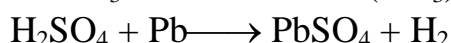
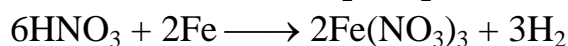
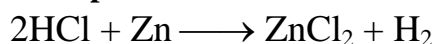
Ethanoic Acid



Chemical Properties of Acid

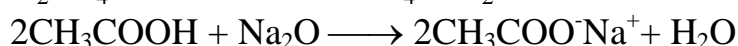
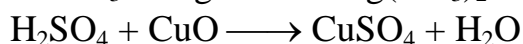
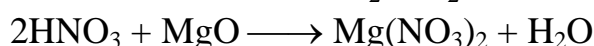
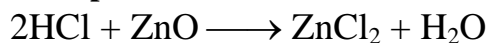
Acid + Reactive Metal \longrightarrow Salt + H_2

Example:



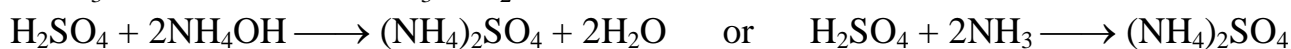
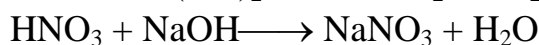
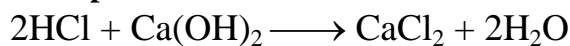
Acid + Metal Oxide \longrightarrow Salt + H_2O

Example:



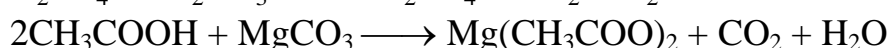
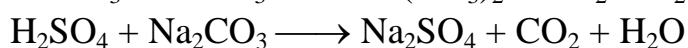
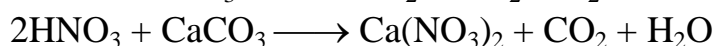
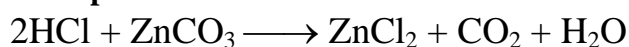
Acid + Metal Hydroxide \longrightarrow Salt + H_2O

Example:



Acid + Metal Carbonate \longrightarrow Salt + CO_2 + H_2O

Example:



Salt

Solubility of Salt

Salt	Solubility
Salt of potassium, sodium and ammonium	All are soluble in water
Salt of nitrate	All are soluble in water
Salt of sulphate	Mostly soluble in water except: (Pb) Lead sulphate (Ba) Barium sulphate (Ca) Calcium sulphate
Salt of chloride	Mostly soluble in water except: (Pb) Lead chloride (Ag) silver chloride (Hg) mercury chloride
Salt of carbonate	Mostly insoluble in water except: Potassium carbonate Sodium carbonate Ammonium carbonate
Oxide and Hydroxide	Solubility
Oxide	Mostly insoluble in water except: K ₂ O and Na ₂ O.
Hydroxide	Mostly insoluble in water except: NH ₄ OH, KOH and NaOH

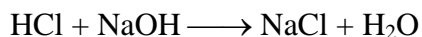
Preparation of Salt

Preparation of Soluble Salt

Salt of Potassium, Sodium and Ammonium

Acid + Alkali \longrightarrow Salt + Water

Example: Preparation of Sodium Chloride (NaCl)



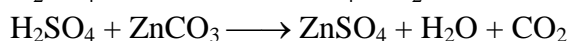
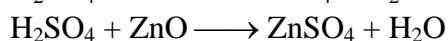
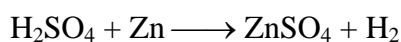
Salt of non-Potassium, Sodium and Ammonium

Acid + Reactive metal \longrightarrow Salt + Hydrogen Gas

Acid + Metal Oxide \longrightarrow Salt + Water

Acid + Metal Carbonate \longrightarrow Salt + Water + Carbon Dioxide

Example: Preparation of Zinc Sulphate (ZnSO₄)

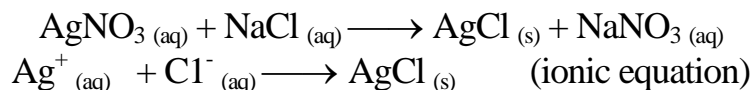


Preparation of Insoluble Salt

Ionic Precipitation

Insoluble salts can be made by double decomposition. This involves mixing a solution that contains its positive ions with another solution that contains its negative ions.

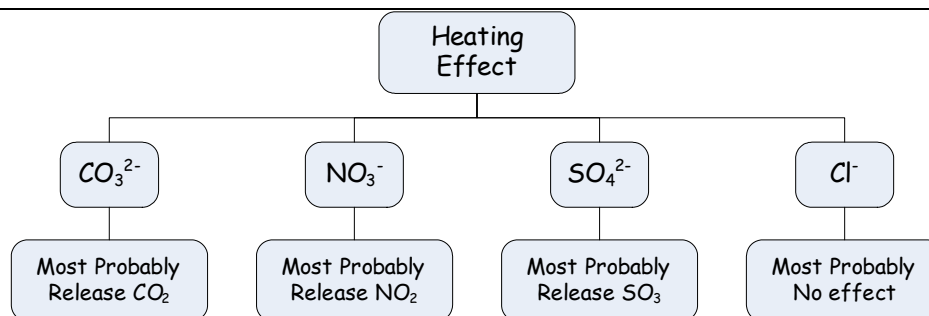
Example: Preparation of Silver Nitrate



Colour of Salt

Salt or metal oxide	Solid	Aqueous solution
Salt of: Sodium, Calcium, Magnesium, Aluminium, zinc, Lead, ammonium Chloride, sulphate, nitrate, carbonate	White	Colourless
Salt of Copper(II).- Copper(II) Carbonate Copper(II) sulphate, Copper(II) nitrate, Copper(II) chloride Copper(II) oxide	Green Blue Black	Insoluble Blue Insoluble
Salt of Iron (II) Iron(II) sulphate; Iron(II) nitrate; Iron(II) chloride	Green	Green
Salt of Iron (III). Iron(III) sulphate; Iron(III) nitrate; Iron(III) chloride	Brown	Brown
Lead Iodide	Yellow	Insoluble
Lead Chloride	White	Insoluble
Zinc oxide	Yellow when it is hot and white when it is cold.	Insoluble
Lead(II) oxide-	Brown when it is hot and yellow when it is cold.	Insoluble
Magnesium oxide, Aluminium oxide	White	Insoluble
Potassium oxide, Sodium oxide, Calcium oxide	White	Colourless

Heating effect on Salt



Heating Effect on Carbonate Salt

Carbonate Salt	Equation of The Reaction
Potassium carbonate Sodium carbonate	Not decomposable
Calcium carbonate Magnesium carbonate Aluminium carbonate Zinc carbonate Iron (III) carbonate Lead(II) carbonate Copper(II) carbonate	$\text{CaCO}_3 \longrightarrow \text{CaO} + \text{CO}_2$ $\text{MgCO}_3 \longrightarrow \text{MgO} + \text{CO}_2$ $\text{Al}_2(\text{CO}_3)_3 \longrightarrow \text{Al}_2\text{O}_3 + 3\text{CO}_2$ $\text{ZnCO}_3 \longrightarrow \text{ZnO} + \text{CO}_2$ $\text{Fe}_2(\text{CO}_3)_3 \longrightarrow \text{Fe}_2\text{O}_3 + 3\text{CO}_2$ $\text{PbCO}_3 \longrightarrow \text{PbO} + \text{CO}_2$ $\text{CuCO}_3 \longrightarrow \text{CuO} + \text{CO}_2$
Mercury(II) carbonate Silver(I) carbonate	$2\text{HgCO}_3 \longrightarrow 2\text{Hg} + 2\text{CO}_2 + \text{O}_2$ $2\text{Ag}_2\text{CO}_3 \longrightarrow 4\text{Ag} + 2\text{CO}_2 + \text{O}_2$
Ammonium carbonate	$(\text{NH}_4)_2\text{CO}_3 \longrightarrow \text{NH}_3 + \text{CO}_2 + \text{H}_2\text{O}$

Heating Effect on Nitrate Salt

Nitrate Salt	Equation of The Reaction
Potassium nitrate Sodium nitrate	$2\text{KNO}_3 \longrightarrow 2\text{KNO}_2 + \text{O}_2$ $2\text{NaNO}_3 \longrightarrow 2\text{NaNO}_2 + \text{O}_2$
Calcium nitrate Magnesium nitrate Aluminium nitrate Zinc nitrate Iron (III) nitrate Lead(II) nitrate Copper(II) nitrate	$2\text{Ca}(\text{NO}_3)_2 \longrightarrow 2\text{CaO} + 4\text{NO}_2 + \text{O}_2$ $\text{Mg}(\text{NO}_3)_2 \longrightarrow 2\text{MgO} + 4\text{NO}_2 + \text{O}_2$ $4\text{Al}(\text{NO}_3)_3 \longrightarrow 2\text{Al}_2\text{O}_3 + 12\text{NO}_2 + 3\text{O}_2$ $\text{Zn}(\text{NO}_3)_2 \longrightarrow 2\text{ZnO} + 4\text{NO}_2 + \text{O}_2$ $4\text{Fe}(\text{NO}_3)_3 \longrightarrow 2\text{Fe}_2\text{O}_3 + 12\text{NO}_2 + 3\text{O}_2$ $\text{Pb}(\text{NO}_3)_2 \longrightarrow 2\text{PbO} + 4\text{NO}_2 + \text{O}_2$ $\text{Cu}(\text{NO}_3)_2 \longrightarrow 2\text{CuO} + 4\text{NO}_2 + \text{O}_2$
Mercury(II) nitrate Silver(I) nitrate	$\text{Hg}(\text{NO}_3)_2 \longrightarrow \text{Hg} + 2\text{NO}_2 + \text{O}_2$ $2\text{AgNO}_3 \longrightarrow 2\text{Ag} + 2\text{NO}_2 + \text{O}_2$
Ammonium nitrate	$\text{NH}_4\text{NO}_3 \longrightarrow \text{N}_2\text{O} + 2\text{H}_2\text{O}$

[NOTES: Nitrogen dioxide, NO_2 is acidic gas and is brown in colour.]

Heating effect on sulphate salt	The heating effect on chloride salts
<p>Most sulphate salts do not decompose by heat. Only certain sulphate salts are decomposed by heat when heated strongly.</p> <p>Zinc sulphate, Copper (II) sulphate, Iron (III) sulphate</p> $\text{ZnSO}_4 \longrightarrow \text{ZnO} + \text{SO}_3$ $\text{CuSO}_4 \longrightarrow \text{CuO} + \text{SO}_3$ $2\text{Fe}_2(\text{SO}_4)_3 \longrightarrow \text{Fe}_2\text{O}_3 + \text{SO}_2 + \text{SO}_3$ <p>Ammonium sulphate</p> $(\text{NH}_4)_2\text{SO}_4 \longrightarrow 2\text{NH}_3 + \text{H}_2\text{SO}_4$	<p>All chloride salts are not decomposable by heat except ammonium chloride.</p> <p>Example:</p> $\text{NH}_4\text{Cl} \longrightarrow \text{NH}_3 + \text{HCl}$

Identification of Gases































Gasses	Characteristics
Oxygen	Rekindle glowing splinter.
Hydrogen	Explode with a 'pop' sound when brought close to a lighted splinter.
Carbon Dioxide	Turns lime water chalky.
Chlorine	Bleach moist litmus paper.
Ammonia	Pungent smell. Turn moist red litmus paper to blue. Produces white fume when reacts with concentrated hydrochloric Acid.
Sulphur Dioxide	Pungent smell. Bleach the purple colour of potassium manganate(VII). Turn moist blue litmus paper to red.
Nitrogen Dioxide	Pungent smell. Brown in colour. Turn moist blue litmus paper to red.

Qualitative analysis

Identification of Anions (Negative ions)

	Diluted HCl or diluted HNO ₃ or diluted H ₂ SO ₄	BaCl (aq) or Ba(NO ₃) ₂ (aq) follow by diluted HCl/HNO ₃	AgNO ₃ follow by diluted HNO ₃ .	Brown Ring Test (+ FeSO ₄ (aq)) + concentrated H ₂ SO ₄
CO ₃ ²⁻	Carbon Dioxide is released.	White precipitate is formed. It is soluble in diluted HCl/HNO ₃	White precipitate is formed. It is soluble in diluted HNO ₃	-
SO ₄ ²⁻	-	White precipitate is formed. It is NOT soluble in diluted HCl/HNO ₃	-	-
Cl ⁻	-	-	White precipitate is formed. It is NOT soluble in diluted HNO ₃	-
NO ₃ ⁻	-	-	-	Formation of Brown Ring

Identification of cation

	NaOH(ak)	NH ₃ (ak)	HCl or NaCl	H ₂ SO ₄ or Na ₂ SO ₄	Na ₂ CO ₃	KI
Na ⁺						
Ca ²⁺	White precipitate.			White precipitate is produced.	White precipitate is produced.	
Mg ²⁺	White precipitate is produced.	White precipitate is produced.			White precipitate is produced.	
Al ³⁺	White precipitate is produced. Dissolve in excess NaOH solution.	White precipitate is produced.			White precipitate is produced.	
Zn ²⁺	White precipitate is produced. Dissolve in excess NaOH solution.	White precipitate is produced. Dissolve in excess NH ₃ solution.			White precipitate is produced.	
Pb ²⁺	White precipitate is produced. Dissolve in excess NaOH solution.	White precipitate is produced.	White precipitate is produced. Dissolve in hot water	White precipitate is produced.	White precipitate is produced.	Yellow precipitate is produced. Dissolve in hot water
Fe ²⁺	Dirty green precipitate is produced.	Dirty green precipitate is produced.			Green precipitate is produced.	
Fe ³⁺	Red brown precipitate is produced.	Red brown precipitate is produced.			Brown precipitate is produced.	A red brown solution formed.
Cu ²⁺	Blue precipitate is produced.	Blue precipitate is produced. Dissolve in excess NH ₃ solution and form a blue solution.			Blue precipitate is produced.	White precipitate form in brown solution
NH ₄ ⁺						



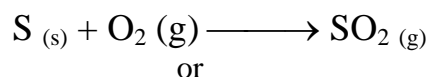
= No changes is observed

Distibguish Iron(II) and Iron(III)

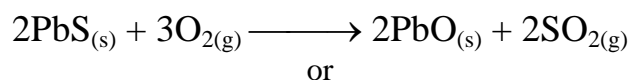
Reagent	Observation	Ion presents
Solution of potassium hecxacioferate(II)	Light blue precipitate	Fe ²⁺
	Dark Blue precipitate	Fe ³⁺
Solution of potassium hecxacioferate(III)	Dark blue precipitate	Fe ²⁺
	Greenish brown solution	Fe ³⁺
Solution of potassium Thiocyanate(II)	Pinkish solution	Fe ²⁺
	Blood red solution	Fe ³⁺

Manufactured Substances in Industry**Contact Process (Making Sulphuric Acid)****Stage 1: Formation of SO₂**

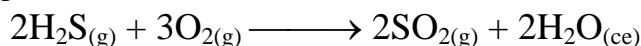
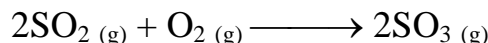
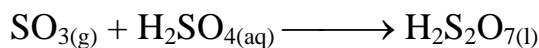
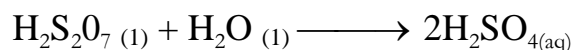
Combustion of Sulphur



Heating of metal sulphide such as lead(II) sulphide



Combustion of hydrogen sulphide

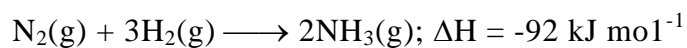
**Stage 2: Formation of SO₃**Catalyst: **vanadium(V) oxide**Temperature: **450°C**Pressure: **2-3 atmospheres****Stage 3 Formation of oleum H₂S₂O₇****Stage 4: Formation of Sulphuric acid**

Haber Process (Making Ammonia)**Sources of the raw material**

Hydrogen	<p>1. Reaction between steam and heated coke</p> $\text{H}_2\text{O} + \text{C} \longrightarrow \text{CO} + \text{H}_2$ <p>2. Reaction between steam and natural gas.</p> $2\text{H}_2\text{O} + \text{CH}_4 \longrightarrow \text{CO}_2 + 4\text{H}_2$
Nitrogen	From distillation of liquid air.

The reaction

1. Ammonia is made by the Haber process from nitrogen and hydrogen:



Catalyst: Iron

Promoter: Aluminium oxide

Temperature: 450 °C

Pressure: 200-1000 atm