	Cations			Anions		
	1+	2+	3+	1–	2–	3–
Simple Ions	**Lithium** Li^+	**Calcium** Ca^{2+}	**Aluminium** Al^{3+}	**Fluoride** F^-	**Oxide** O^{2-}	**Phosphide** N^{3-}
	Sodium Na^+	**Magnesium** Mg^{2+}	**Iron (III)** Fe^{3+}	**Chloride** Cl^-	**Sulfide** S^{2-}	
	Potassium K^+	**Barium** Ba^{2+}		**Bromide** Br^-		
	Hydrogen H^+	**Zinc** Zn^{2+}		**Iodide** I^-		
	Silver Ag^+	**Iron (II)** Fe^{2+}				
		Lead Pb^{2+}				
		Copper (II) Cu^{2+}				
Complex Ions	**Ammonium** NH_4^{1+}			**Hydroxide** OH^{1-}	**Sulfite** SO_3^{2-}	**Phosphite** PO_3^{3-}
				Nitrite NO_2^{1-}	**Sulfate** SO_4^{2-}	**Phosphate** PO_4^{3-}
				Nitrate NO_3^{1-}	**Carbonate** CO_3^{2-}	
				Bicarbonate HCO_3^{1-}		

Table 1. The 'Valency' table

	Souble	Insoluble
oxides	K^+, Na^+, NH_4^{1+}	All others
hydroxides	K^+, Na^+, NH_4^{1+}	All others
carbonates	K^+, Na^+, NH_4^{1+}	All others
halides	All others	Pb^{2+}, Ag^+
sulphates	All others	Pb^{2+}, Ba^{2+}
nitrates	All others	-

Table 2 The solubility table

General names

	Name	Symbol
Metals	Potassium	K
	Sodium	Na
	Lithium	Li
	Calcium	Ca
	Magnesium	Mg
	Aluminium	Al
	Zinc	Zn
	Iron	Fe
	Lead	Pb
	Copper	Cu
	Silver	Ag
	Gold	Au

Ammonium salts	Ammonium chloride	NH_4Cl
	Ammonium sulfate	$(NH_4)_2SO_4$
	Ammonium nitrate	NH_4NO_3
	Ammonium bromide	NH_4Br

Salts	Sodium chloride	NaCl
	Potassium sulfate	K_2SO_4
	Calcium iodide	CaI_2
	Magnesium nitrate	$Mg(NO_3)_2$
	Lithium fluoride	LiF
	Barium sulfate	$BaSO_4$
	Zinc chloride	$ZnCl_2$

	Name	Symbol
Halogens	Fluorine	F
	Chlorine	Cl
	Bromine	Br
	Iodine	I

Halides	Fluoride	F^-
	Chloride	Cl^-
	Bromide	Br^-
	Iodide	I^-

Acids	Hydrogen chloride/ Hydrochloric acid	HCl
	Hydrogen sulfate/ Sulfuric acid	H_2SO_4
	Hydrogen nitrate/ Nitric acid	HNO_3
	Hydrogen ethanoate/ Ethanoic acid	$HC_2H_3O_2$

Alkalis	Sodium hydroxide	NaOH
	Potassium hydroxide	KOH
	Calcium hydroxide	$Ca(OH)_2$
	Magnesium hydroxide	$Mg(OH)_2$
	Aqueous ammonia	NH_4OH

Table 3 The general names table

$$\text{Concentration } (g/dm^3) = \frac{\text{Mass of solute (g)}}{\text{Volume of solvent } (dm^3)}$$

$$\text{Molarity } (mol/dm^3) = \frac{\text{No. of moles of solute (mol)}}{\text{Volume of solvent } (dm^3)}$$

$$\text{Vol. of gas at RTP} = \text{No. of moles} \times 24\ (dm^3)$$

$$\text{Molarity } (mol/dm^3) = \frac{\text{Concentration } (g/dm^3)}{\text{Mr. Value}}$$

$$\text{No. of moles} = \text{Molarity } (mol/dm^3) \times \text{Volume } (dm^3)$$

$$\text{No. of moles} = \frac{\text{Concentration } (g/dm^3) \times \text{Volume } (dm^3)}{\text{Mr. Value}}$$

Mole calculation formulae

No.	Reactants				Products				
Acid & bases reactions									
1	Acid	+	Metal	→	Salt	+	H_2		
2	Acid	+	Metal oxide	→	Salt	+	H_2O		
3	Acid	+	Metal hydroxide	→	Salt	+	H_2O		
4	Acid	+	Metal carbonate	→	Salt	+	H_2O	+	CO_2
5	Alkali	+	Ammonium salt	→	Salt	+	H_2O	+	NH_3
Displacement reactions									
6	More reactive metal	+	Less reactive metal compound	→	More reactive metal compound	+	Less reactive metal		
7	More reactive halogen	+	Less reactive halide compound	→	More reactive halide compound	+	Less reactive halogen		
Precipitation reactions									
8	Soluble Salt	+	Soluble Salt	→	Insoluble Salt	+	soluble Salt		
Thermal decomposition									
9	Metal carbonate		$\xrightarrow{\Delta}$		Metal oxide	+	CO_2		
10	Metal hydroxide		$\xrightarrow{\Delta}$		Metal oxide	+	H_2O		
11	Metal nitrate		$\xrightarrow{\Delta}$		Metal oxide	+	NO_2	+	O_2
12	Alkali Metal nitrate		$\xrightarrow{\Delta}$		Alkali Metal nitrite	+	O_2		
Redox reaction									
13	Group I metal	+	$H_2O(l)$	→	Metal hydroxide	+	H_2		
14	metal	+	H_2O (g)	→	Metal oxide	+	H_2		
15	metal	+	O_2	→	Metal oxide				
16	Non metal	+	O_2	→	Non-Metal oxide				
17	Metal oxide	+	H_2	→	metal	+	H_2O		
18	Metal oxide	+	CO	→	metal	+	CO_2		
19	Metal oxide	+	C	→	metal	+	CO_2		

Table 4 The general reactions (Inorganic)

	Solids	Liquids	Gases
Arrangement	Closely packed	Intermediate	Very far apart
Movement	Vibrate about their fixed positions	Intermediate	Complete freedom of movement
Speed	Very slow	Intermediate	Very fast
Compressibility	Incompressible [*Closely packed and negligible space between the particles*]	Incompressible	Compressible [*A lot of space between the particles*]
Density	High density [*More particles packed per unit volume*]	High density	Low density [*Only a few particles packed per unit volume*]
Shape	Fixed shape [*Particles are strongly bonded together and are restrained from moving freely*]	No fixed shape [*Bonds are flexible and are not as strong as solids and particles can slide over each other*]	No fixed shape [*Bonding between the particles are almost negligible*]

Table 5 Comparison of solids, liquids and gases

<table>
<tr><th>Gas</th><th>Solubility in water</th><th>Density compared to air</th><th>Colour</th><th>Acidity/ Alkalinity</th><th>Method of collection</th></tr>
<tr><td>N_2</td><td rowspan="2">Insoluble</td><td rowspan="2">Denser than air</td><td rowspan="3">colourless</td><td rowspan="2">Neutral</td><td rowspan="3">Downward displacement of water</td></tr>
<tr><td>O_2</td></tr>
<tr><td>H_2</td><td rowspan="2">Slightly soluble</td><td>Less dense than air</td><td rowspan="2">Acidic</td></tr>
<tr><td>CO_2</td><td rowspan="5">Soluble</td><td rowspan="4">Denser than air</td><td rowspan="3">Downward delivery</td></tr>
<tr><td>Cl_2</td><td>Greenish yellow</td></tr>
<tr><td>SO_2</td><td>colourless</td></tr>
<tr><td>HCl</td><td rowspan="2">brown</td></tr>
<tr><td>NO_2</td></tr>
<tr><td>NH_3</td><td>Less dense than air</td><td>colourless</td><td>Alkaline</td><td>Upward delivery</td></tr>
</table>

Table 6 Properties of gases

Flowchart for choosing the salt preparation technique

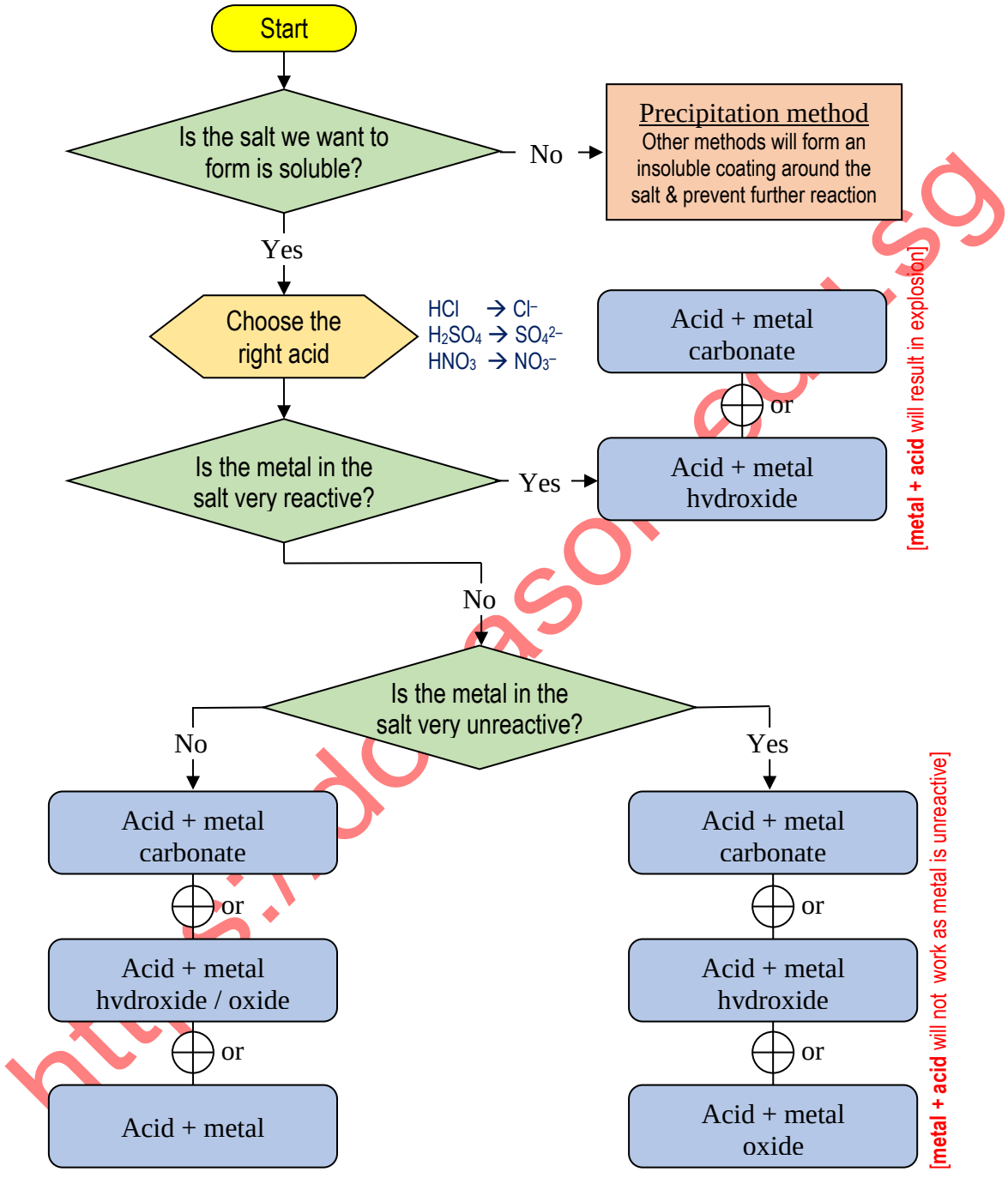


Figure 1 Flowchart of salt preparation techniques.

	Method	Reactants	Limitations (when cannot use this method)
1	Acid - metal reaction	Metal + acid	Metal is too reactive or metal is too unreactive or the salt is insoluble.
2	Acid - base reaction	Metal oxide + acid	The salt is insoluble or the base is an alkali.
3	Titration	Metal hydroxide + acid	If other easier methods are available.
4	Acid -carbonate reaction	Metal carbonate + acid	Metal carbonate is soluble in water or the salt formed is insoluble.
5	Precipitation	Soluble salt + soluble salt	If both the salts formed are insoluble.
6	Synthesis	Metal + non-metal	-

Table 7 Methods of making salts.

Transition metal / compound / ion	Colour
Copper (II) Oxide, CuO	Black
Copper (II) sulphate, $CuSO_4$	Blue
Iron (II) hydroxide, $Fe(OH)_2$	Green
Iron (III) hydroxide, $Fe(OH)_3$	Brown
Cu^{1+}	Brick red
Ti^{3+}	Purple
V^{3+}	Green
Cr^{3+}	Violet
CrO_4^{2-}	Yellow
$Cr_2O_7^{2-}$	Orange
Mn^{2+}	Pink
Mn^{3+}	Yellow
MnO_4-	Purple
Ni^{2+}	Green

Table 8 Colours of transition metal compounds

Examples of oxidizing agents	Examples of reducing agents
Potassium permanganate (VII) solution.	Carbon monoxide.
Potassium dichromate (VI) solution.	Sulphur dioxide.
Iron (III) chloride solution.	Carbon.
Concentrated sulfuric acid.	Hydrogen.
Nitric acid.	Electrons.
Oxygen.	Potassium iodide

Table 9 Examples of oxidizing and reducing agents

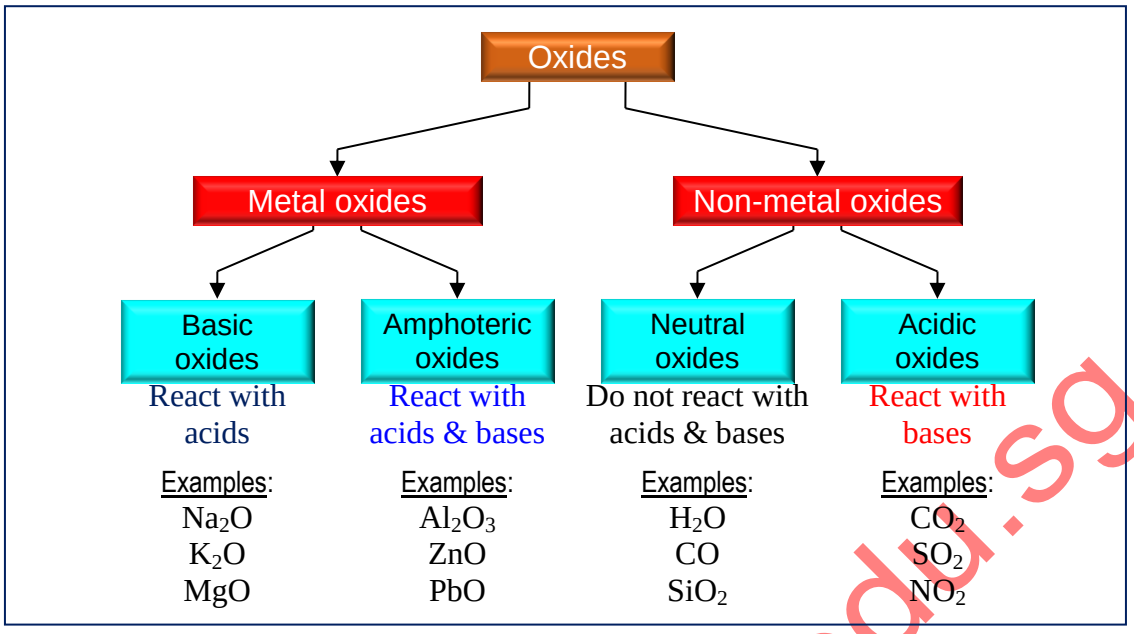


Figure 2 Reaction of oxygen with metals and non-metals

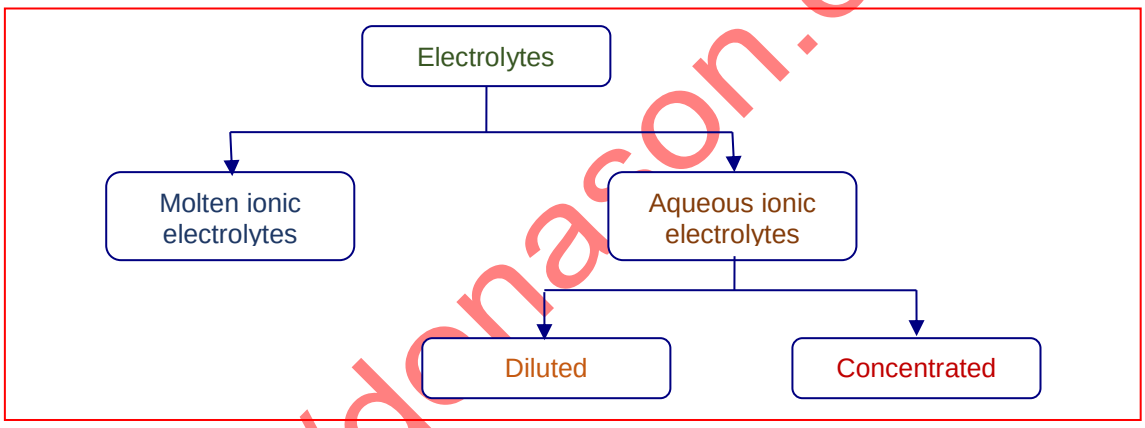
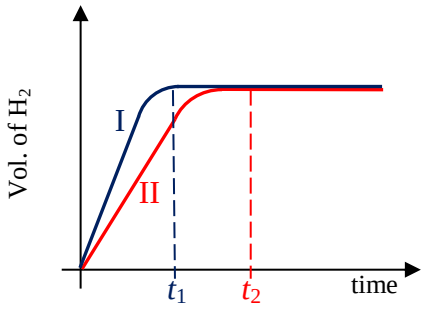


Figure 3 Types of electrolytes

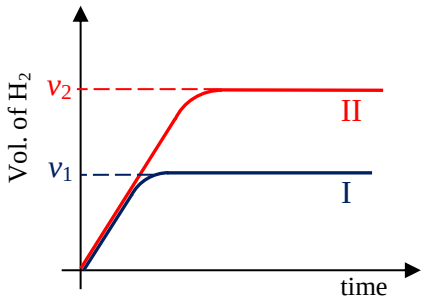
Cations		Anions	
K^+ Na^+ Li^+ Ca^{2+} Mg^{2+} Al^{3+} Zn^{2+} Fe^{2+} Pb^{2+} H^+ Cu^{2+}	Most difficult to discharge Easiest to Discharge	SO_4^{2-} NO_3^- Cl^- OH^- I^-	Most difficult to discharge Easiest to Discharge

Table 10 The electrochemical series



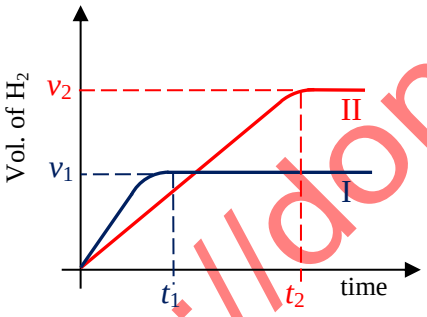
Reaction I
The gradient is steeper → Rate of reaction is higher.
The entire reaction is completed at a shorter time, t_1.
Reaction II
The gradient is less steep → Rate of reaction is lower.
The entire reaction is completed at a longer time, t_2.
Reactions I & II
Volumes of H_2 formed are the same → equal no. of moles of reactants used.

Figure 4.1 Reactions curves - different rates but same final volumes



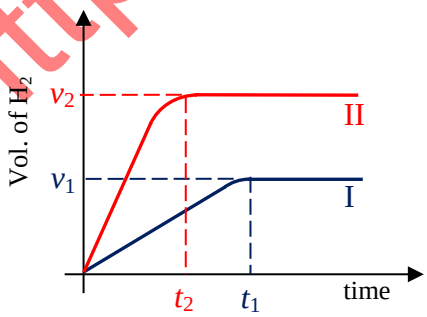
Reaction I
Volume of H_2 formed is lower → less no. of moles of reactants used.
Reaction II
Volume of H_2 formed is higher → more no. of moles of reactants used.
Reactions I & II
The gradients are equal → Rates of reactions are equal.

Figure 4.2 Reactions curves - Same rates but different final volumes



Reaction I
Volume of H_2 formed is lower → Less no. of moles of reactants used.
The gradient is steeper → Rate of reaction is higher.
Reaction II
Volume of H_2 formed is higher → more no. of moles of reactants used.
The gradient is less steep → Rate of reaction is lower.

Figure 4.3 Reactions curves - Different rates and different final volumes



Reaction I
Volume of H_2 formed is lower → Less no. of moles of reactants used.
The gradient is less steep → Rate of reaction is lower.
Reaction II
Volume of H_2 formed is higher → more no. of moles of reactants used.
The gradient is steeper → Rate of reaction is higher.

Figure 4.4 Reactions curves -Different rates and different final volumes

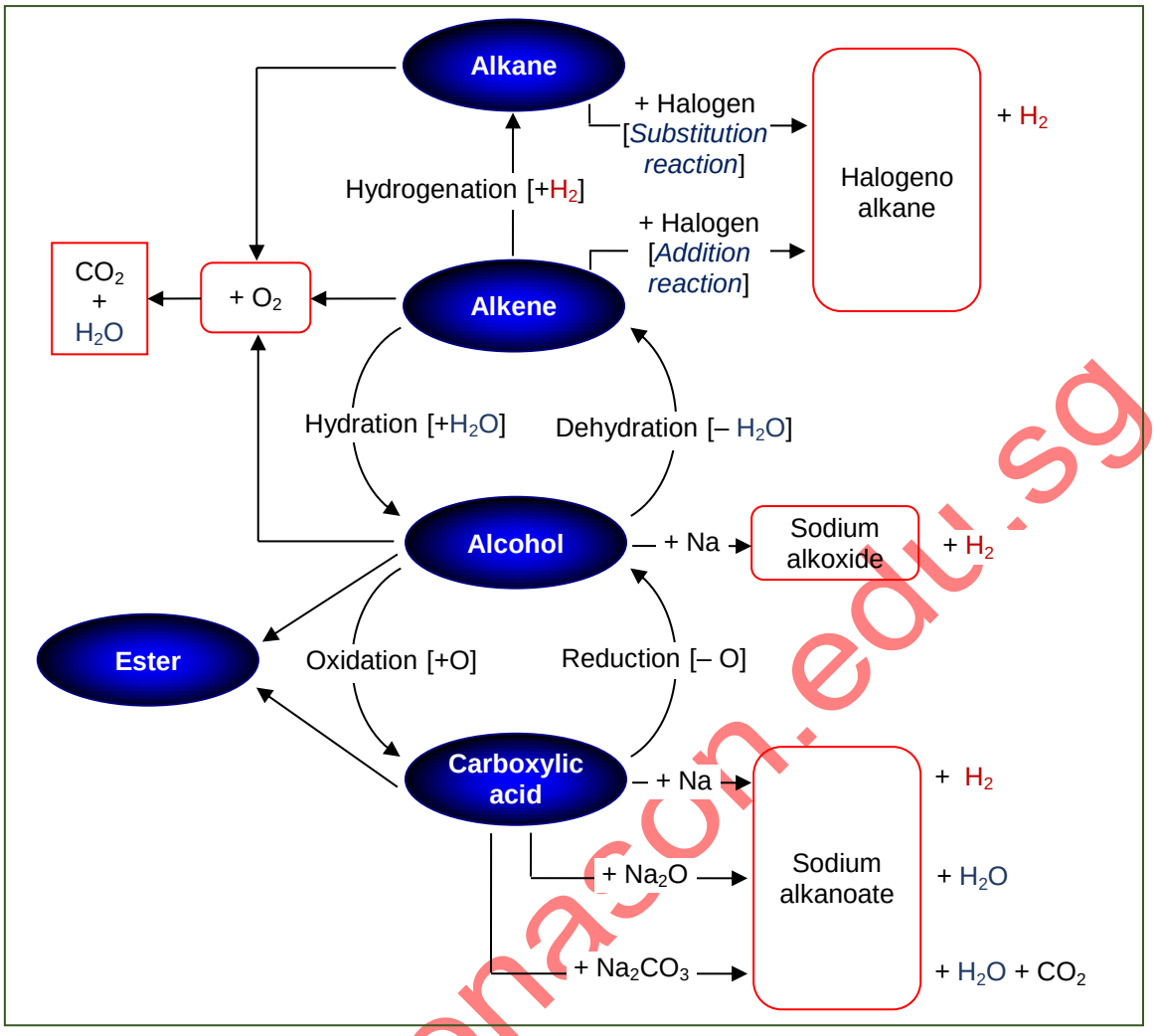


Figure 5 Reaction web – (Organic Chemistry)

Gas	Colour	Smell	Action on damp blue limus paper	Action on damp red limus paper	Action on lighted splint	Action on glowing splint	Action on blue cobalt (II) chloride paper	Action on Limewater	Action on exposure to HCl gas	Action on exposure to NH_3 gas	Action on acidified $K_2Cr_2O_7$
O_2	Colour less	Odourless	Nil	Nil	Flame gets bigger	Bursts into flame	Nil	Nil	Nil	Nil	Nil
H_2	Colour less	Odourless	Nil	Nil	Production ‘pop’ sound	-	Nil	Nil	Nil	Nil	Nil
H_2O	Colour less	Odourless	Nil	Nil	-	-	Turns Pink	-	-	-	-
CO_2	Colour less	Odourless	Turns red	-	Flame is extinguished	-	-	Forms a white precipitate	-	-	-
SO_2	Colour less	Unpleasant smell	Turns red	-	-	-	-	-	-	-	Turns Green
HCl	Colour less	Sharp stinging Smell	Turns red	-	-	-	-	-	-	Forms a thick white smoke	-
Cl_2	Greenish yellow	Choking Smell	Turns red then white	Turns white	-	-	-	-	-	-	-
NO_2	Brown	-	Turns red	-	-	-	-	-	-	-	-
NH_3	Colourless	Pungent	-	Turns blue	-	-	-	-	Forms a thick white smoke	-	-

Table 11 test results for various gases

Observation	Inference
No precipitate formed	NH_4^+, Ca^{2+} possibly present
Faint white precipitate insoluble in excess aqueous NH_3	Pb^{2+}, Al^{3+} possibly present
White precipitate soluble in excess aqueous NH_3	Zn^{2+} present
Blue precipitate	Cu^{2+} present
Dirty Green precipitate	Fe^{2+} present
Brown precipitate	Fe^{3+} present

Table 12 test results with aqueous ammonia solution

Observation	Inference
No precipitate formed. A gas that turns moist red litmus blue evolved.	NH_4^+ present
Faint white precipitate insoluble in excess NaOH	Ca^{2+} present
White precipitate soluble in excess NaOH	Zn^{2+}, Pb^{2+}, Al^{3+}, possibly present
Blue precipitate	Cu^{2+} present
Dirty Green precipitate	Fe^{2+} present
Brown precipitate	Fe^{3+} present

Table 13 test results with sodium hydroxide

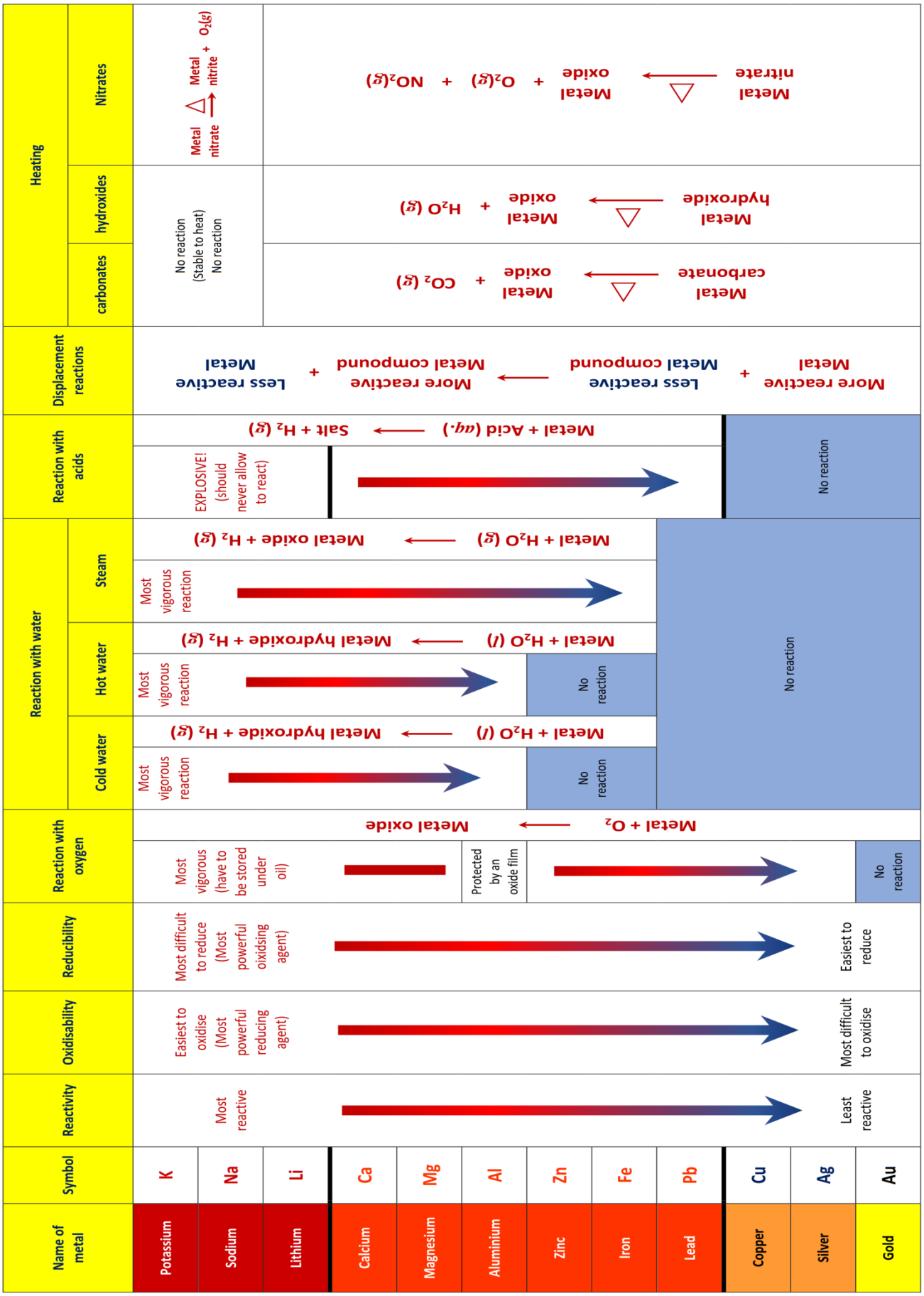


Table 14 Reactivity & reactions of metals