

CHAPTER 4: PERIODIC TABLE

1. Position element in Periodic Table GROUP - The number of valence electrons PERIOD - The number of shells occupied with electrons	3. GROUP 17 (HALOGENS) Physical properties	PHYSICAL PROPERTIES																																
2. Group 1 (alkali metal) PHYSICAL PROPERTIES <ul style="list-style-type: none"> Soft metals low melting & boiling points silvery and shiny surfaces good conductors of heat and electricity <table border="1" style="width: 100%; text-align: center; border-collapse: collapse;"> <thead> <tr> <th>symbol</th> <th>Size</th> <th>Melting points (°C)</th> <th>Boiling points (°C)</th> <th>Density (g cm⁻³)</th> </tr> </thead> <tbody> <tr> <td>Li</td> <td rowspan="4">↓ Increase</td> <td rowspan="4">↓ Decrease</td> <td rowspan="4">↓ Decrease</td> <td rowspan="4">↓ Decrease</td> </tr> <tr><td>Na</td></tr> <tr><td>K</td></tr> <tr><td>Rb</td></tr> </tbody> </table>	symbol	Size	Melting points (°C)	Boiling points (°C)	Density (g cm ⁻³)	Li	↓ Increase	↓ Decrease	↓ Decrease	↓ Decrease	Na	K	Rb	<table border="1" style="width: 100%; text-align: center; border-collapse: collapse;"> <thead> <tr> <th>Symbol</th> <th>Physical state at</th> <th>Colour</th> <th>Melting point</th> <th>Boiling point</th> </tr> </thead> <tbody> <tr> <td>F</td> <td>Gas</td> <td>Yellow</td> <td rowspan="4">↓ Increase</td> <td rowspan="4">↓ Increase</td> </tr> <tr> <td>Cl</td> <td>Gas</td> <td>Greenish yellow</td> </tr> <tr> <td>Br</td> <td>Liquid</td> <td>Reddish brown</td> </tr> <tr> <td>I</td> <td>Solid</td> <td>Purplish black</td> </tr> </tbody> </table> <p style="text-align: center;">M.P and B.P INCREASE DOWN A GROUP</p> <ul style="list-style-type: none"> the molecular size increases Forces of attraction between molecules becomes stronger Need more energy to overcome the forces of attraction between molecules <p style="text-align: center;">CHEMICAL PROPERTIES</p> $X_2 + 2NaOH \rightarrow NaX + NaOX + H_2O \quad ; X \text{ is halogen}$ $Fe + 3X_2 \rightarrow 2FeX_3 \quad ; X \text{ is halogen}$ $X_2 + H_2O \rightarrow HX + HOX \quad ; X \text{ is halogen}$ <p style="text-align: center;">REACTIVITY decrease down a group</p> <ul style="list-style-type: none"> ✓ The atomic size increases down the group. ✓ The distance of the outermost shell becomes greater from the nucleus. ✓ The force of attraction between nucleus valence electrons decrease. ✓ the tendency of an atom to receive one/two/three electron to achieve an octet electron arrangement decrease. ✓ This causes the electronegativity decreases down the group. <p style="text-align: center;">4. GROUP 18 ELEMENT</p> <ul style="list-style-type: none"> Known as Noble gas Monoatomic chemically unreactive because they achive octet/duplet electron arrangement. 	Symbol	Physical state at	Colour	Melting point	Boiling point	F	Gas	Yellow	↓ Increase	↓ Increase	Cl	Gas	Greenish yellow	Br	Liquid	Reddish brown	I	Solid	Purplish black	<p style="text-align: center;">PHYSICAL PROPERTIES</p> <ul style="list-style-type: none"> colourless gases cannot dissolve in water. cannot conduct electricity and heat. low melting and boiling point. low densities. <p style="text-align: center;">M.P and B.P INCREASE DOWN A GROUP</p> <ul style="list-style-type: none"> ↪ because the atomic size of each element increases ↪ the forces of attraction between the atoms of each element become stronger ↪ thus more energy is required to overcome the stronger forces of attraction <p style="text-align: center;">4. TRANSITION ELEMENTS</p> <ul style="list-style-type: none"> Between Group 2 to Group 13 Special Characteristics: <ol style="list-style-type: none"> Form coloured ions or compounds Have different oxidation numbers Acts as catalysts <p style="text-align: center;">5. ELEMENTS IN A PERIOD</p> <ul style="list-style-type: none"> - Basic oxides reacts with acid to form salt & H₂O - Acidic oxides reacts with alkali to form salt & H₂O - Amphoteric oxides can react with both acids & alkali <div style="border: 1px solid black; padding: 5px; margin-top: 10px;"> <p style="text-align: center;">Atomic size DECREASE</p> <p style="text-align: center;">→</p> <ul style="list-style-type: none"> ✓ the proton number increases ✓ the increasing of the attraction force between nucleus and valence electrons. <p style="text-align: center;">Electronegativity INCREASE</p> <p style="text-align: center;">→</p> <ul style="list-style-type: none"> ✓ Size of atom decrease ✓ the increasing of the attraction force between nucleus and valence electrons. </div>
symbol	Size	Melting points (°C)	Boiling points (°C)	Density (g cm ⁻³)																														
Li	↓ Increase	↓ Decrease	↓ Decrease	↓ Decrease																														
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I	Solid	Purplish black																																
<p style="text-align: center;">PHYSICAL CHANGES DOWN A GROUP</p> <ul style="list-style-type: none"> ➤ The atomic size increases - the number of shells increases. ➤ The density increases - increasing in atomic mass is faster than the increasing in atomic volume/size. ➤ The melting and boiling points decreases - the atomic size increases, the metal bond between the metal atoms becomes weaker. ➤ The hardness of the metal decreases. <p style="text-align: center;">CHEMICAL PROPERTIES</p> <ul style="list-style-type: none"> ➤ G1 + H₂O → alkali + H₂ ➤ G1 + O₂ → white solid oxide ➤ G1 + Cl₂ → white solid chloride ➤ G1 + Br₂ → metal bromide <p style="text-align: center;">REACTIVITY increase down a group</p> <ul style="list-style-type: none"> ♠ the atomic size increases ♠ valence electron in the outermost occupied shell becomes far away from the nucleus ♠ the attraction between the nucleus and the valence electron becomes weaker ♠ Therefore, it is easier for the atom to donate the single valence electron to achieve the stable electron arrangement. ♠ This causes the electropositivity increase down the group 																																		

← GROUP →

	1	2	3	4	5	6	7	8	9	10	12	4				
1	H* 1											He 2				
2	7 Li 3	8 Be 4								11 B 5	12 C 6	14 N 7	16 O 8	19 F 9	20 Ne 10	
3	23 Na 11	24 Mg 12								27 Al 13	28 Si 14	31 P 15	32 S 16	35 Cl 17	40 Ar 18	
4	39 K 19	40 Ca 20	TRANSITION METALS												80 Br 35	

A → Nucleon Number

X → Proton Number

Z → Proton Number

- Group 1 - Alkali metals
- Group 2 - Alkali-earth metals.
- Group 3 to 12 - Transition elements
- Group 17 - Halogens
- Group 18 - Noble gases

The group of an element

Period number

Determine by

Determine by

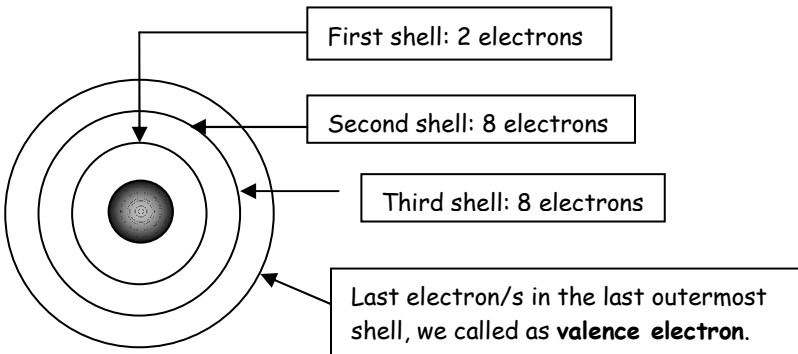
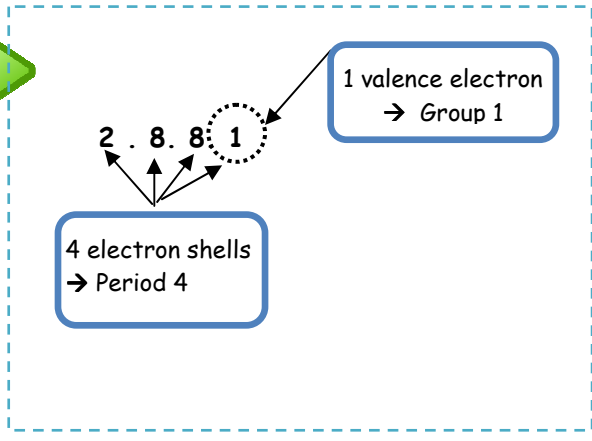
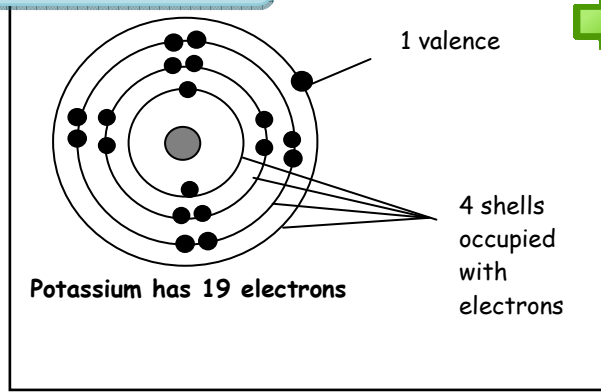
The number of valence electrons

The number of shells occupied with electron

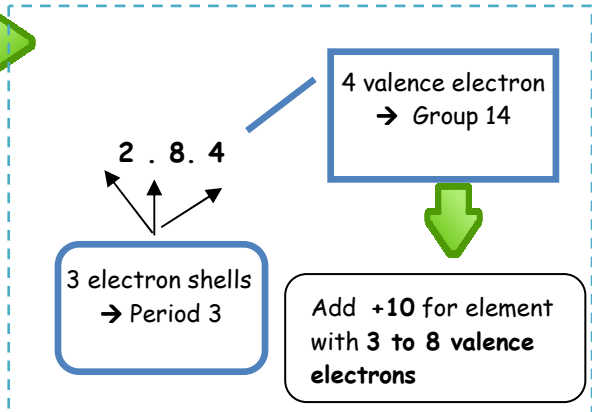
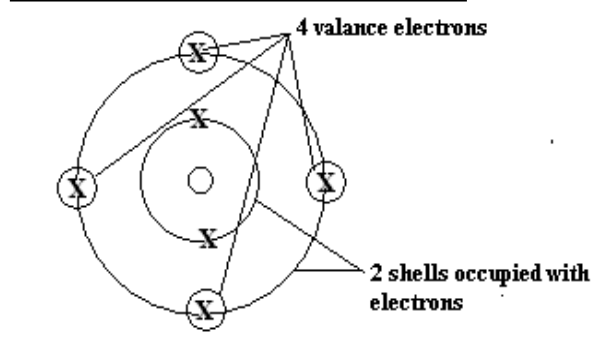
First 20 elements

ELEMENTS			ELEMENTS		
H	Hydrogen	Hajat	Na	Sodium	Nak
He	Helium	Hendak	Mg	Magnesium	Mgorat
Li	Lithium	Lihat	Al	Aluminium	Alamak
Be	Berylium	Bedah	Si	Silicon	Si
B	Boron	Balas	P	Phosporus	Peli
C	Carbon	Cinta	S	Sulphur	Sedia
N	Nitrogen	Nanti	Cl	Chlorine	Clewang
O	Oxygen	Orang	Ar	Argon	Aku
F	Flourine	Fikir	K	Potassium	Kena
Ne	Neon	Niat	Ca	Calcium	Chow

For elements with 1 to 2 valence electrons



For elements with 3 to 8 valence electrons



GROUP 18: NOBLE GAS

Elements

Elements	Electron arrangement
Helium	2
Neon	2.8
Argon	2.8.8
Krypton	2.8.18.8
Radon	2.8.18.32.18.8

Physical

- ✓ Colourless gas
- ✓ Cannot conduct electricity
- ✓ Poor conductor of heat
- ✓ Insoluble in water
- ✓ Low melting point

Chemical properties

- ✓ Known as monoatomic gas/inert gas
- ✓ Chemically uncreative because chemically unreactive because they **achive octet/duplet electron arrangement**
- ✓ Do not release, accept or share electron with other element

Think Smart!

Change in Physical properties down a group 18

Atomic size of element increases



↪ Number of occupied with electron increase

Melting and boiling points of elements increases



↪ When atomic size of each element **increase**
 ↪ The forces of attraction between the atoms of each element become **stronger**
 ↪ thus **more energy** is required to overcome the stronger forces of attraction during melting or boiling.

Density of elements increases



↪ the atomic mass of each element is **increases**.



Helium

- ✓ Used to fill airships and weather balloons
- ✓ Used to fill oxygen tank used



Argon

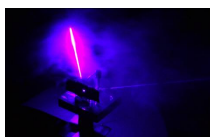
- ✓ Used to fill light bulbs



Neon

- ✓ Used in advertising lights and television tubes.

Krypton



- ✓ Used in lasers to repair the retina of the eye
- ✓ Used to fill photographic flash lamp.

Xenon



- ✓ Used in the brightest bulb in lighthouse

Radon



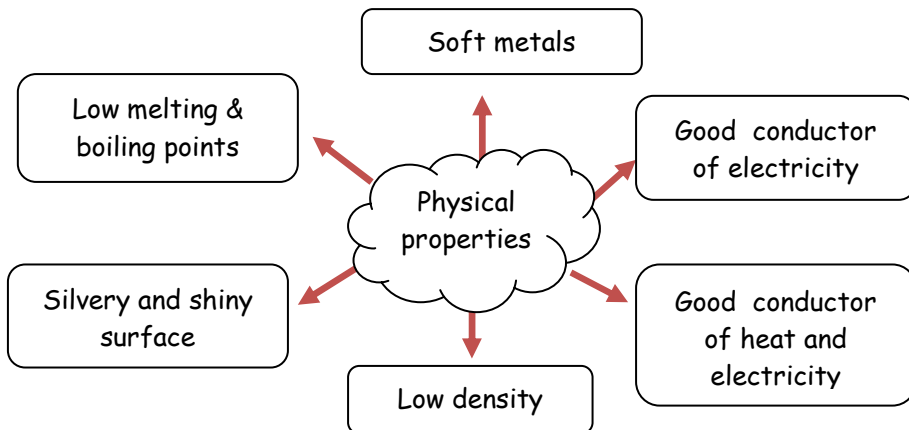
- ✓ Used in the treatment of cancer.
- ✓ To detect pipe leakage

PREPARED BY SULAIMAN SMKSM

GROUP 1 (ALKALI METAL)

Elements

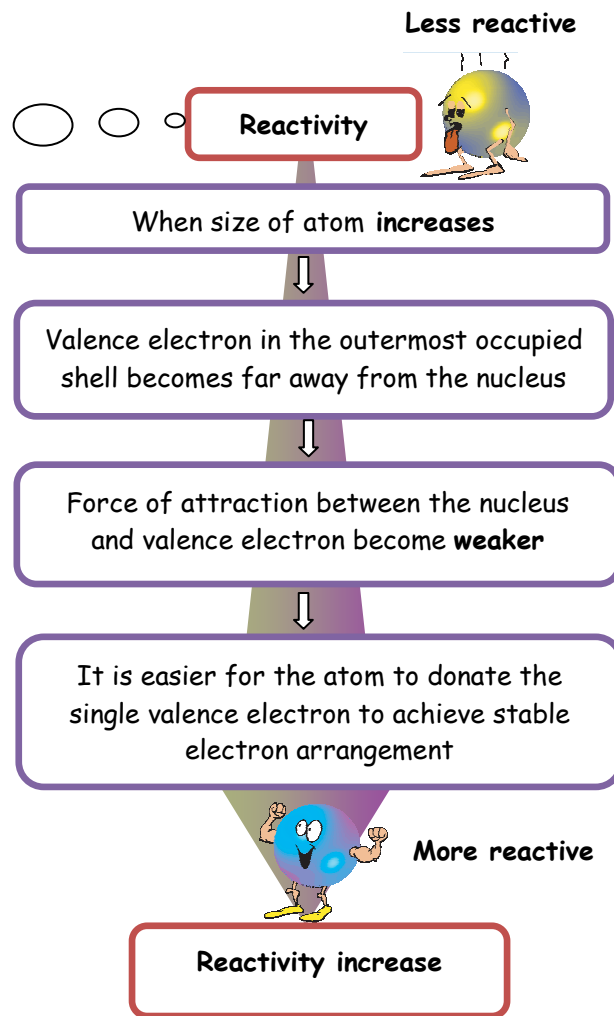
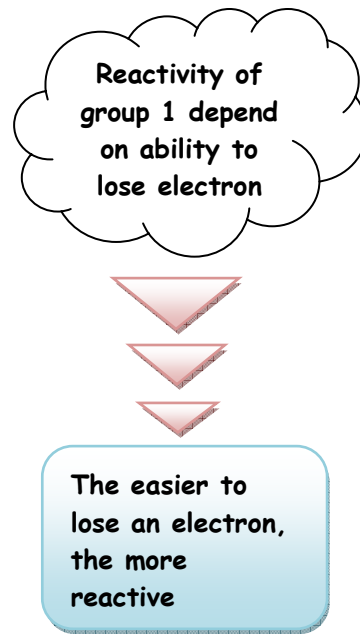
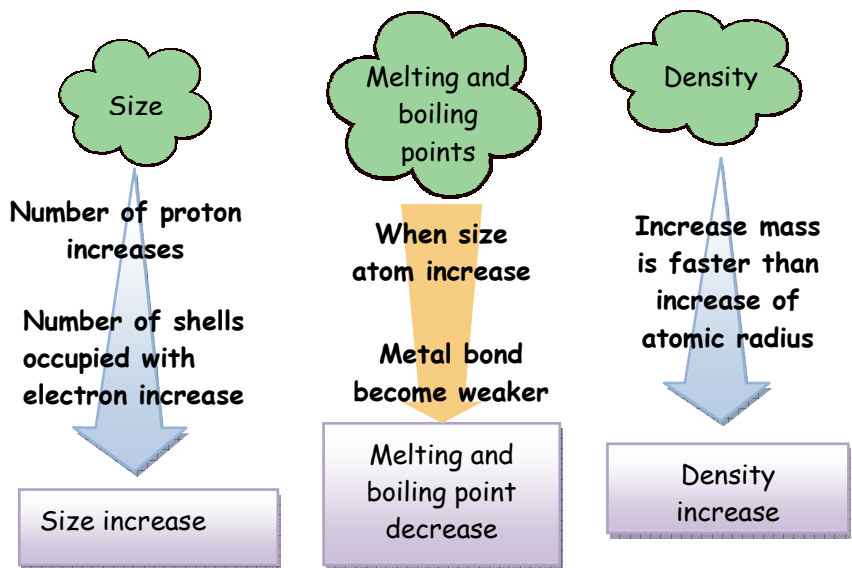
Elements	Symbol of Element
Lithium	Li
Sodium	Na
Potassium	K
Rubidium	Rb
Caesium	Cs
Francium	Fr



Chemical reaction

- **Reaction with water**
 $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$
- **Reaction with oxygen**
 $4\text{Na} + \text{O}_2 \rightarrow 2\text{Na}_2\text{O}$
- **Reaction with halogen**
 $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$

Change in physical properties down the group 1



Chemical properties and electron arrangement

- ✓ Alkali metals have **one** valence electron in their outermost occupied shells.
- ✓ To achieving the stable electron arrangement (octet or duplet)
- ✓ They will **donating one electron** from its outermost occupied shell to **form an ion** with a charge of +1

Example:

Na → Na⁺ + e⁻
 2.8.1 2.8

K → K⁺ + e⁻
 2.8.8.1 2.8.8

Chemical reaction

- **Reaction with iron**
 $3\text{Cl}_2 + 2\text{Fe} \longrightarrow 2\text{FeCl}_3$
- **Reaction halogen with water**
 $\text{Cl}_2 + \text{H}_2\text{O} \longrightarrow \text{HCl} + \text{HOCl}$
- **Reaction halogen with sodium hydroxide**
 $2\text{KOH} + \text{Cl}_2 \longrightarrow \text{KCl} + \text{KOCI} + \text{H}_2\text{O}$



Less reactive

Reactivity decrease down a group

When size of atom increases

The distance of the outermost shell becomes **greater** from the nucleus.

Force of attraction between the nucleus and valence electron become **weaker**

the tendency of an atom to receive electrons to achieve an octet electron arrangement **decrease**.



less reactive

Reactivity decrease

Elements

Elements	Symbol of Element
Flouroine	F
Chlorine	Cl
Bromine	Br
Iodine	I

Reactivity of group 1 depend on ability to attract electron

The easier to attract an electron, the more reactive

Density

Increase mass is faster than increase of atomic radius

Density increase

GROUP 17 (HALOGEN)

- ◆ Valance electron 7
- ◆ exist as **diatomic** molecules.
 $\{\text{F}_2, \text{Cl}_2, \text{Br}_2, \text{I}_2\}$

Change in physical properties down the group

Size

Number of proton increases

Number of shells occupied with electron increase

Size increase

Melting and boiling points

When size atom increase

Force attraction between molecules

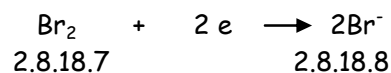
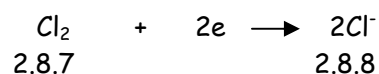
More heat is required to overcome the attractive force

Melting and boiling point increase

Chemical properties and electron arrangement

- ✓ Alkali metals have 7 valence electron in their outermost occupied shells.
- ✓ To achieving the stable electron arrangement (octet or duplet)
- ✓ They will **accept one electron** to **form an ion** with a charge of -1

Example:



Change across period 3

Size of element decrease

- ✓ Number of proton increase
- ✓ The positive charge of the nucleus increase
- ✓ The attraction force on nucleus on the electron become stronger
- ✓ Electron pull closer to nucleus causes atomic size decrease

Electronegativity increase

- ✓ When atomic size decrease the positive charge will increase
- ✓ The attraction force between nucleus and electron become stronger
- ✓ The element will easily to accept electron

Change in oxide properties

Na ₂ O	MgO	Al ₂ O ₃	SiO ₂	P ₄ O ₁₀	SO ₂	Cl ₂ O ₇
Basic		Amphoteric	Acidic			
reacts with acid to form salt & H ₂ O		can react with both acids & alkali	reacts with base to form salt & H ₂ O			

Metallic properties

Na	Mg	Al	Si	P	S	Cl
Metal			Metalloid	Non metal		

Transition metal
Example:
Copper, iron, zinc, Nickel

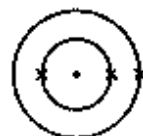
Form colour of ions
Cu²⁺ - blue
Fe²⁺ - Green

Form complex ions

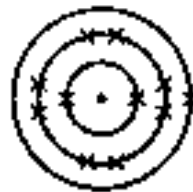
Have different oxidation number

Act as catalyst
Fe - Haber process
Pt - ostwald process

Going down a group 1



Lithium (2.1)



Sodium (2.8.1)

Size of sodium bigger than lithium

- ✓ The number of proton sodium more than lithium atom
- ✓ Number of shell occupied with electron of sodium more than lithium atom.

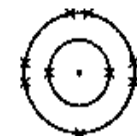
Sodium is more reactive than lithium atom

- ✓ Size of sodium larger than lithium
- ✓ The attraction forces between nucleus and valence electron in sodium stronger than lithium
- ✓ Sodium more easily to released electron to form positive ions

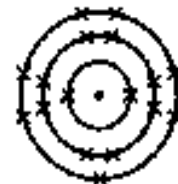
Going down group 17

Fluorine more reactive/electronegative than chlorine:

- ✓ Size of Fluorine larger than lithium
- ✓ The attraction forces between nucleus and valence electron in fluorine stronger than chlorine
- ✓ Fluorine atom easily to accept electron to form negative ions

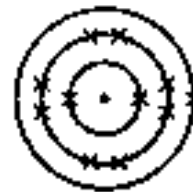


Fluorine(2.7)

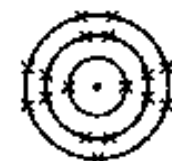


Chlorine (2.8.7)

Across period of 3



Sodium (2.8.1)



Chlorine (2.8.7)

Chlorine atom smaller than sodium:

- ✓ Number of proton chlorine more than sodium
- ✓ The attraction force on nucleus on the electron become stronger
- ✓ Electron pull closer to nucleus causes atomic size decrease

Chlorine atom more electronegative than sodium:

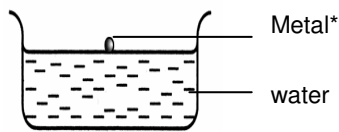
- ✓ Size of chlorine atom smaller than sodium
- ✓ The attraction forces between nucleus and valence electron in chlorine stronger than sodium
- ✓ Chlorine atom easily to accept electron to form negative ions

Chemical reaction of Group 1(alkali metal)

Aim: To investigate the reactivity of alkali metal toward water

PS : How does the reactivity of alkali metal toward water

HyPo: when going down a group 1, reactivity of A.M toward water increase



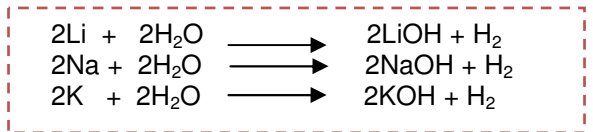
	Variable	Action to be taken
M	Metal G1	Repeat exp using diff. alkali metal
R	Reactivity of alkali metal	Observe movement alkali metal on water surface
C	Size of alkali metal	Use same size of alkali metal

RESULT:

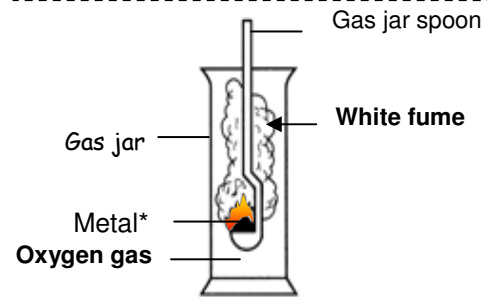
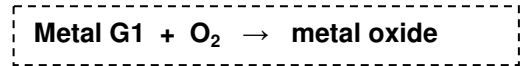
Metal*	Observation
Li	Lithium moves slowly on water surface with ' hiss ' sound. The colourless solution formed; turns red litmus paper to blue .
Na	Sodium moves quickly on water surface with ' hiss ' sound. The colourless solution formed; turns red litmus paper to blue .
K	Potassium moves vigorously on water surface with ' hiss ' sound. The colourless solution formed; turns red litmus paper to blue .

Reaction becomes more vigorous

Chemical equation:



React with oxygen gas to produce metal oxides [*white solids*].



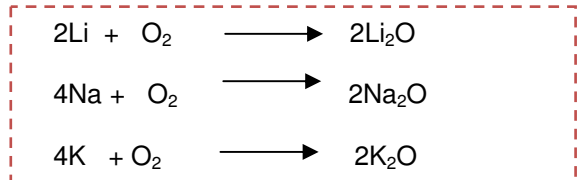
PROCEDURE:

- ✓ The lithium is heated in jar spoon until its start burn and put into gas jar containing oxygen gas
- ✓ The observation is recorded
- ✓ When the reaction stops, 5 cm³ of distilled water is poured into gas jar and solution formed is tested with red litmus paper
- ✓ The experiment is repeated with sodium and potassium

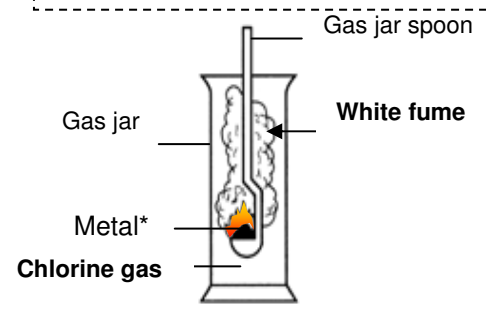
RESULT:

Metal*	Observations
Li	Lithium burns slowly with a red flame. A white / fume solid is produced.
Na	Sodium burns brightly with a yellow flame. A white solid is produced.
K	Potassium burns very bright with a purple/lilac flame. A white solid is produced.

Chemical equation



React with chlorine gas to produce metal chlorides [*white solids*].



PROCEDURE

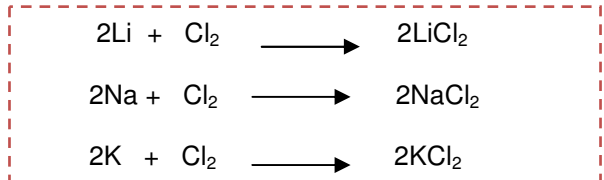
- ✓ The lithium is heated in jar spoon until its start burn and put into gas jar containing chlorine gas
- ✓ The observation is recorded
- ✓ The experiment is repeated with sodium and potassium

RESULT:

Metal	Observations
Li	Lithium burns slowly with a red flame. A white solid is produced.
Na	Sodium burns brightly with a yellow flame. A white solid is produced.
K	Potassium burns very bright with a purple flame. A white solid is produced.

Reaction becomes more vigorous

Chemical Equation

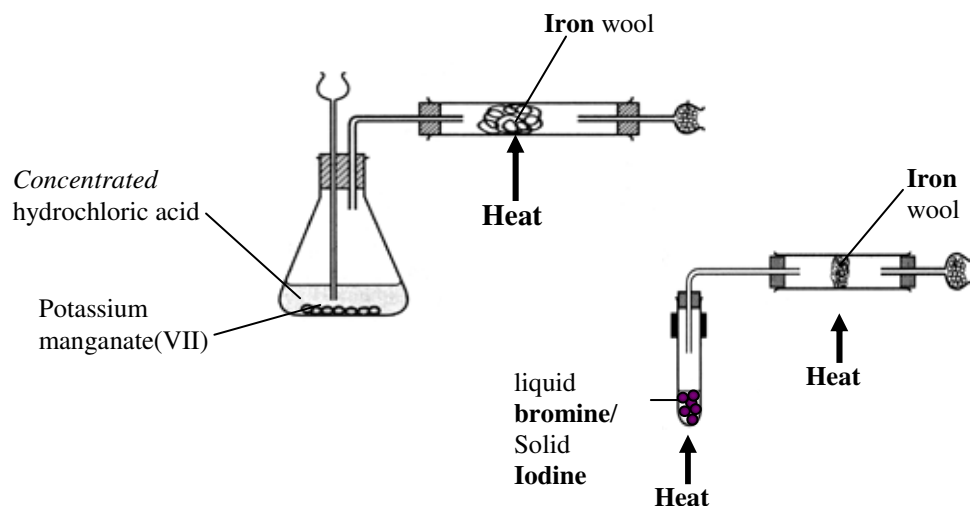


1. Reaction with iron wool,

Aim : To investigate the reactivity of halogen toward iron

Problem statements : How does the reactivity of halogen toward iron

Hypothesis : When going down a group of 17, reactivity of halogen toward iron decrease



	Variable	Action to be taken
Manipulated	Type of halogen	Repeat the experiment by using different halogen
Responding	Reactivity of halogen	Observe the burning of iron
Constant	Size of iron	Use same size of iron metal

Observation:

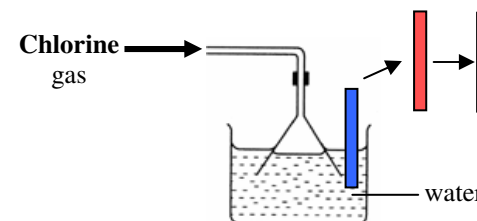
Halogen	Observation	Equation
Chlorine, Cl₂	Iron wool ignites rapidly with bright flame	$2\text{Fe} + 3\text{Cl}_2 \rightarrow 2\text{FeCl}_3$
Bromine, Br₂	Iron wool glow moderately bright, moderate fast	$2\text{Fe} + 3\text{Br}_2 \rightarrow 2\text{FeBr}_3$
Iodine, I₂	Iron wool glow dimly	$2\text{Fe} + 3\text{I}_2 \rightarrow 2\text{FeI}_3$

2. Reaction with water, H₂O

Aim : To investigate the halogen with water

Problem statements : How does halogen react with water

Hypothesis : When going down a group of 17, reactivity of halogen toward iron decrease



Variables:

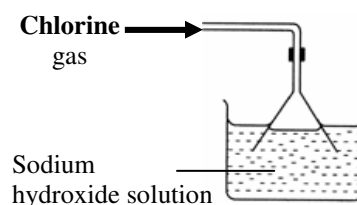
Manipulated : Type of halogen used

Responding : The rate at which the halogen dissolves in water and product of reaction

Constant : temperature of water

Halogen	Observation	Equation
Chlorine, Cl₂	Dissolve quickly in water to form light yellowish solution. Turn blue litmus paper to red and then white	$\text{Cl}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{HCl} + 2\text{HOCl}$
Bromine, Br₂	Dissolve slowly in water to form brown solution. Turn blue litmus paper to red and then white	$\text{Br}_2 + \text{H}_2\text{O} \rightarrow 2\text{HBr} + 2\text{HOBr}$
Iodine, I₂	Dissolve very slowly in water to form brown solution. Turn blue litmus paper to red very slowly	$\text{I}_2 + 2\text{H}_2\text{O} \rightarrow 2\text{HI} + 2\text{HOI}$

3. Reaction with NaOH



Halogen	Observation
Chlorine, Cl₂	Dissolve rapidly in sodium hydroxide to produce colourless solution.
Bromine, Br₂	Dissolve steadily in sodium hydroxide to produce colourless solution.
Iodine, I₂	Dissolve steadily in sodium hydroxide to produce colourless solution.