

a) Atomic Structure and Mixtures

b) Periodic Table

c) Structure and Bonding

d) Quantitative Chemistry

e) Chemical Changes

f) Energy Changes

4.1.2 The periodic table
4.1.3 Properties of transition metals (chemistry only)

4.1.2.1 The periodic table
4.1.2.2 Development of the periodic table
4.1.2.3 Metals and non-metals
4.1.2.4 Group 0
4.1.2.5 Group 1
4.1.2.6 Group 7

DEVELOPMENT OF THE PERIODIC TABLE

John Dalton

1808

Published table of Elements

Elements were arranged in the order of increasing atomic weights.

John Newland

1864

→ Gave Newland law of Octaves

- arranged elements according to atomic weights.
- Found similarities in the first elements and the eighth element like octaves
- Worked well upto calcium
- Since all the elements were not discovered at that time and he organised all known so the pattern did not fit.

Dmitri Mendeleev

1869

→ arranged elements according to atomic weights

- found patterns of similarities within elements
- Left gaps where the elements did not fit the pattern which later helped to find the undiscovered elements
- Not all elements fit into this pattern

Mendeleev's Table Shortcomings

- Argon atoms have a greater relative mass than potassium which will place Argon in the group of sodium and lithium and potassium in the group of noble gases.
- Many other elements were found not fitting this pattern and were swapped by Mendeleev's to maintain the periodicity.

Present Periodic Table

- Organise the elements in the order of increasing atomic number
- All the shortcoming due to atomic weights were solved by organising the elements in the order of increasing atomic number.
- Heavy atoms are due to the presence of different isotopes of the elements.

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MODERN PERIODIC TABLE

Metals

Non-metals

Noble Gases

Transition Metals

Alkali Metals

Group 1

Group 2

Alkaline Earth Metals

Metalloids

Group →	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
↓ Period																		
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57-70 * Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89-102 ** Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo
			* 57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb		
			** 89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No		

Source: Wikipedia

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BASIS	METALS	NON METALS
Appearance	They are Shiny and lustrous	They are dull in appearance
Position	Found in the left.	Found in the right
Conductors	Metal are good conductors	Non-metals are insulators except graphite
Malleability	Metals are Malleable	Non metals are not malleable
Ductility	Metals are ductile	Non metals are ductile
Ions	lose electrons and form + ions	gain electrons and form - ions
Density, mp and bp	They have high densities, mp and bp	They have low density, mp and bp
Examples	Sodium, potassium Group 1, 2 and 3	Carbon , Sulphur Group 4, 5 , 6 and 7

GROUPS IN THE PERIODIC TABLE

Group Number	Common Name	Reason for the name	Properties	Examples
Group 0	Noble Gas	They are stable as they have full outer shell therefore they do not react.	They are stable, unreactive. They have full outershell electronic configuration. They are found at extreme right.	Helium, neon, Argon, Krypton, Xenon, Radon
Group 1	Alkali Metals	They are metals and react with water to form alkali (metal hydroxide)	They are reactive, have one electron in their outermost shell. Loose one electron and form +1 ions to gain full outer shell configuration.	lithium, sodium, potassium, rubidium, cesium, and francium.
Group 2	Alkaline Earth Metals	These metals react with water to form alkalis (metal hydroxide) and they are found mainly in rocks.	They are reactive, have two electron in their outermost shell. Loose two electron and form +2 ions to gain full outer shell configuration.	beryllium (Be), magnesium (Mg), calcium (Ca), strontium (Sr), barium (Ba), radium (Ra).
Group 7	Halogens	They react with metals to form salts so they are names are (Halo= salt + Gens= forming)	They are reactive, have seven electrons in their outermost shell. Gains one electron to form -1 ions to gain full outershell configuration	fluorine, chlorine, bromine, iodine, and astatine



Elements	Symbol	Electronic Configuration	Properties
Lithium	${}^3\text{Li}^7$	2, 1	Least Reactive in the series
Sodium	${}^{11}\text{Na}^{23}$	2, 8, 1	More reactive than lithium but less reactive than sodium
Potassium	${}^{19}\text{K}^{39}$	2, 8, 8, 1	More reactive than sodium
Rubidium	${}^{37}\text{Rb}^{85}$	2, 8, 8, 18, 1	Highly reactive
Caesium	${}^{55}\text{Cs}^{133}$	2, 8, 8, 18, 18, 1	Too reactive
Francium	${}^{87}\text{Fr}^{223}$	2, 8, 8, 18, 18, 32, 1	Unstable radioactive reactive

REACTIVITY
 INCREASES
 DUE TO
 INCREASE
 IN TENDENCY
 OF LOOSING
 ELECTRONS



GROUP 1: Alkali Metals Physical Properties

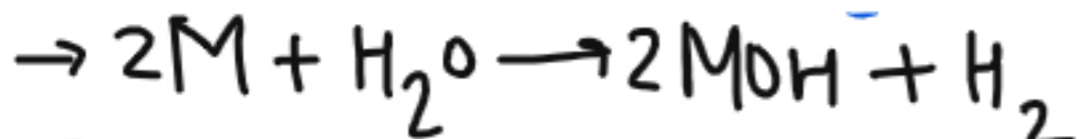
- ★ They are highly reactive
- ★ Reactivity increases down the group. — because tendency to lose one electron increases down the group due to increase in size and decrease in nuclear charge
- ★ They lose one electron and form +1 ions.
- ★ They are stored in kerosene or oil to prevent them reacting from air and water
- ★ They are soft, silvery and shiny.
- ★ They look dull in air as they react with oxygen and form oxide which coats their surface
- ★ Lithium is less reactive and francium is highly reactive.

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★ They have low melting and boiling point and the melting and boiling point decreases down the group

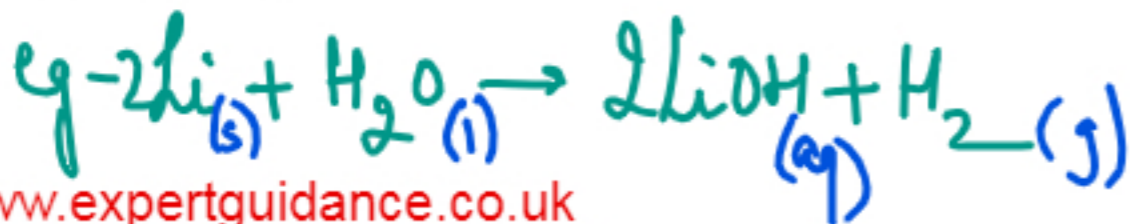
REACTION WITH WATER

Reacts with water to metal hydroxide



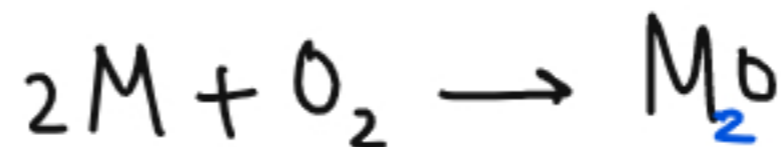
→ Metal hydroxide are alkali therefore the pH increases. Reactivity increases down the group so potassium reacts violently

→ Fizzing is produced due to the formation of hydrogen.

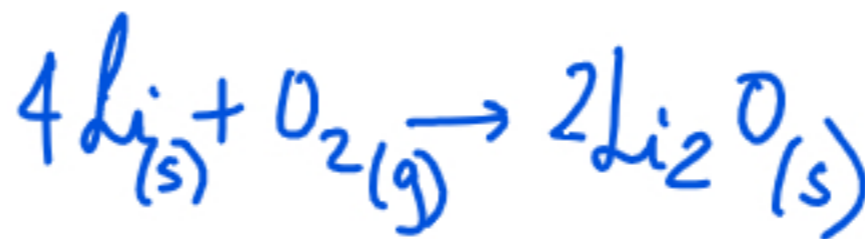


REACTION WITH OXYGEN

→ Reacts with oxygen to form a metal oxide

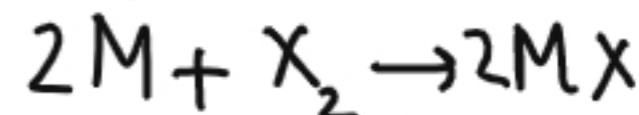


→ Metal goes dull in air due to this reaction.

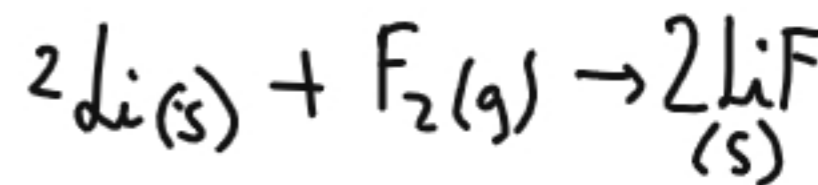


REACTION WITH HALOGENS

→ React with halogens to form metal halides



→ Metal halides $[X = \text{F, Cl, Br, I}]$ are white solids but dissolve in water to form colourless solutions.



REACTION WITH WATER

LITHIUM	SODIUM	POTASSIUM
$2 \text{Li}_{(s)} + 2 \text{H}_2\text{O}_{(l)} \rightarrow 2 \text{LiOH}_{(aq)} + \text{H}_{2(g)}$	$2 \text{Na}_{(s)} + 2 \text{H}_2\text{O}_{(l)} \rightarrow 2 \text{NaOH}_{(aq)} + \text{H}_{2(g)}$	$2 \text{K}_{(s)} + \text{H}_2\text{O}_{(l)} \rightarrow 2 \text{KOH}_{(aq)} + \text{H}_{2(g)}$
Floats in water due to less density than water	Floats in water due to less density than water	Floats in water due to less density than water
Fizzes due to the formation of hydrogen gas.	Fizzes due to the formation of hydrogen gas.	Fizzes due to the formation of hydrogen gas.
Shape is retained while reacting and gets smaller.	It melts into a ball while reacting.	Melts into a ball, catches fire and produces a lilac flame.

WHY REACTIVITY OF GROUP 1 INCREASES DOWN THE GROUP ?

→ The Reactivity of Group 1 increases down the group as the tendency to lose an electron increases down the group.

React by losing electron

To lose an electron small nuclear charge greater size of atom and greater shielding is required

FACTORS AFFECTING TENDENCY TO LOOSE AN ELECTRON

→ Nuclear Charge

→ Great the size of the atom, the outer electron becomes further away from the nucleus decreasing the nuclear charge

→ SHIELDING

→ More the number of inner electrons due to increases in number of shell greater will be the shielding of the outer electron from the nuclear charge

→ SIZE OF ATOMS

→ Greater the size of the atom, the outer electron will become further away from the nucleus resulting in decreases in nuclear charge

Down the group the atom size increases due to increase in number of electron shells. This results in the outer electron being further away from the nucleus. As the outer electron becomes further away from the nucleus the nuclear charge decreases. Increase in number of shells also increases the shielding and shields the outer electron from the nuclear charge. Therefore, the tendency of atom to lose an electron increases down the group resulting in increase in reactivity down the group.

GROUP 7 : Halogens (Salt Forming)

Element	Symbol	Electronic Configuration	State at room temperature
Fluorine	${}^9\text{F}^{19}$	2, 7	Yellow Gas
Chlorine	${}^{17}\text{Cl}^{35}$	2, 8, 7	Green Gas and pale green in solution
Bromine	${}^{35}\text{Br}^{80}$	2, 8, 18, 7	Volatile brown liquid yellow in solution
Iodine	${}^{53}\text{I}^{127}$	2, 8, 18, 18, 7	Volatile purple solid brown in solution
Astatine	${}^{85}\text{At}^{210}$	2, 8, 18, 32, 18, 7	Radioactive

REACTIVITY
DECREASES
DUE TO
DECREASE
IN
ELECTRON
AFFINITY

- They are non metals
- They gain an electron to form -1 ions.
- They have low melting and boiling points
- Their melting point increases down the group due to increases in intermolecular forces.
- They are found in pairs and exist as diatomic molecules (X_2)
- They are poisonous and smelly
- Their reactivity increase down the group
- Their density increases down the group.
- They are poor conductors of heat and electricity

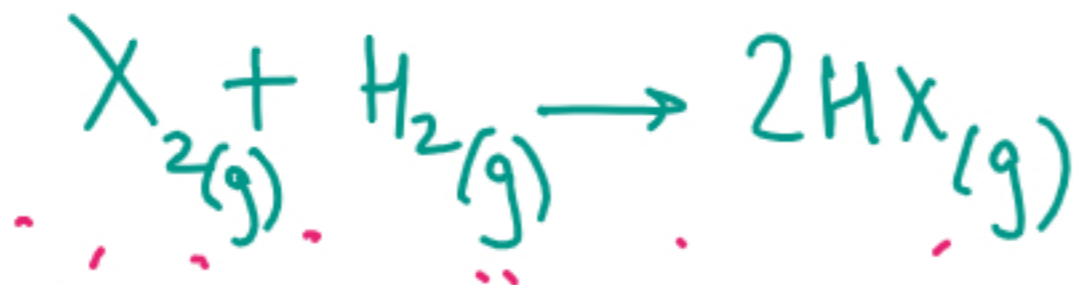
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HALOGEN REACTION



REACTION WITH HYDROGEN

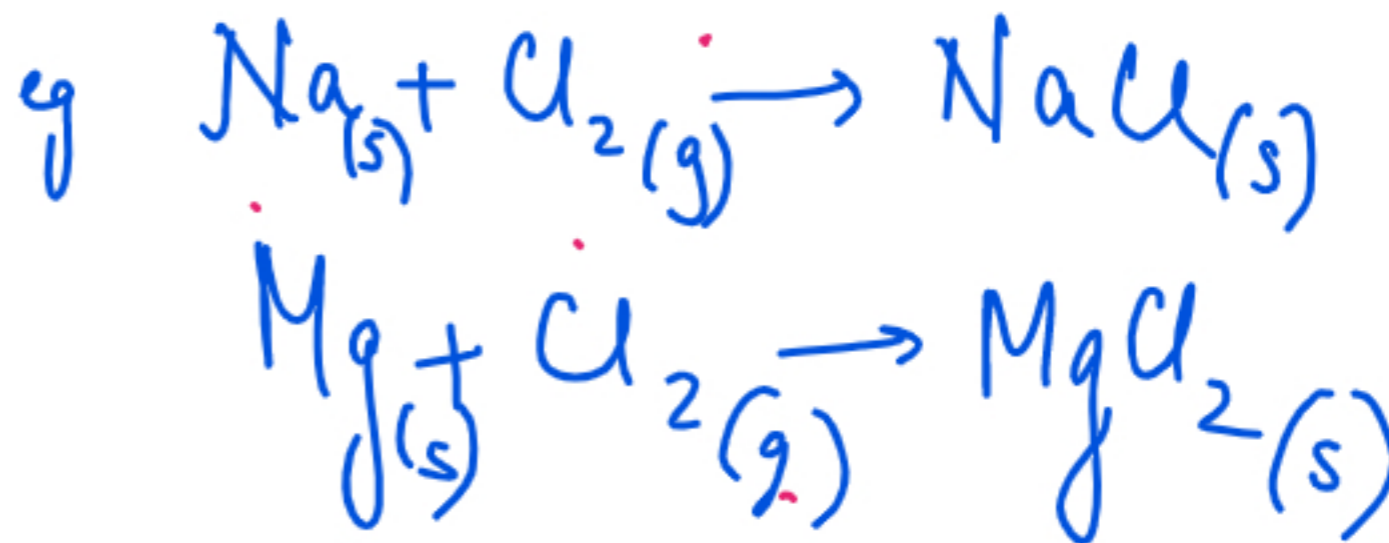
→ They react with hydrogen to form hydrogen halides.



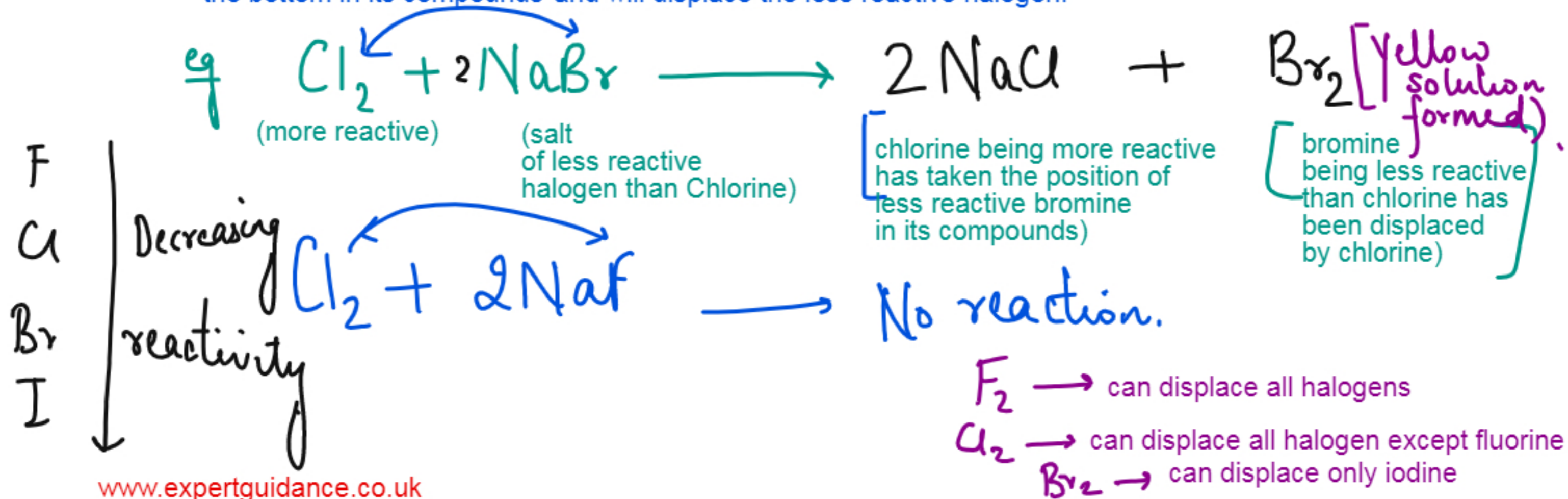
→ Reactivity decreases down the group so fluorine and chlorine reacts explosively and bromine and iodine reacts at higher temperature in the presence of catalyst.

REACTION WITH METALS

→ They react with metals to form ionic compounds. In ionic compounds, halogens gain one electron from the metals to form -1 ions and attain noble gas electronic configurations.



- ★ The more reactive halogen displaces the less reactive halogen from its salt
- ★ As the reactivity decreases down the group, the halogen at the top can take the position of the halogen at the bottom in its compounds and will displace the less reactive halogen.



→ The Reactivity of Group 7 decreases down the group as the electron affinity or tendency to gain the electron decreases down the group.

React. by electron

FACTORS AFFECTING TENDENCY TO GAIN AN ELECTRON

To gain an electron, smaller nuclear charge, smaller size and less shielding is required.

→ Nuclear Charge

Smaller the size of the atom, greater will be the force of the nucleus as the electron will be closer to the nucleus.

→ SHIELDING

Less electrons and shells, smaller will be the shielding which will in turn increase the nuclear charge.

→ SIZE OF ATOMS

Greater the size of the atom, the outer electron will become further away from the nucleus resulting in decreases in nuclear charge

Down the group the atom size increases due to increase in number of electron shells. As a result the nuclear charge decreases.

The size of the atom also increases down the group which makes the nuclear charge weaker

The electron shells also increases which decreases the effective nuclear charge on the incoming electron.

Due to all these factors, the nuclear charge decreases which decreases the tendency of gaining electrons down the group of halogen making them less reactive.

GROUP 1 Alkali Metals	GROUP 7 Halogens
a) Have one electron in their outermost shells	Have seven electrons in their outermost shell
b) They are metals	They are non metals
c) They react by losing electrons	They react by gaining electrons
d) They form +1 ions	They form -1 ions
e) Their reactivity increases down the group	Their reactivity decreases down the group
f) Reactivity depends on tendency to lose an electron	Reactivity depends on tendency to gain an electron

Group → 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 Found between group 2 and group 3

↓ Period

1	1 H																2 He	
2	3 Li	4 Be										5 B	6 C	7 N	8 O	9 F	10 Ne	
3	11 Na	12 Mg										13 Al	14 Si	15 P	16 S	17 Cl	18 Ar	
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba		72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra		104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og

- ★ They are hard
- ★ They are strong
- ★ They are malleable and ductile
- ★ They have higher densities than group 1 and group 2 hence they are used in construction purpose like iron.

Lanthanides	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
Actinides	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

★ They show the reaction with oxygen, water and halogen like group 1 but they react much slowly than alkali metals.

- ★ They show variable oxidation states
- ★ They are used commercially as catalyst
- ★ They form coloured compounds.

Periodic Table → A table that shows arrangement of all the known elements in the order of increasing atomic number. The table is organised into periods and groups.

Metals Elements found to the left of the periodic table which are soft, shiny, conductors malleable and ductile. eg Group 1, group 2 and group 3 elements

Non Metals — Elements found to the right of the periodic table which are dull, insulators. Group 4,5,6 and 7 are non metals.

Halogens — Group 7 elements are halogens as they are salt forming.

Alkali Metals — Group 1 elements which react with water to form alkali

Noble Gases — Group 0 elements which are stable and do not react as they have complete outer shell.

Transition Metals — Elements found between group 2 and group 3 which have high densities, show variable oxidation states and form coloured compounds.

Periods — Horizontal rows of the periodic table.

Groups — Vertical columns of the periodic table

Group Number — Indicates the number of electrons in the outermost shell.

Alkali — Bases that are soluble in water.

Displacement Reaction — When a more reactive element displaces the less reactive element from its salt.

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Q1 Look at the periodic table and give two examples of each
Metal —

• Non Metal

Alkali Metal

Halogens

Noble Gas

Semi metal or metalloid

Metals that form +1 ions

Non metal that form -1 ions

Metal that form +2 ions

Transition metal

Q2 Write the name of most reactive halogen
and most reactive alkali metals

Q3 Why the alkali metals gets more reactive down the group

Q4 Why halogens get less reactive down the group

Q5 Write the balanced chemical equation with state symbols of
a) Potassium with water
b) Lithium with oxygen
c) Sodium with bromine
d) Chlorine with hydrogen

Q6 Explain displacement reaction of halogens with examples.

Q1 Look at the periodic table and give two examples of each

- Metal — Li, Na
- Non Metal — O₂, F₂
- Alkali Metal — K, Li
- Halogens — F, Cl
- Noble Gas — He, Ar
- Semi metal or metalloid — Si
- Metals that form +1 ions — Li, K
- Non metal that form -1 ions — F, Cl
- Metal that form +2 ions — Mg, Ca
- Transition metal — Fe, Cu

Q2 Write the name of most reactive halogen and most reactive alkali metals

Halogen - F Alkali Metal - Fr

Q3 Why the alkali metals gets more reactive down the group

Down the group the atom size increases due to increase in number of electron shells. This results in the outer electron being further away from the nucleus. As the outer electron becomes further away from the nucleus the nuclear charge decreases. Increase in number of shells also increases the shielding and shields the outer electron from the nuclear charge. Therefore, the tendency of atom to loose an electron increases down the group resulting in increase in reactivity down the group.

Q4 Why halogens get less reactive down the group

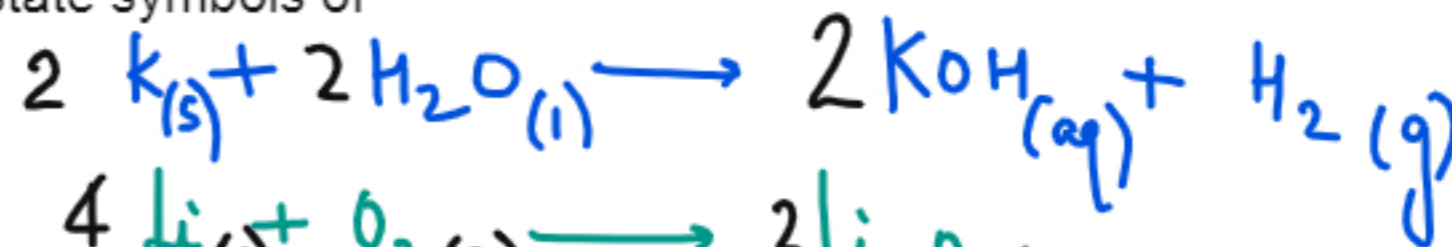
Down the group the atom size increases due to increase in number of electron shells. As a result the nuclear charge decreases. The size of the atom also increases down the group which makes the nuclear charge weaker. The electron shells also increases which decreases the effective nuclear charge on the incoming electron.

Due to all these factors, the nuclear charge decreases which decreases the tendency of gaining electrons down the group of halogen making them less reactive.

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Q5 Write the balanced chemical equation with state symbols of

- Potassium with water
- Lithium with oxygen
- Sodium with bromine
- Chlorine with hydrogen



Q6 Explain displacement reaction of halogens with examples.

When the more reactive halogens displaced the less reactive halogen from its salt.



NEXT STEP !!!

- ★ Check the Specification
- ★ Do Exam questions on this chapter

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