Group 1 — The Alkali Metals

Group 1 elements are known as the alkali metals. As metals go, they're pretty reactive.

Group 1 Elements All React in a Similar Way with Water

1) Simple reactions can be used to work out if an element is part of the same family as other elements. Elements of the same family will react in a similar way.
2) For example, when lithium, sodium and potassium are put in water, they all react vigorously.
3) The reaction produces a metal hydroxide solution. This solution is alkaline — this is why Group 1 elements are known as the alkali metals.
4) The reaction of the alkali metals with water also produces hydrogen — this is why you can see fizzing.
5) These reactions can be written as chemical equations — e.g. for sodium the equation is...

Word equation: sodium + water → sodium hydroxide + hydrogen

Symbol equation: $2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)}$

STATE SYMBOLS:
(s) = solid, (l) = liquid, (g) = gas,
(aq) = aqueous (dissolved in water)

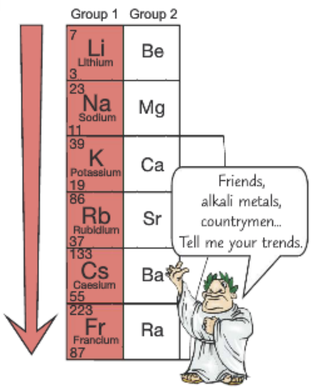
6) The Group 1 metals can also react with oxygen in the air to form metal oxides.
7) Different types of oxide will form depending on the Group 1 metal:
   - Lithium reacts to form lithium oxide (Li_2O).
   - Sodium reacts to form a mixture of sodium oxide (Na_2O) and sodium peroxide (Na_2O_2).
   - Potassium reacts to form a mixture of potassium peroxide (K_2O_2) and potassium superoxide (KO_2).

This is why they tarnish when left in air, leaving a dull metal oxide layer.

Group 1 Elements Become More Reactive Down the Group

1) As you go down Group 1 the elements become more reactive.
2) You can see this in the rate of reaction with water (i.e. the time taken for a lump of the same size of each element to react completely with the water and disappear).
3) Lithium takes longer than sodium or potassium to react, so it's the least reactive.
4) Potassium takes the shortest time to react of these three elements, so it's the most reactive.
5) The trend in reactivity can also be seen in the reaction between the alkali metals and oxygen. Potassium reacts to form its oxide quicker than sodium and lithium when left in air.
6) You can use the trend in reactivity to predict how other group 1 metals will react.

The elements in Group 1 get more reactive as the atomic number increases.

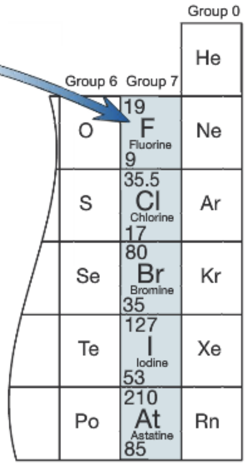


E.g. you could predict that caesium will react more vigorously than potassium with water (in fact, it explodes).

Group 7 — The Halogens

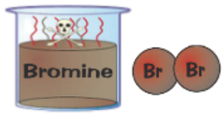
Here's a page on another periodic table group that you need to be familiar with — the halogens.

HALOGEN — Seven Letters — Group 7

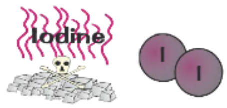


1) The elements in Group 7 of the periodic table are called the halogens.
2) As the atomic number of the halogens increases, the elements have a darker colour and a higher boiling point. This means at room temperature:
   - Chlorine (Cl_2) is a fairly reactive, poisonous, green gas.

   - Bromine (Br_2) is a poisonous, red-brown liquid, which gives off an orange vapour at room temperature.



   - Iodine (I_2) is a dark grey crystalline solid which gives off a purple vapour when heated.



3) This table shows how the properties of the elements in Group 7 gradually change as you go down the group:

Group VII Elements	Properties			
	Atomic number	Colour	Physical state at room temperature	Boiling point
Chlorine	17	green	gas	−34 °C
Bromine	35	red-brown	liquid	59 °C
Iodine	53	dark grey	solid	185 °C

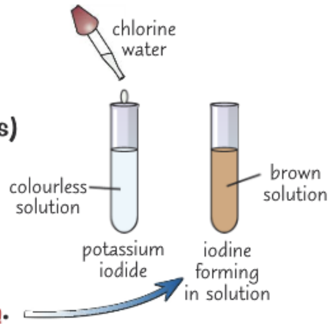
4) The higher up Group 7 an element is, the more reactive it is.
5) You might need to use these trends to predict the properties of other halogens.

E.g. You can see that boiling point increases down the group, and the colours of the halogens get darker, so you could predict that astatine (which comes below iodine) would be a dark-coloured solid at room temperature. Sure enough, astatine is a black solid with a melting point of around 300 °C.

Displacement Reactions

The halogens are a pretty competitive lot really. In fact the more reactive ones will push the less reactive ones out of a compound. How uncivilized — has nobody ever taught them that it's bad manners to push?

More Reactive Halogens will Displace Less Reactive Ones



1) The elements in Group 7 take part in displacement reactions.
2) A displacement reaction is where a more reactive element "pushes out" (displaces) a less reactive element from a compound.
3) For example, chlorine is more reactive than iodine (it's higher up Group 7).
4) So, if you add chlorine water to potassium iodide solution the chlorine will react with the potassium in the potassium iodide to form potassium chloride.
5) The iodine is displaced from the salt and gets left in the solution, turning it brown.
6) The table below shows what happens when you mix different combinations of chlorine, bromine and iodine with the salts potassium chloride, potassium bromide and potassium iodide.

Start with:	Potassium chloride solution $KCl_{(aq)}$ — colourless	Potassium bromide solution $KBr_{(aq)}$ — colourless	Potassium iodide solution $KI_{(aq)}$ — colourless
Add chlorine water $Cl_{2\,(aq)}$ — colourless	no reaction	orange solution (Br_2) formed	brown solution (I_2) formed
Add bromine water $Br_{2\,(aq)}$ — orange	no reaction	no reaction	brown solution (I_2) formed
Add iodine water $I_{2\,(aq)}$ — brown	no reaction	no reaction	no reaction

These experiments are dead easy. All you need to do is add a few drops of the halogen solution to the salt solution. Then look for a colour change.

Halogen Displacement Reactions Involve Transfer of Electrons

1) You can show the displacement reactions between halogens and salt solutions as equations.
E.g.

$$Cl_{2(aq)} + 2KI_{(aq)} \rightarrow I_{2(aq)} + 2KCl_{(aq)}$$

This is the equation for chlorine displacing iodine from potassium iodide. They might give you a different example in the exam, but the principle is always the same.

2) When this reaction happens electrons are passed from the iodine to the chlorine.

Each chlorine atom in the Cl_2 molecule gains an electron to form two negative Cl^- ions.

$$Cl_{2(aq)} + 2I^-_{(aq)} \rightarrow 2Cl^-_{(aq)} + I_{2(aq)}$$

Two iodide ions lose an electron each and then form a neutral I_2 molecule.

3) A loss of electrons is called oxidation. A gain in electrons is called reduction.
Oxidation and reduction can also describe the gain and loss of oxygen — see p.44.
4) In displacement reactions, reduction and oxidation happen simultaneously.
For example, in this reaction the chlorine is reduced and the iodine is oxidised.
5) An oxidising agent accepts electrons and gets reduced. So, here chlorine is an oxidising agent.
6) A reducing agent donates electrons and gets oxidised. So iodine is a reducing agent.
7) Reactions where reduction and oxidation happen at the same time are called redox reactions.

You can remember which is which by using OIL RIG. Oxidation Is Loss, Reduction Is Gain (of electrons).

New information displaces old information from my brain...

If you remember that the halogens get less reactive as you go down the group, you can work out what will happen when you mix any halogen with any halide salt. You need to know the colour changes that go with the reactions too.

Q1 A student added a few drops of a halogen solution to a potassium iodide solution. The solution turned brown. Explain what the student should do to help him identify the halogen solution. [2 marks]

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Q1 He should add a few drops of the solution to a bromine salt solution (e.g. potassium bromide) ***[1 mark]***. If the solution turns orange, the halogen solution contains chlorine. If there is no reaction, the halogen solution contains bromine ***[1 mark]***.