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EB Education Revision Guide

How to work with Halogens

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Group 7: The Halogens

The facts

Group 7 elements are known as the Halogens.

All the halogens have seven electrons in their outer shell. This means their **chemical properties** are similar.

They form ionic compounds with metals when they gain an electron.

They exist as diatomic molecules by sharing one pair of electrons in a covalent bond. (Cl_2, Br_2)

Physical properties:

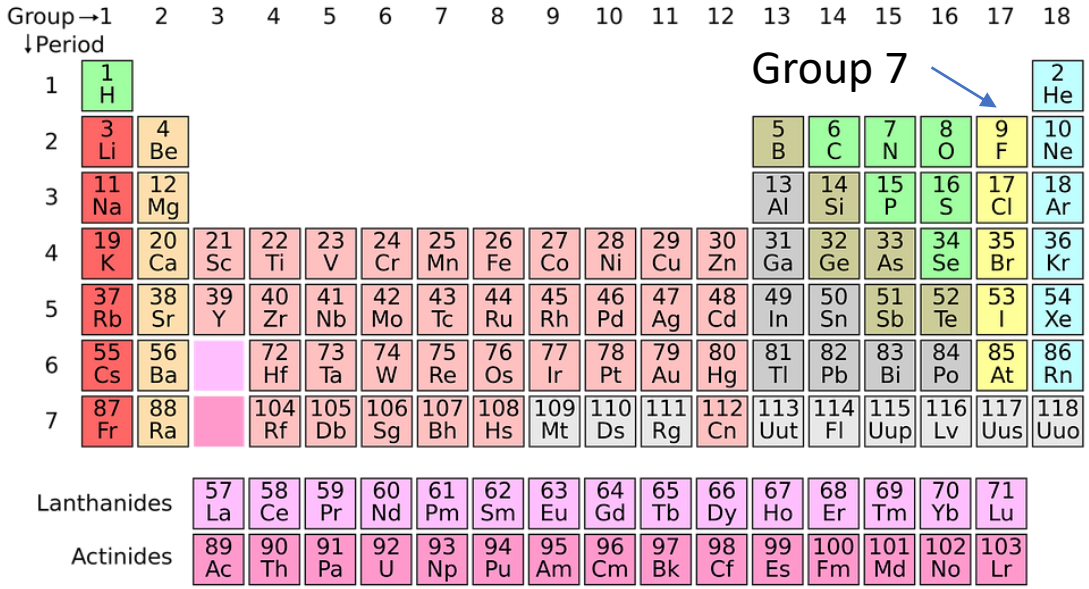
- Melting points and boiling points increase as you go down Group 7.
- The colour of the halogens gets darker as you go down the Group.

a) Chlorine is a poisonous green gas.

b) Bromine is a poisonous red-brown liquid and gives off an orange vapour.

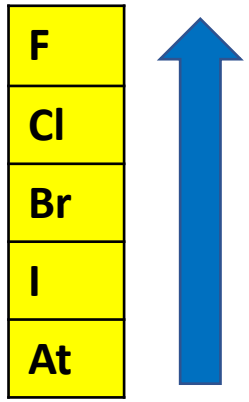
c) Iodine is a dark grey crystalline solid and gives off a purple vapour when it is heated.

Where to find the Halogens in the Periodic table



Test for Chlorine:
Hold a piece of blue litmus paper over it. Chlorine will turn the paper red first, as a chlorine solution is acidic, and will then bleach it white.

Reactivity

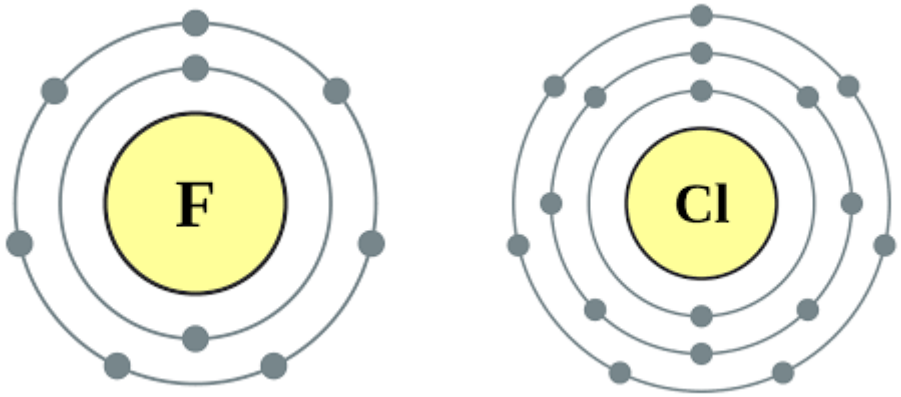


Reactivity Increases

Why are they reactive?

Halogens only need to gain one electron to form a 1- ion.

As you go down the group, the halogens become less reactive. This is because, as the atom gets larger it becomes harder for it to gain an electron, as it is further away from the positive nucleus. The electron is not as strongly attracted to the nucleus by the electrostatic forces. This means that fluorine is the most reactive halogen, as it is the smallest atom.



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Halogen Reactions

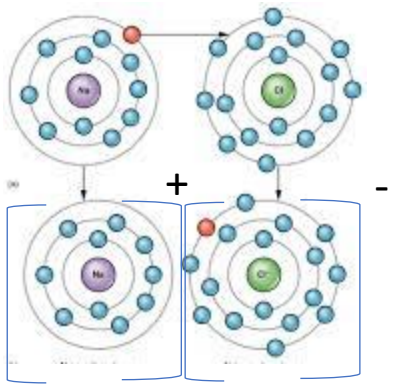
Halogens and Metals

Halogens will react with some metals to form salts which are called metal halides.

metal + halogen ⟶ metal halide (salt)

sodium + chlorine ⟶ sodium chloride

$2Na + Cl_2 \longrightarrow 2NaCl$



Halogens and Hydrogen

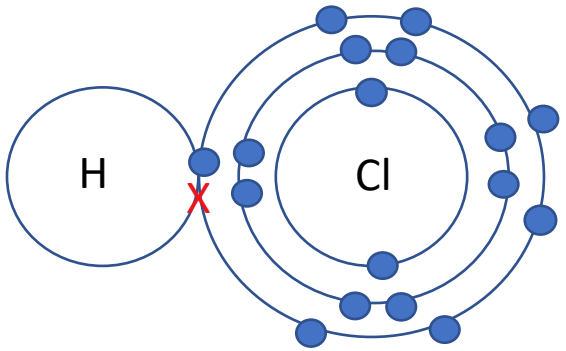
Halogens will react with hydrogen to form hydrogen halides.

hydrogen + halogen ⟶ hydrogen halide

hydrogen + chlorine ⟶ hydrogen chloride

$H_2 + Cl_2 \longrightarrow 2HCl$

Hydrogen halides are soluble. When they dissolve in water, they form acidic solutions. Hydrogen chloride will form hydrochloric acid in water.



Displacement Reactions

What is displacement?

Displacement is when a more reactive element displaces a less reactive element from a compound.

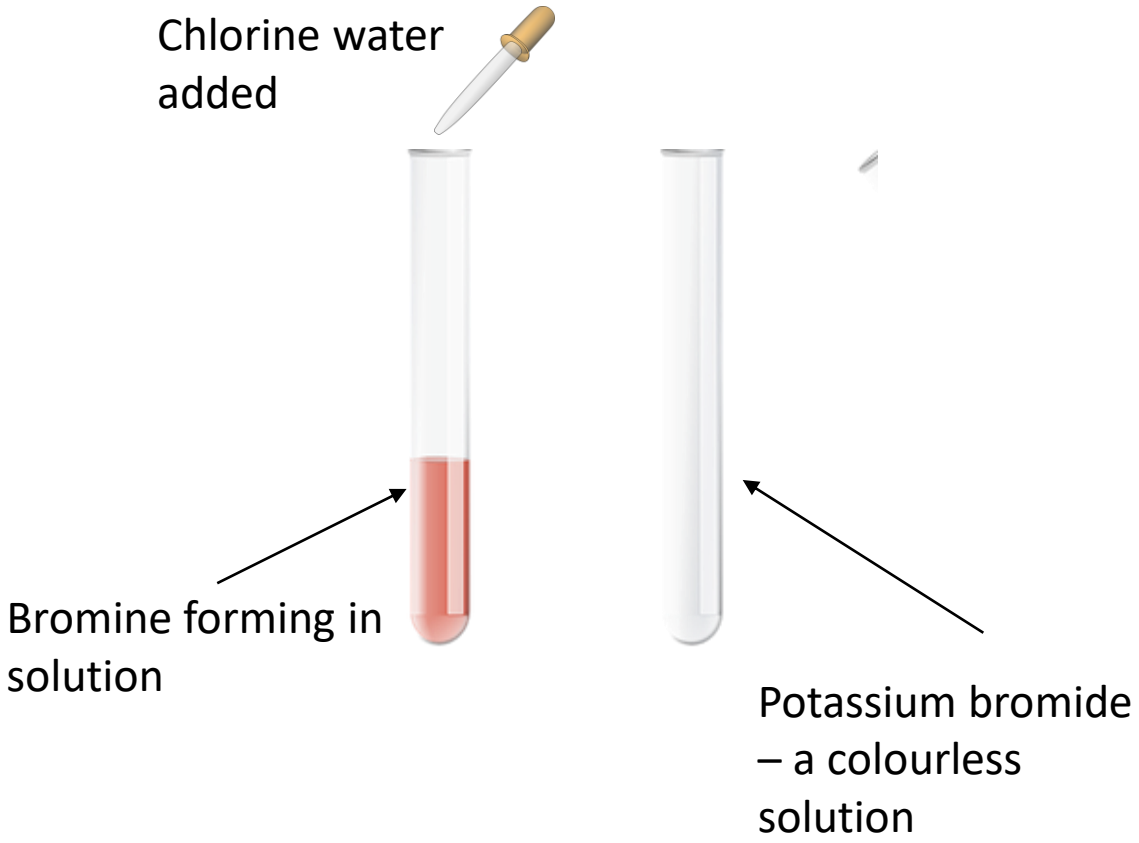
Chlorine + potassium bromide ⟶ bromine + potassium chloride

Cl_2 + 2KBr ⟶ Br_2 + 2KCl

Chlorine is more reactive than bromine as it is higher up in Group 7. When chlorine water is added to potassium bromide solution, chlorine will displace the bromine from the salt solution.

The chlorine will be REDUCED (gain electrons) to chlorine ions.

The bromide ions will be OXIDISED (lose electrons) to become bromine. The bromine will turn the solution orange.



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Displacement Reactions

Trends in Reactivity

Displacement reactions can be used to show trends in reactivity of the halogens.

A few drops of the halogen solutions can be added to the halide salt solutions.

If the colour changes, it indicates that a reaction has taken place. This means that the halogen has displaced the halide ions from the salt, and so is more reactive.

- Chlorine – displaces bromine and iodine
- Bromine – displaces iodine
- Iodine – is less reactive so does not displace either bromine or iodine.
- Astatine is the least reactive Halogen so will not displace anything whereas Fluorine is the most reactive so will displace every other Halogen

	Potassium Chloride solution	Potassium Bromide solution	Potassium Iodide solution
Chlorine Water (Colourless)	No reaction	Orange solution formed (Br_2)	Brown solution formed (I_2)
Bromine water (Orange)	No reaction	No reaction	Brown solution formed (I_2)
Iodine water (Brown)	No reaction	No reaction	No reaction

Your turn:

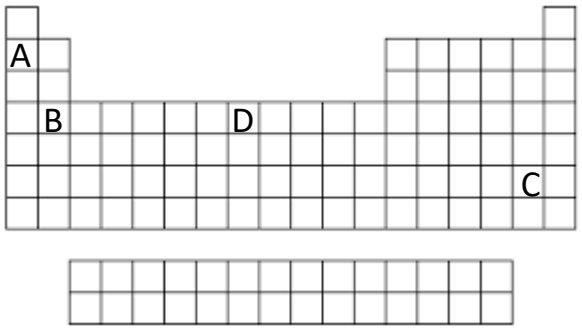
1. Potassium bromide and chlorine react in solution to form bromine and potassium chloride.

a) What type of reaction is taking place?

A displacement
B combustion
C precipitation
D thermal decomposition

b) What colour will the mixture be at the end of the reaction?

c) Chlorine reacts with an element to form a solid chloride. The solid chloride is dark red.
Where is this element most likely to be found in the periodic table?



d) Some metals react with halogens.
Iron reacts with chlorine to form iron (III) chloride, $FeCl_3$.
What is the balanced equation for this reaction?

e) What state and colour is iodine at room temperature?

f) Hydrogen reacts with the halogens to form hydrogen halides.

Complete and balance the equation for the reaction between bromine and hydrogen.

$H_2 + Br_2 \longrightarrow$ .....

Your turn:

2. A displacement reaction can happen when a halogen is added to a solution of halide ions. The table below shows whether a displacement reaction occurs.

Halogen	Halide ion in solution		
	Chloride ion	Bromide ion	Iodide Ion
Chlorine		Yes	Yes
Bromine	No		
Iodine	No	No	

Explain the order of reactivity of chlorine, bromine and iodine using information from the table.

3. Chlorine, bromine and iodine are in group 7 of the periodic table.

At room temperature:

- Chlorine is a green gas
- Bromine is a red-brown liquid
- Iodine is a grey solid

Predict the appearance of astatine - which is below iodine in group 7.

Your turn:

4. Displacement experiments can be carried out to demonstrate the order of reactivity of the halogens.

Using the chemical solutions named below, describe how you could carry out a series of experiments to determine the order of reactivity of chlorine, bromine and iodine.

Explain how your results show the order of reactivity, using equations where required.

- Bromine solution
- Iodine solution
- Chlorine solution
- Potassium bromide solution
- Potassium chloride solution
- Potassium iodide solution

5. Sodium chloride can be electrolysed when electrical current is passed through a solution of it.
This produces hydrogen and chlorine.
Sodium hydroxide is left in the solution.

a) Why is chlorine gas hazardous?

b) What test can you use to prove that the gas produced is chlorine?

c) What can chlorine be used for?

d) Complete the equation below, for when sodium chloride solution is electrolysed. Ensure it is balanced.

……..NaCl + ……H_2O ⟶ ……..+ …….. + ……

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Answers:

1. Potassium bromide and chlorine react in solution to form bromine and potassium chloride.

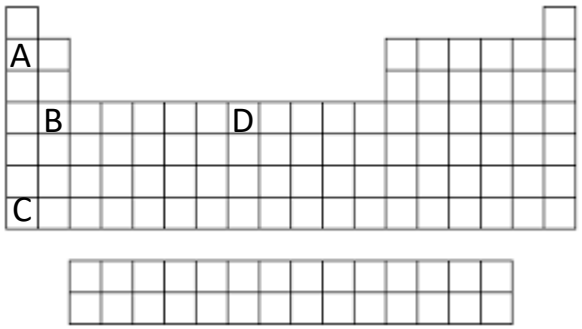
a) What type of reaction is taking place?

A displacement
B combustion
C precipitation
D thermal decomposition

b) What colour will the mixture be at the end of the reaction?

Orange – because bromine is present

c) Chlorine reacts with an element to form a solid chloride. The solid chloride is dark red.
Where is this element most likely to be found in the periodic table?



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d) Some metals react with halogens.
Iron reacts with chlorine to form iron (III) chloride, $FeCl_3$.
What is the balanced equation for this reaction?

$2Fe + 3Cl_2$ $2FeCl_3$

e) What state and colour is iodine at room temperature?

A grey solid

f) Hydrogen reacts with the halogens to form hydrogen halides.

Complete and balance the equation for the reaction between bromine and hydrogen.

$H_2 + Br_2 \longrightarrow 2HBr$

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Your turn:

2. A displacement reaction can happen when a halogen is added to a solution of halide ions. The table below shows whether a displacement reaction occurs.

Halogen	Halide ion in solution		
	Chloride ion	Bromide ion	Iodide Ion
Chlorine		Yes	Yes
Bromine	No		
Iodine	No	No	

Explain the order of reactivity of chlorine, bromine and iodine using information from the table.

Order of reactivity is: Chlorine – bromine – iodine
Chlorine displaces bromine and iodine.
Bromine displaces iodine, but not chlorine.
Iodine does not displace chlorine or bromine because it is less reactive.

3. Chlorine, bromine and iodine are in group 7 of the periodic table.

At room temperature:

- Chlorine is a green gas
- Bromine is a red-brown liquid
- Iodine is a grey solid

Predict the appearance of astatine - which is below iodine in group 7.

Dark grey/black solid

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Answers:

4. Displacement experiments can be carried out to demonstrate the order of reactivity of the halogens.
Using the chemical solutions named below, describe how you could carry out a series of experiments to determine the order of reactivity of chlorine, bromine and iodine.
Explain how your results show the order of reactivity, using equations where required.

- Bromine solution
- Iodine solution
- Chlorine solution
- Potassium bromide solution
- Potassium chloride solution
- Potassium iodide solution

Order of reactivity: chlorine – bromine – iodine

- Add chlorine solution to potassium bromide solution – it turns orange as bromine is produced. Chlorine is more reactive and displaces bromine.
- Add bromine solution to potassium iodide –it turns brown as iodine is produced. Bromine is more reactive and displaces iodine.
- Add chlorine solution to potassium iodide solution – it turns brown as iodine is produced. Chlorine is more reactive and displaces iodine.
- Adding iodine solution to potassium chloride/bromide results in no reaction.
- Adding bromine solution to potassium chloride produces no reaction.

5. Sodium chloride can be electrolysed when electrical current is passed through a solution of it.
This produces hydrogen and chlorine.
Sodium hydroxide is left in the solution.

a) Why is chlorine gas hazardous?

Toxic/poisonous gas

b) What test can you use to prove that the gas produced is chlorine?

Damp blue litmus paper.
Turns red and then bleaches

c) What can chlorine be used for?

Bleach/killing bacteria/PVC/solvents/medicines

d) Complete the equation below, for when sodium chloride solution is electrolysed. Ensure it is balanced.

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For more help and resources, or to work with us as a tutor, please contact us

www.ebeducationservices.co.uk

contact@ebeducationservices.co.uk

0161 442 5270

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