SC17c Halogen Reactivity.

iron + copper sulphate →

zinc + sodium carbonate →

Starter B:

What ***three*** **(!)** elements are needed to make hydrochloric acid?!

Starter A:

What do you recall about the reactions shown above? ***Give as much detail as you can.***

SC17c Halogen Reactivity.

iron + copper sulphate → iron sulphate + copper

Iron displaces copper ...

... because iron is more reactive than copper.

zinc + sodium carbonate → no reaction

Zinc cannot displace sodium ...

... because sodium is more reactive than zinc.

Reactions with hydrogen.

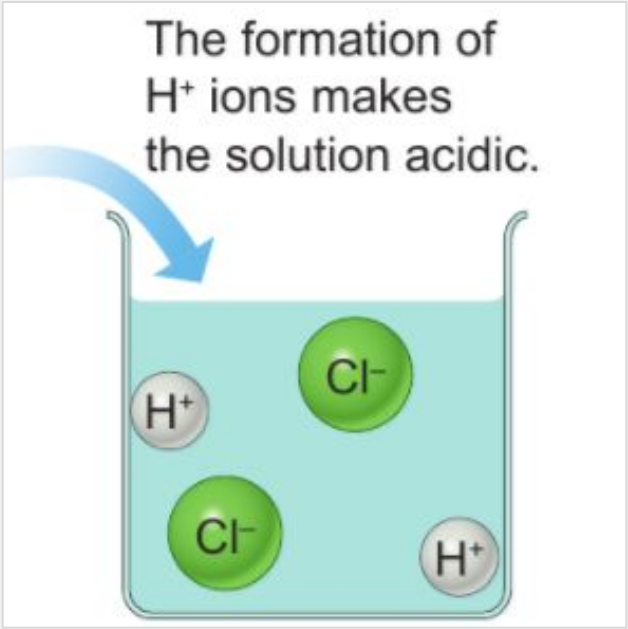
- Halogens react with metals, making metal halides.
- They also react with hydrogen, making hydrogen halides.

e.g., hydrogen + chlorine ⟶ hydrogen chloride

$$H_2\,(g) + Cl_2\,(g) \longrightarrow 2\,HCl\,(g)$$

- Hydrogen chloride dissolves in water to form hydrochloric acid.

$$HCl\,(g) \longrightarrow HCl\,(aq)$$



Reactions with hydrogen.

- Describe the formation of hydrofluoric acid:
  a) using word equations.
  b) using balanced symbol equations.

hydrogen + fluorine ⟶ hydrogen fluoride

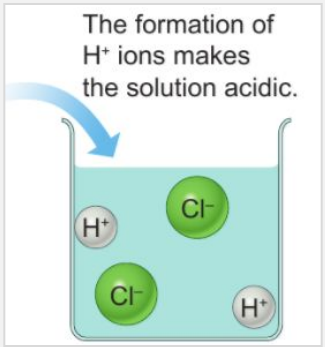
? dissolves in water to form hydrofluoric acid.

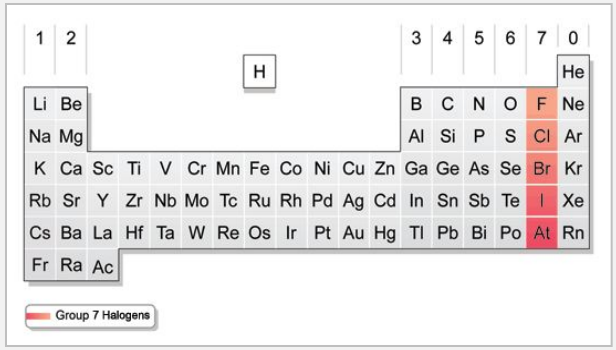
$H_2\,(g) + F_2\,(g) \longrightarrow 2\,HF\,(g)$

$HF\,(g) \longrightarrow HF\,(aq)$

SC17c Halogen Reactivity.

- Describe experiments and collect data to demonstrate the relative reactivities of halogens.
- Use the reactivity of halogens to predict outcomes of displacement reactions.
- Recall that hydrogen reacts with halogens to make acidic gases.





Displacement reactions.

- The order of reactivity of the halogens is:

  fluorine – most reactive.

  chlorine

  bromine

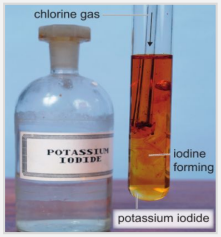
  iodine – least reactive.

- So what ***should*** happen in these:

chlorine + sodium fluoride →

chlorine + sodium bromide → bromine + sodium chloride

Displacement reactions.



- What would happen in these reactions?

fluorine + potassium bromide → **bromine** + potassium fluoride

iodine + potassium bromide → no reaction

chlorine + potassium iodide → **iodine** + potassium chloride

astatine + potassium chloride → no reaction

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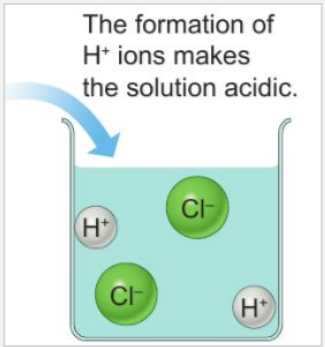

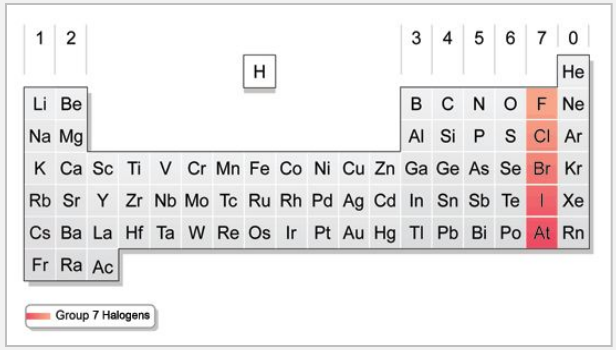

Displacement experiments.

- You will now perform a series of reactions.
- You have several potassium halide solutions.
- You will mix each potassium halide solution with different halogen solutions.
- **Follow the method sheet carefully and record your results as you go.**

Balanced extension.
Write balanced equations (with state symbols) for any successful reactions.

Challenge.
In your displacement reactions, which halogens are being oxidised and which are being reduced?

Everyone must record observations for the displacement of halogens (C)

Observing Displacement reactions

Fill in this table to show where a reaction occurred:

Substance in the test tube	Substance Added		
	Chlorine water	Bromine water	Iodine water
Potassium chloride	X		
Potassium bromide		X	
Potassium iodide			X

You should write a word equation for the displacement reactions and reactions with sodium (B)

Results

Substance in the test tube	Substance Added		
	Chlorine water	Bromine water	Iodine water
Potassium chloride	✗	✗	✗
Potassium bromide	✓ KCl	✗	✗
Potassium iodide	✓ KCl	✓ KBr	✗

How could we write this as a word equation?
Use Mini-whiteboards

1. Why is this happening?

- ✔ If a MORE REACTIVE halogen is added to a halide compound it will <u>DISPLACE</u> (kick out) the halide in the compound.

2. Why did nothing happen when iodine water was added?

- ✔ Iodine is not as reactive as the other two halogens.
- ✔ This means it will be unable to displace the other halogens from their compounds.

SC17c Halogen Reactivity.

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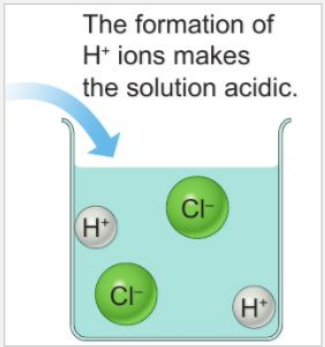

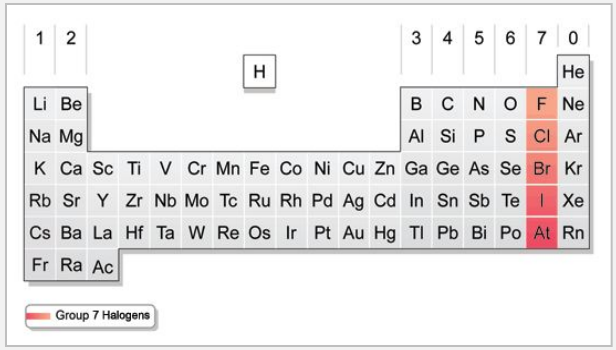

Redox in displacement reactions.

In these reactions, which **halogens** become **oxidised** and which become **reduced**?

Chlorine forms Cl^- ions; it gains an electron, so it is reduced.

Bromide is oxidised; it loses electrons.

$$Cl_2\,(aq) + 2\,KBr\,(aq) \rightarrow Br_2\,(aq) + 2\,KCl\,(aq)$$

Bromine forms Br^- ions; it gains an electron, so it is reduced.

Iodide is oxidised; it loses electrons.

$$Br_2\,(aq) + 2\,KI\,(aq) \rightarrow I_2\,(aq) + 2\,KBr\,(aq)$$

Extension/alternative/homework

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

The order of reactivity of these three elements can be shown by carrying out displacement experiments.

You are provided with

- potassium bromide solution
- potassium chloride solution
- potassium iodide solution
- bromine solution
- chlorine solution
- iodine solution

Describe how these solutions could be used to carry out experiments to show the order of reactivity of bromine, chlorine and iodine, explaining how the results would show the order of reactivity.
You may use equations if you wish.

(6)

Question Number	Indicative Content	Mark
*6(c)	A description, comparison and explanation including some of the following points Order of reactivity: chlorine > bromine > iodine Experiment • add (aqueous) chlorine to a solution of potassium bromide • the solution turns orange/yellow • bromine is produced Conclusion/Explanation and equation: (so) chlorine is more reactive than / displaces bromine $Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$ / $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ Experiment • add (aqueous) bromine to a solution of potassium iodide • the solution turns brown • iodine is produced Conclusion/Explanation and equation: (so) bromine is more reactive than / displaces iodine $Br_2 + 2KI \rightarrow I_2 + 2KBr$ / $Br_2 + 2I^- \rightarrow I_2 + 2Br^-$	

Experiment

- add (aqueous) chlorine to a solution of potassium iodide
- the solution turns brown
- iodine is produced

Conclusion/Explanation and equation:

(so) chlorine is more reactive than / displaces iodine

$Cl_2 + 2KI \rightarrow I_2 + 2KCl$ / $Cl_2 + 2I^- \rightarrow I_2 + 2Cl^-$

- Allow use of organic solvents to identify halogens
- Allow use of suggested reactions which do not produce a displacement reaction eg add (aqueous) bromine to a solution of a potassium chloride with suitable conclusion/explanation
- Allow use of table of suggested experiments

(6)

Level	0	No rewardable content
1	1 - 2	• a limited description of at least one experiment in which any halogen solution is added to any halide solution (not of the same halogen) **OR** describes order of reactivity as Cl > Br > I • the answer communicates ideas using simple language and uses limited scientific terminology • spelling, punctuation and grammar are used with limited accuracy
2	3 - 4	• a simple description of at least two displacement experiments AND • EITHER at least one correct explanation/conclusion OR • at least one correct observation of a displacement reaction that works/balanced equation. • the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately • spelling, punctuation and grammar are used with some accuracy
3	5 - 6	• a detailed description of at least two displacement experiments **AND** • (a total of) at least two correct explanations/conclusions **AND** • at least one correct observation of a displacement reaction that works/ balanced equation • the answer communicates ideas clearly and coherently uses a

Halogens in-depth.

- Write **word equations** for the reaction of a magnesium bromide solution with chlorine gas, and a magnesium iodide solution with a bromine solution.
- Describe what you would ***see*** in each reaction (magnesium bromide solution is colourless).

Balanced equations.
Answer the questions above using balanced equations (with state symbols).

Challenge.
In your displacement reactions, which halogens are oxidised and which are reduced?

(remember that magnesium is in group 2)

Redox in displacement reactions.

chlorine + magnesium bromide → **bromine** + potassium chloride

$Cl_2(g) + MgBr_2(aq) \rightarrow Br_2(aq) + MgCl_2(aq)$

Chlorine forms Cl^- ions; it gains an electron, so it is reduced.

Bromide is oxidised; it loses electrons.

bromine + magnesium iodide → **iodine** + magnesium bromide

$Br_2(aq) + MgI_2(aq) \rightarrow I_2(aq) + MgBr_2(aq)$

Bromine forms Br^- ions; it gains an electron, so it is reduced.

Iodide is oxidised; it loses electrons.