ROYAL SOCIETY OF CHEMISTRY

Halogen displacement reactions

Practical video

Supporting resources

Contents

Teacher notes

These resources support the practical video **Halogen displacement reactions**, available here: rsc.li/3tZxFgu

The value of experiencing live practical work cannot be overstated. Numerous studies provide evidence of its value in terms of learner engagement, understanding, results and the likelihood of continuing to study chemistry or work in a related field. This video can be used to complement live practical work, as well as helping learners to understand the methods, equipment and skills when they cannot access the lab.

How to use this video

The video and additional resources are designed to be used flexibly, but some suggestions follow.

Flipped learning

Learners view the video ahead of the live practical lesson to help it run more smoothly and keep objectives in focus. This may also help build confidence for some learners and improve their outcomes in the lesson. Use questions from the set provided as part of the preparation task.

Consolidation and revision

Learners view the video after the practical – this may be directly after the lesson or learners can return to it as part of revision for examinations.

Revisiting a practical with a different focus

A practical experiment can support many learning outcomes. Focussing on just one or two of those in a lesson will help ensure that the aims are achieved. The video could be used to revisit the experiment with a different focus.

Home learning

Whether it is remote teaching, homework, or individual learner absence, the video provides an opportunity to engage with a practical experiment and the associated skills when learners are not in the lab.

Other tips

- **Provide your own commentary**

  Mute the voice over and provide your own commentary. This will allow you to better engage with learners and adapt to the needs and objectives of your lesson.
- **Use questions**

  A set of pause-and-think questions are provided in two formats, one for teacher-led questions and discussion and a student worksheet which can be used independently by learners. Select from these or create your own questions to help engage learners and target specific aims.

Notes on running the practical experiment

Technician notes including the equipment list and safety notes are available as a separate document here: rsc.li/3tZxFgu. If you are planning to carry out the practical in the classroom, you will need to carry out your own risk assessment.

The microscale displacement of halogens reaction takes around 10 minutes and it is safe for learners to work in pairs.

TIP: *Once completed learners can take a photo of their results using a mobile phone or tablet, so that they can clear away immediately. This will help avoid learners spilling chemicals on their results table.*

Procedure for the displacement of halogens

- Take a dimple tray and label the rows, Cl_2, Br_2, I_2 and the columns H_2O, KCl, KBr, KI either using a non-permanent marker pen or by placing the dimple tray on top of a piece of paper.

Alternatively this experiment could be carried out on a laminated copy of the integrated instructions.

- Using the dropper bottle add 3–4 drops of the chlorine water to each dimple in the first row.
- Using the dropper bottle add 3–4 drops of the bromine water to each dimple in the second row.
- Using the dropper bottle add 3–4 drops of the iodine solution to each dimple in the third row.
- Note down the colours of each solution.
- Add 3–4 drops of distilled water to each dimple in column 1.
- Add 3–4 drops of potassium chloride solution to each of the three dimples in column 2 of the tile.
- Add 3–4 drops of potassium bromide solution to each of the three dimples in column 3 of the tile.
- Add 3–4 drops of potassium iodide solution to each of the three dimples in column 4 of the tile
- Observe and record any colour changes that take place in each row by comparing the first dimple with the others in the row.

Integrated instructions

Printable integrated instructions are provided for learners. These are available as a separate download at rsc.li/3tZxFgu.

Integrated instructions use clear numbering, arrows and simple pictograms, like an eye to show where observations are required. These have been developed using cognitive load theory. Integrated instructions remove unnecessary information, and therefore reduce extraneous load on learners, increasing the capacity of their working memory to think about what they are doing and why. Read more about the use of integrated instructions here: rsc.li/2SdSqkQ.

Results tables

Printable results tables have been provided with and without headings.

Further practical activities

If you would like to explore the halogens further, details of the following two experiments can be accessed from rsc.li/2OKP9x1:

- the halogens in water and a hydrocarbon solvent
- acidic and bleaching properties of the halogens

Key terms

Learners will need to have a clear understanding of the following scientific terminology:

Displacement – a type of chemical reaction where part of one reactant is replaced with another reactant. The displacement reactions occurring in this practical are single displacement reactions and take the form:

$$AB + C \rightarrow AC + B$$

Reactivity – a measure of how readily a substance undergoes a chemical reaction.

Metal halide – general term used to describe the group of ionic compounds that form when a metal reacts with a halogen.

Ionic compound – a compound made up of oppositely charged ions. Ionic compounds are held together by strong electrostatic forces between oppositely charged ions. These forces are called ionic bonds.

We have included an example Frayer model for introducing the term ‘displacement’. You can find more examples, and tips on how to use Frayer models in your teaching here: rsc.li/2WXtuAz.

Prior knowledge

Learners should be able to:

- identify the halogens as group 7 on the periodic table
- recall the electron configuration of the halogens
- recall that ionic bonding occurs between metals and non-metals
- name different ionic compounds using the suffix '-ide'

Learners may need to be introduced to the general term 'metal halide' to describe the group of compounds formed when a metal reacts with a halogen.

Learners should be confident writing word and symbol equations.

There are some questions included which ask learners to balance symbol equations and write ionic equations. Depending on where the displacement of halogens comes in your scheme of work your learners may not have come across this yet. Adapt the questions to make them relevant to the stage and level that you are at. Some of the challenge tasks require learners to use and apply their knowledge from other topics.

Common misconceptions

1. Confusing dilution with a colour change

   When using small quantities in a dimple tray the effects of dilution can be exaggerated. Learners may confuse the effect of dilution as an indication that a reaction has taken place. The dilution effect should be acknowledged and addressed when discussing why distilled water is used in this experiment as a control.

2. Describing solutions

   The terms clear, colourless and cloudy are often confused and used incorrectly by learners. A clear solution is one that does not contain any solid particles or gases and can be any colour.

3. Displacement reactions are also redox reactions

   Learners may need to recognise that the halogen/halide undergo oxidation and reduction during a displacement reaction. Some students find it difficult to classify reactions, in particular where one reaction might fit into several categories of reaction. It may be pertinent to talk about different classifications here that all apply to the reaction including exothermic, reversible etc.

4. Oxidation/reduction terminology

   Definitions of oxidation and reduction are confusing to students as there are four ways of defining these (*see table*). Although learners do not meet the last two definitions until their post–16 studies.

Oxidation	Reduction
Gain of oxygen	Loss of oxygen
Loss of electrons	Gain of electrons
Loss of hydrogen	Gain of hydrogen
Increase in oxidation number	Decrease in oxidation number

5. Identifying the 'most reactive'

   Learners may have trouble identifying the 'most reactive' halogen as being the one that forms a compound rather than the one that leaves the compound. Learners may have a misconception that the one they can 'see' is the most dominant and therefore the most reactive. This should be addressed using animations and by displaying equations to embed what is really happening (see 04:59 in the video).

   Diagnostic multiple-choice questions are a great way to explore learners' reasoning behind their answers. Best Evidence Science Teaching resources provide a great starting point to explore their ideas about periodic patterns. Resources on the topic of periodic patterns can be found within the chemical reactions topic.here: https://www.stem.org.uk/best/chemistry-earth-science/big-idea-chemical-reactions. You will also find a template for putting together your own diagnostic grouping element questions including multiple choice, predict explain questions, talking heads style questions. Read more about diagnostic questioning here: rsc.li/3u1kED3.

Intended outcomes

It is important that the purpose of each practical is clear from the outset, defining the intended learning outcomes helps to consolidate this. Outcomes can be categorised as hands on, what learners are going to do with objects, and minds on, what learners are going to do with ideas to show their understanding. We have offered some differentiated suggestions for this practical. You may wish to focus on just one or two, or make amendments based your learners' own needs. (Read more at rsc.li/2JMvKa5.)

Consider how you can share outcomes and evaluation with learners, empowering them to direct their own learning.

	Hands on	Minds on
Effective at a lower level	**Students correctly:** • Use equipment to safely carry out tests • Follow instructions • Make careful observations	**Students can:** • Record observations in a results table • Write a word equation for each reaction • Use the results to deduce the trend in reactivity of the halogens
Effective at a higher level	**Students correctly:** • Plan and carry out an investigation into the reactivity of the halogens	**Students can:** • Use trends to make predictions about the reactivity of other non-metals • Describe reactions as either oxidation or reduction • Explain what is happening on a sub-microscopic level during the reaction • Write balanced symbol and ionic equations for each reaction

How to use the additional resources

Using the pause-and-think questions

Pause-and-think questions are supplied in two formats: a teacher version for 'live' questioning and a student version which can be used during independent study. The time stamps allow you to pause the video when presenting to a class, or learners to use for active revision.

The questions could also be used to support delivery of the experiment as a demonstration or class practical. Responses will help you to assess understanding and address misconceptions.

Teacher version

The questions are presented in a table and you can choose to use as many as appropriate for your class and the learning objectives.

Some questions have two timestamps to allow you to adapt the questions for different classes or scenarios. Pause the videos at the earlier timestamp to ask a question before the answer is given, useful for revision or to challenge learners. Pause at the later timestamp to ask a question reflectively and assess whether learners have understood what they have just heard or seen. This would be useful when introducing a topic, in a flipped learning scenario or when additional support and encouragement is needed.

Think about how you will ask for responses. Variation may help to increase engagement – learners could write and hold up short answers; more complex questions could be discussed in groups.

Not all answers to questions are included in the video. Some of the questions will draw on prior learning or extend learners' thinking beyond the video content.

Student version

The same questions are offered as a printable worksheet for learners. Use in situations where there is not a teacher present to guide discussion during the video, for example homework, revision or remote learning.

Using the structure strips

Writing about chemistry encourages learners to reflect on their understanding, formulate new ideas and make links between ideas in new ways. Learners also need to practice for longer-answer questions in examinations. Structure strips provide scaffolded prompts and help overcome ‘fear of the blank page’. The learner sticks the strip into the margin of their exercise book or onto an A4 sheet of paper and writes alongside it. Use this long-answer question to consolidate learning after the practical and/or for revision. (Read more at rsc.li/2P0JDlW.)

Long-answer question:

Group 7 of the periodic table contains the elements known as the halogens. The order of reactivity of the halogens can be determined experimentally by carrying out displacement reactions.

Explain how displacement reactions can be used to show the relative reactivity of chlorine, bromine and iodine.

Using the follow-up worksheets

Two worksheets have been included as part of the supporting resources, with editable versions available. The first is structured to support learners to recall the knowledge from this practical, whilst the second sheet provides more challenging questions and applies the learning to wider contexts. These sheets could be used to follow up the practical activity, for example as homework or a revision exercise.

Additional resources

Frayer model: displacement

1. **What does the word displacement mean to you?**

   Where have you come across this word before?

2. **Explore displacement.**

   Dis and placement.

   Can you think of any words which are similar to displacement?

Displacement

3. **Definition of displacement.**

4. **Can you explain why this is a displacement reaction?**

   Calcium + copper chloride → calcium chloride + copper

Available in landscape format as editable slide at rsc.li/3tZxFgu.

Pause-and-think questions

Teacher version

Timestamp(s)		Question	Answer/discussion points
00:14	00:21	Name the halogens and describe where they are found in the periodic table.	Fluorine (F), chlorine (Cl), bromine (Br), iodine (I), astatine (At). The halogens are found in group 7 of the periodic table which is the second column on the right hand side of the periodic table. They are non-metals.
00:45	01:06	What do you think is meant by the term ‘displacement’? Write a definition in your own words or share your ideas with the class.	Please see the separate Frayer model as an example of how to explore learners’ ideas about ‘displacement’.
01:14	01:18	Write down or improve your definition. Try to write a general equation.	A displacement reaction is a type of chemical reaction where part of one reactant is replaced with another reactant: $AB + C \rightarrow AC + B$
01:25		Why are displacement reactions being used in this experiment?	To investigate the reactivity of the halogens.
		The experiment	
02:39		How would you describe the colour and appearance of chlorine water?	Colourless, clear.
02:50		How would you describe the colour and appearance of bromine water?	Clear, pale yellow.
03:03		How would you describe the colour and appearance of iodine solution?	Clear, orange-brown.
03:09		What will we be looking for during the tests? How will you know if a chemical reaction has actually take place?	Signs that a chemical reaction has taken place. A colour change, evolution of gas, formation of a precipitate.
03:12		Why have some of the boxes in the table been shaded in?	A halogen will not displace itself from a compound. Therefore we do not need to test potassium chloride with chlorine water, for example.
03:32		Why do you think distilled water is added to column 1?	To act as a control; so you can see the effect of dilution on the colour of the halogen waters. This should help to determine whether a reaction has taken place.
03:46		Complete the first column of your table. Why does the bromine water and iodine solution appear slightly paler?	Results on screen. It has been diluted.
03:59	04:14	Record observations in the table.	No colour change.
04:19		Predict what changes will take place when potassium bromide is added to the halogen waters.	A reaction will take place with the chorine water but not the others.
04:36	04:43	Record observations in the table.	First row: colour change (colourless to pale yellow). Second and third row: no change.

05:06	05:10	Complete the word and balanced symbol equation.	Potassium bromide + chlorine → potassium chloride + bromine $2KBr(aq) + Cl_2(aq) \rightarrow 2KCl(aq) + Br_2(aq)$
05:19		Predict what changes will take place when potassium iodide is added to the halogen waters.	A reaction will take place with the chorine water and the bromine water but not the iodine solution.
05:32	05:40	Record observations in the table.	First row: colour change (colourless to pale brown) Second row: colour change (pale yellow to pale brown)
05:48		Write down the word or symbol equations for the two reactions you have observed	Potassium iodide + chlorine → potassium bromide + iodine $2KI(aq) + Cl_2(aq) \rightarrow 2KCl(aq) + I_2(aq)$ Potassium iodide + bromine → potassium bromide + iodine $2KI(aq) + Br_2(aq) \rightarrow 2KBr(aq) + I_2(aq)$
05:56	06:05	What is a redox reaction? Define the words oxidation and reduction.	A redox reaction is one where oxidation and reduction occur at the same time. An oxidation reaction is one in which there is a gain of oxygen or a loss of electrons. A reduction reaction is one in which there is a loss of oxygen or a gain in electrons.
06:11		When writing the ionic equation, why didn't we include the potassium ion?	Ionic equations only include the ions or molecules that actually take part in the reaction. The potassium ions do not take part in the reaction as they are found both at the start and the end. Ions that do not take part are called spectator ions.
06:31		Now write an ionic equation for the reaction of a) chlorine with potassium bromide and b) bromine with potassium iodide.	$Cl_2(aq) + 2Br\text{-}(aq)_{)} \rightarrow Br_2(aq) + 2Cl^-(aq)$ $Br_2(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2Br^-(aq)$
06:48	06:56	From the results of this experiment, what can we conclude about the order of reactivity of the halogens?	Reactivity decreases as you go down the group. Chlorine is more reactive than bromine, which is more reactive than iodine.
06:57		Fluorine is found at the top of group 7 and astatine is found at the bottom. Predict the order of reactivity for the whole group.	Fluorine > chlorine > bromine > iodine > astatine

Pause-and-think questions

Student version

Pause the video at the time stated to test or revise your knowledge of these practical experiments.

Time	Question
00:14	Name the halogens and describe where they are found in the periodic table.
00:45	What do you think is meant by the term 'displacement'? Write a definition in your own words.
01:14	Improve your definition.
	Write a 'general' equation.
01:16	Why are displacement reactions being used in this experiment?
03:09	What will we be looking for during the tests? How will you know if what you are looking for has actually taken place?
	How will you know if what you are looking for has actually taken place?
03:12	Why have some of the boxes in the table been shaded in?
03:32	Why do you think distilled water is added to column 1?

Results Table

Halogen water	Distilled water	Potassium chloride solution	Potassium bromide solution	Potassium iodide solution
Chlorine				
Bromine				
Iodine				

03:46 Complete the first column of your table.

Why does the bromine water and iodine solution appear slightly paler?

____

04:02 Record observations in the second column of your table.

04:19 Predict what changes will take place when potassium bromide is added to the halogen waters.

____

____

05:32 Record observations in the third column of your table.

05:06 Complete the word and balanced symbol equation:

potassium bromide + chlorine → __________ + __________

$2KBr(aq) + Cl_2(aq) \rightarrow$ __________ + __________

05:19 Predict what changes will take place when potassium iodide is added to the halogen waters.

____

____

05:32 Record observations in the final column of your table.

05:48 Complete the word and balanced symbol equations for the two reactions you have observed.

potassium iodide + chlorine → __________ + __________

$2KI(aq) + Cl_2(aq) \rightarrow$ __________ + __________

potassium iodide + ______________ → ___________________________ + ______________

_________ + _________ → __________ + __________

05:56 What is a redox reaction?

____

Define the words oxidation and reduction.

____

____

____

____

06:11 When writing the ionic equation, why didn't we include the potassium ion?

____

____

06:31 Write an ionic equation for the reaction of:

a) chlorine water with potassium bromide

_________ + _________ → __________ + __________

b) bromine water with potassium iodide

_________ + _________ → __________ + __________

06:48 From the results of this experiment, what can we conclude about the order of reactivity of the halogens?

____

____

06:57 Fluorine is found at the top of group 7 and astatine is found at the bottom. Predict the order of reactivity for the whole group.

____

06:58 Now try writing a longer answer to this question using the structure strips:

Group 7 of the periodic table contains the elements known as the halogens. The order of reactivity of the halogens can be determined experimentally by carrying out displacement reactions.

Explain how displacement reactions can be used to show the relative reactivity of chlorine, bromine and iodine.

This question has a structure strip. Find more resources to support you here rsc.li/3tZxFgu.

Halogen displacement Structure strip	Halogen displacement Structure strip	Halogen displacement Structure strip	Halogen displacement Structure strip	Halogen displacement Structure strip
State the order of reactivity of the halogens.	State the order of reactivity of the halogens.	State the order of reactivity of the halogens.	State the order of reactivity of the halogens.	State the order of reactivity of the halogens.
What is a displacement reaction?	What is a displacement reaction?	What is a displacement reaction?	What is a displacement reaction?	What is a displacement reaction?
Choose suitable reactants to show the relative reactivity of **chlorine** and **bromine**.	Choose suitable reactants to show the relative reactivity of **chlorine** and **bromine**.	Choose suitable reactants to show the relative reactivity of **chlorine** and **bromine**.	Choose suitable reactants to show the relative reactivity of **chlorine** and **bromine**.	Choose suitable reactants to show the relative reactivity of **chlorine** and **bromine**.
Describe the change you would observe.	Describe the change you would observe.	Describe the change you would observe.	Describe the change you would observe.	Describe the change you would observe.
Write a balanced symbol equation for the reaction.	Write a balanced symbol equation for the reaction.	Write a balanced symbol equation for the reaction.	Write a balanced symbol equation for the reaction.	Write a balanced symbol equation for the reaction.
Choose suitable reactants to show the relative reactivity of **bromine** and **iodine**.	Choose suitable reactants to show the relative reactivity of **bromine** and **iodine**.	Choose suitable reactants to show the relative reactivity of **bromine** and **iodine**.	Choose suitable reactants to show the relative reactivity of **bromine** and **iodine**.	Choose suitable reactants to show the relative reactivity of **bromine** and **iodine**.
Describe the change you would observe.	Describe the change you would observe.	Describe the change you would observe.	Describe the change you would observe.	Describe the change you would observe.
Write a balanced symbol equation for the reaction.	Write a balanced symbol equation for the reaction.	Write a balanced symbol equation for the reaction.	Write a balanced symbol equation for the reaction.	Write a balanced symbol equation for the reaction.
Choose suitable reactants to show the relative reactivity of **chlorine** and **iodine**.	Choose suitable reactants to show the relative reactivity of **chlorine** and **iodine**.	Choose suitable reactants to show the relative reactivity of **chlorine** and **iodine**.	Choose suitable reactants to show the relative reactivity of **chlorine** and **iodine**.	Choose suitable reactants to show the relative reactivity of **chlorine** and **iodine**.
Describe the change you would observe.	Describe the change you would observe.	Describe the change you would observe.	Describe the change you would observe.	Describe the change you would observe.
Write a balanced symbol equation for the reaction.	Write a balanced symbol equation for the reaction.	Write a balanced symbol equation for the reaction.	Write a balanced symbol equation for the reaction.	Write a balanced symbol equation for the reaction.
Explain how these results will lead to a conclusion about the relative reactivity of the halogens.	Explain how these results will lead to a conclusion about the relative reactivity of the halogens.	Explain how these results will lead to a conclusion about the relative reactivity of the halogens.	Explain how these results will lead to a conclusion about the relative reactivity of the halogens.	Explain how these results will lead to a conclusion about the relative reactivity of the halogens.

Structure strip: suggested answer content

Halogen displacement Structure strip	
State the order of reactivity of the halogens.	The reactivity of the halogens decreases down the group. Therefore, chlorine is more reactive than bromine and bromine is more reactive than iodine.
What is a displacement reaction?	Relative reactivity can be determined using a displacement reaction. A displacement reaction occurs when a more reactive element displaces a less reactive element from a compound.
Choose suitable reactants to show the relative reactivity of **chlorine** and **bromine**.	A suitable reaction to determine the relative reactivity of chlorine and bromine would be the reaction of aqueous chlorine (chlorine water) with potassium bromide (accept any metal iodide).
Describe the change you would observe.	The solution would change from colourless to pale yellow (accept yellow or orange).
Write a balanced symbol equation for the reaction.	chlorine + potassium bromide → bromine + potassium chloride $Cl_2(aq) + 2KBr(aq) \rightarrow Br_2(aq) + 2KCl(aq)$
Choose suitable reactants to show the relative reactivity of **bromine** and **iodine**.	A suitable reaction to determine the relative reactivity of bromine and iodine would be the reaction of bromine water with potassium iodide.
Describe the change you would observe.	The solution would change from pale yellow to brown (accept yellow or orange, red or brown).
Write a balanced symbol equation for the reaction.	bromine + potassium iodide → iodine + potassium bromide $Br_2(aq) + 2KI(aq) \rightarrow I_2(aq) + 2KBr(aq)$
Choose suitable reactants to show the relative reactivity of **chlorine** and **iodine**.	A suitable reaction to determine the relative reactivity of chlorine and iodine would be the reaction of aqueous chlorine (chlorine water) with potassium iodide (accept any metal iodide).
Describe the change you would observe.	The solution would change from colourless to pale yellow (accept yellow or orange).
Write a balanced symbol equation for the reaction.	chlorine + potassium bromide → bromine + potassium chloride $Cl_2(aq) + 2KI(aq) \rightarrow I_2(aq) + 2KCl(aq)$
Explain how these results will lead to a conclusion about the relative reactivity of the halogens.	Since both reactions with chlorine water have resulted in a displacement reaction we can conclude that chlorine is more reactive than bromine and iodine. Chlorine has displaced both of the other halogens from their solution. Chlorine is the most reactive. In the reaction between bromine water and potassium iodide, bromine displaced the iodine from its solution. Therefore we can conclude that bromine is more reactive than iodine. Therefore the order of reactivity is: chlorine > bromine > iodine

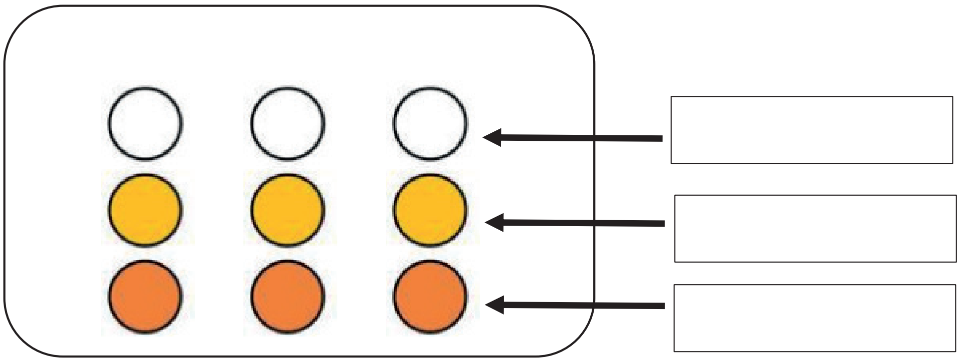
Follow-up worksheet: support

1. Some students decided to investigate the reactivity of the halogens by carrying out a series of displacement reactions.

   They put two drops of chlorine solution in each of three dimples in the spotting tile

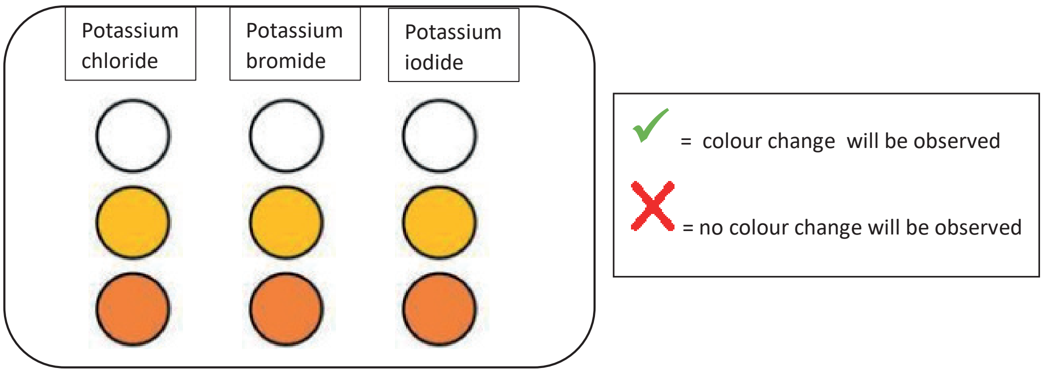
   Then, did the same for bromine water and iodine solution.

   Complete the diagram by adding the following labels: **iodine solution, chlorine water, bromine water**.



2. Next they added two drops of potassium chloride to each dimple in the first column, two drops of potassium bromide in the second column and two drops of potassium iodide in the third column.

   On each circle in the diagram, please put either a tick or a cross to indicate where a reaction will take place:



3. Write the halogens in order of decreasing reactivity:

   ____

   ____

   ____

4. Complete the word equations:

   potassium chloride + bromine → ____________________ + ____________________

   potassium bromide + iodine → ____________________ + ____________________

5. Predict what will be observed if fluorine gas is bubbled through a solution of potassium bromide. (*Hint*: fluorine is found at the top of group 7 on the periodic table.)

   ____

Follow-up worksheet: challenge

1. Define the term ‘displacement reaction’.

2. Complete the results table. State where no reaction will take place and describe the colour change observed where a reaction takes place.

	Reaction with potassium chloride solution	Reaction with potassium bromide solution	Reaction with potassium iodide solution
Chlorine water			
Bromine water			
Iodine solution			

3. Write the halogens in order of decreasing reactivity:

4. In these reactions, the potassium ion is often described as a spectator ion. Explain why?

5. Write a chemical equation for each colour changed observed. The first one has been done for you.

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

6. Predict what will be observed if:

(a) astatine is mixed with sodium bromide solution

(b) fluorine is mixed with sodium iodide solution

Where appropriate you should include a chemical equation.

(a)

(b)

7. The halogens are more soluble in a hydrocarbon solvent than water. When added to a hydrocarbon solvent the following colours are observed.

Halogen	Colour in hydrocarbon solvent
Chlorine	Pale yellow-green
Bromine	Pale yellow-orange
Iodine	Purple

Use this information to answer the following question.

A student mixed some chlorine water with some potassium bromide solution and observed the colour change. He thought that a reaction had taken place but was slightly unsure. Describe another experiment the student could do, to determine whether he was right.

8. The reaction between bromine and potassium iodide can also be described as a redox reaction. Use your knowledge of oxidation and reduction to explain why.

You should include some ionic or half equations in your answer.

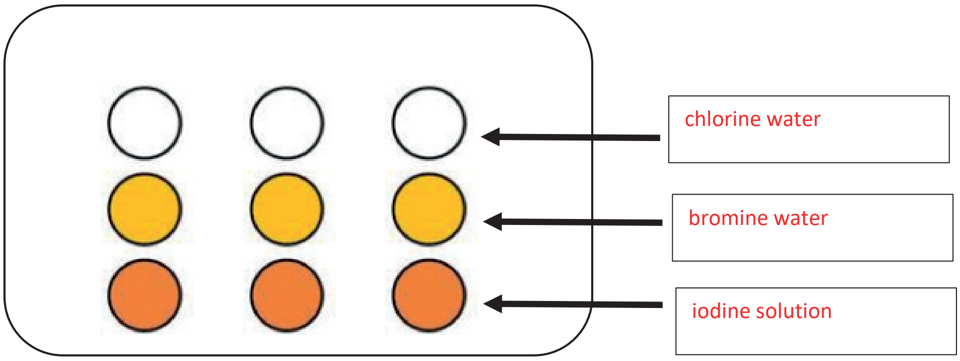
Follow-up worksheet: support ANSWERS

1. Some students decided to investigate the reactivity of the halogens by carrying out a series of displacement reactions.

   They put two drops of chlorine solution in each of three dimples in the spotting tile

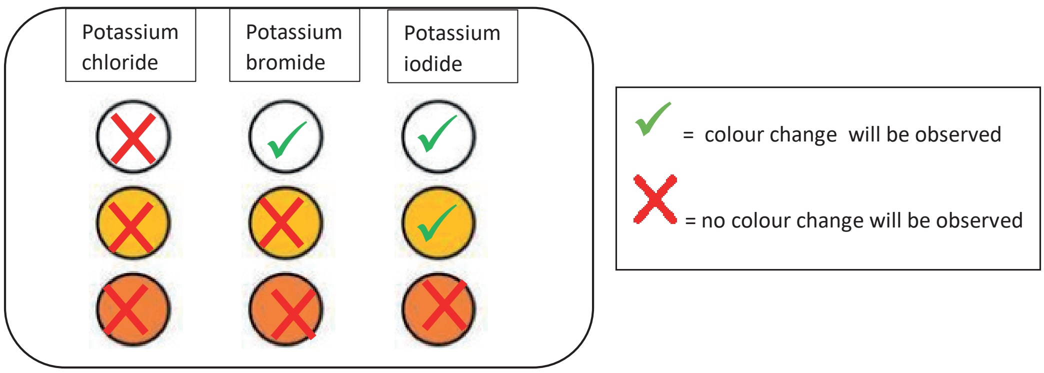
   Then, did the same for bromine water and iodine solution.

   Complete the diagram by adding the following labels: **iodine solution, chlorine water, bromine water**.



2. Next they added two drops of potassium chloride to each dimple in the first column, two drops of potassium bromide in the second column and two drops of potassium iodide in the third column.

   On each circle in the diagram, please put either a tick or a cross to indicate where a reaction will take place:



3. Write the halogens in order of decreasing reactivity:

   Chlorine

   Bromine

   Iodine

4. Complete the word equations:

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

   potassium bromide + iodine → **potassium iodide + bromine**

5. Predict what will be observed if fluorine gas is bubbled through a solution of potassium bromide. (*Hint*: fluorine is found at the top of group 7 on the periodic table.)

   The colourless liquid will turn an orange/ brown colour.

Follow-up worksheet: challenge ANSWERS

1. Define the term 'displacement reaction'.

   A displacement reaction is a type of chemical reaction where part of one reactant is replaced with another reactant:

   $$\mathbf{AB + C \rightarrow AC + B}$$

2. Complete the results table. State where no reaction will take place and describe the colour change observed where a reaction takes place.

	Reaction with potassium chloride solution	Reaction with potassium bromide solution	Reaction with potassium iodide solution
Chlorine water	**No reaction**	**The colourless solution turns a yellow colour**	**The colourless solution goes to a orange-brown colour**
Bromine water	**No reaction**	**No reaction**	**The colour darkens from yellow to orange-brown**
Iodine solution	**No reaction**	**No reaction**	**No reaction**

3. Write the halogens in order of decreasing reactivity:

   Chlorine, bromine, iodine.

4. In these reactions, the potassium ion is often described as a spectator ion. Explain why?

   It does not take part in the reaction as it is present in both the reactants and the products.

5. Write a chemical equation for each colour changed observed. The first one has been done for you.

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

   $$\mathbf{Cl_2(aq) + 2KI(aq) \rightarrow 2KCl(aq) + I_2(aq)}$$

   $$\mathbf{Br_2(aq) + 2KI(aq) \rightarrow 2KBr(aq) + I_2(aq)}$$

6. Predict what will be observed if:

   (a) astatine is mixed with sodium bromide solution

   No changes observed.

   (b) fluorine is mixed with sodium iodide solution

   The solution would turn from colourless to brown.

   $\mathbf{F_2(aq) + 2NaI(aq) \rightarrow 2NaF(aq) + I_2(aq)}$

7. The halogens are more soluble in a hydrocarbon solvent than water. When added to a hydrocarbon solvent the following colours are observed.

Halogen	Colour in hydrocarbon solvent
Chlorine	Pale yellow-green
Bromine	Pale yellow-orange
Iodine	Purple

   Use this information to answer the following question.

   A student mixed some chlorine water with some potassium bromide solution and observed the colour change. He thought that a reaction had taken place but was slightly unsure. Describe another experiment the student could do, to determine whether he was right.

   Put the products into a test tube and add about 1 cm^3 of a non-polar hydrocarbon solvent such as cyclohexane. Stopper the test tube and shake it up. If a pale yellow-orange colour appears in the organic solvent layer, bromine is present and a reaction has taken place. Or if a pale green/yellow colour appears in the organic solvent then chlorine is present and a reaction has not taken place.

8. The reaction between bromine and potassium iodide can also be described as a redox reaction. Use your knowledge of oxidation and reduction to explain why.

You should include some ionic or half equations in your answer.

Oxidation occurs when there is a loss of electron and reduction occurs when there is a gain of electrons.

The ionic equation shows that:

Each bromine atom has gained an electron, so it has been reduced.

Each iodide ion has loss an electron so it has been oxidised

$Br_2(aq) + 2I^-(aq) \rightarrow I_2(aq) + 2Br^-(aq)$

Half equations are:

$Br_2(aq) + 2e^- \rightarrow 2Br^-(aq)$

$2I^-(aq) \rightarrow I_2(aq) + 2e^-$

Halogen water	Distilled water	Reaction with potassium chloride solution	Reaction with potassium bromide solution	Reaction with potassium iodide solution
Chlorine				
Bromine				
Iodine				

Halogen water	Distilled water	Reaction with potassium chloride solution	Reaction with potassium bromide solution	Reaction with potassium iodide solution
Chlorine				
Bromine				
Iodine				

Halogen water	Distilled water	Reaction with potassium chloride solution	Reaction with potassium bromide solution	Reaction with potassium iodide solution
Chlorine				
Bromine				
Iodine				

