CIE Chemistry A-Level

Topic 11 - Group 17

Flashcards

What are the colours and states of chlorine, bromine and iodine at room temperature?

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- Chlorine: yellow-green gas
- Bromine: red-brown liquid
- Iodine: grey solid

Describe and explain the trend in volatility from chlorine to bromine to iodine

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- Volatility decreases down the group.
- This is because the number of electrons per molecule increases, causing stronger van der Waals forces to form.
- More energy is required to overcome these stronger intermolecular forces and so volatility/ boiling point increases.

What is an oxidising agent?

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Elements / compounds that gain electrons to oxidise another element/ compound.

Describe and explain the trend in relative reactivity of the halogens down the group

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- As you go down the group, the oxidising ability of the halogens decreases (reactivity decreases).
- This is because nuclear charge, atomic radius and shielding increase meaning nuclear attraction decreases.
- As a result, it is harder for a halogen atom to gain an electron and act as an oxidising agent further down the group.

How can the reactivity of the halogens as oxidising agents be investigated?

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Using the displacement reactions of halogens with other halides. If a displacement reaction has occurred, there will be a colour change. The results of this experiment are shown below:

Halogen	Displacement	Ionic equation	Oxidising ability
Cl	Chlorine (Cl_2) will displace bromide and iodide ions.	$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$ $Cl_2 + 2I^- \rightarrow 2Cl^- + I_2$	Strongest oxidising agent
Br	Bromine (Br_2) will displace iodide ions.	$Br_2 + 2I^- \rightarrow 2Br^- + I_2$	
I	Iodine (I_2) will not react with chloride or bromide ions	No reactions take place	Weakest oxidising agent

What colours are the halogens in solution?

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Chlorine solution - colourless

Bromine solution - orange

Iodine solution - brown

Write an equation to show how chlorine, reacts with hydrogen

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$$H_2 + Cl_2 \rightarrow 2HCl$$

How do the reactions of group 17 elements with hydrogen show that reactivity decreases down the group?

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- Fluorine reacts explosively with hydrogen, even in a cold atmosphere.
- Chlorine reacts with hydrogen when lightly heated or when exposed to sunlight.
- Bromine reacts with hydrogen if heated with a flame.
- Iodine only partially reacts with hydrogen when heated constantly (equilibrium).

Describe and explain how the thermal stability of hydrogen halides varies

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- Bond enthalpy decreases from H-F to H-I (this is because atomic radius and shielding increase so there is weaker attraction between the nucleus and the bonding electrons).
- This means less energy is required to overcome the hydrogen-halogen bond as you go down the group.
- Thermal stability therefore decreases.

Describe the reactions of halide ions with silver nitrate followed by ammonia

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	Observations upon addition of silver nitrate.	**Observations upon addition of dilute ammonia.**	**Observations upon addition of concentrated ammonia.**
Cl^-	White precipitate of AgCl forms.	White precipitate dissolves to form a colourless solution.	White precipitate dissolves to form a colourless solution.
Br^-	Cream precipitate of AgBr forms.	Precipitate remains.	Cream precipitate dissolves to form a colourless solution.
I^-	Yellow precipitate of AgI forms.	Precipitate remains.	Precipitate remains.

Describe the reactions of NaCl and NaF with concentrated sulfuric acid

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$$NaF + H_2SO_4 \rightarrow NaHSO_4 + HF$$

$$NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$$

(HF and HCl are misty fumes)

HF and HCl are not strong enough reducing agent for further reactions to occur.

Describe the reactions of NaBr with concentrated sulfuric acid

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$NaBr + H_2SO_4 \rightarrow NaHSO_4 + HBr$

(HBr- misty fumes)

HBr is a strong enough reducing agent for a further reaction to occur:

$2HBr + H_2SO_4 \rightarrow Br_2 + SO_2 + 2H_2O$

Describe the reactions of NaI with concentrated sulfuric acid

Describe the reactions of NaI with concentrated sulfuric acid

$NaI + H_2SO_4 \rightarrow NaHSO_4 + HI$

(HI - misty fumes)

HI is a very strong reducing agent meaning 2 further reactions occur:

$2HI + H_2SO_4 \rightarrow I_2 + SO_2 + 2H_2O$

$6HI + SO_2 \rightarrow 3I_2 + H_2S + 2H_2O$

What is a disproportionation reaction?

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A reaction in which the same species is oxidised and reduced.

Write an equation for the reaction of chlorine with cold dilute sodium hydroxide solution. Use oxidation numbers to state what has been oxidised and reduced.

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$2NaOH + Cl_2 \rightarrow NaCl + NaClO + H_2O$

Chlorine has been oxidised from 0 in Cl_2 to +1 in NaClO and reduced from 0 in Cl_2 to -1 in NaCl. This is a disproportionation reaction.

Write an equation for the reaction of chlorine with hot concentrated sodium hydroxide solution. Use oxidation numbers to state what has been oxidised and reduced.

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$$6NaOH + 3Cl_2 \rightarrow 5NaCl + NaClO_3 + 3H_2O$$

The chlorine has been oxidised from 0 in Cl_2 to +5 in $NaClO_3$ and reduced from 0 in Cl_2 to -1 in NaCl. This is a disproportionation reaction.

Why is chlorine used in water purification?

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- Chlorine kills bacteria that could cause disease.
- Removes bad tastes and smells.
- Removes discolouration.
- Prevents growth of algae.
- Chlorine that persists in the water prevents reinfection in the long term.

What are the concerns regarding the use of chlorine in water purification?

What are the concerns regarding the use of chlorine in water purification?

- Chlorine is toxic.
- Chlorine can react with organic matter in water to form potentially cancer causing compounds.

As a small amount of chlorine is added, it is agreed that the benefits outweigh the risks.

What is the industrial importance of halogens and the compounds that they form?

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- Chlorine is used in water purification to kill bacteria and prevent disease.
- Halogens are used in bleaches.
- Halogens are present in PVC (used for windows and drain pipes. When plasticisers are added, PVC is used for electrical cable insulation and clothing).
- Halogenated hydrocarbons are used as solvents, refrigerants and in aerosols.

What is the environmental problem with the use of CFCs (chlorofluorocarbons)?

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- CFCs damage the ozone layer (ozone is in the upper atmosphere and it absorbs a lot of UV radiation).
- CFCs are broken down by UV light, releasing a chlorine radical. This chlorine radical react with ozone and breaks it down:

$$Cl\cdot + O_3 \rightarrow O_2 + ClO\cdot$$

$$ClO\cdot + O_3 \rightarrow 2O_2 + Cl\cdot$$

$$\text{Overall: } 2O_3 \rightarrow 3O_2$$