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# REDUCING POWER OF HALIDES

## 2.5.3 - Reducing power of Halides



When a halide ion reduces another substance, the halide is oxidised to a halogen.

This experiment compares how well the halides reduce  $H_2SO_4$  to compare the reducing power of the halide ions.

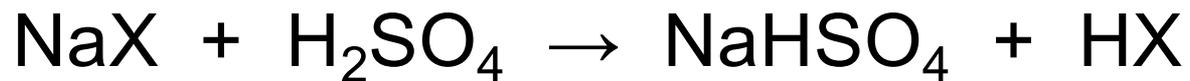
halide	products	observation	reaction type	equation
$\text{Cl}^-$				
$\text{Br}^-$				
$\text{I}^-$				

halide	products	observation	reaction type	equation
$\text{Cl}^-$	HCl	steamy fumes		
$\text{Br}^-$				
$\text{I}^-$				

halide	products	observation	reaction type	equation
$\text{Cl}^-$	HCl	steamy fumes		
$\text{Br}^-$	HBr	steamy fumes		
	$\text{Br}_2$	brown fumes		
	$\text{SO}_2$	colourless gas		
$\text{I}^-$				

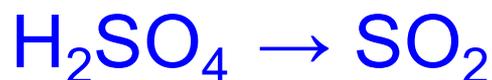
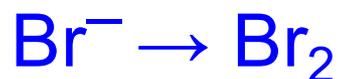
halide	products	observation	reaction type	equation
$\text{Cl}^-$	HCl	steamy fumes		
$\text{Br}^-$	HBr	steamy fumes		
	$\text{Br}_2$	brown fumes		
	$\text{SO}_2$	colourless gas		
$\text{I}^-$	HI	steamy fumes		
	$\text{I}_2$	purple fumes		
	$\text{SO}_2$	colourless gas		
	S	yellow solid		
	$\text{H}_2\text{S}$	gas (bad egg smell)		

Formation of hydrogen halides:



halide	products	observation	reaction type	equation
Cl <sup>-</sup>	HCl	steamy fumes	acid-base	$\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$
Br <sup>-</sup>	HBr Br <sub>2</sub> SO <sub>2</sub>	steamy fumes brown fumes colourless gas	acid-base	$\text{NaBr} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HBr}$
I <sup>-</sup>	HI I <sub>2</sub> SO <sub>2</sub> S H <sub>2</sub> S	steamy fumes purple fumes colourless gas yellow solid gas (bad egg smell)	acid-base	$\text{NaI} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HI}$

Write half equations for:



halide	products	observation	reaction type	equation
Cl <sup>-</sup>	HCl	steamy fumes	acid-base	$\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$
Br <sup>-</sup>	HBr	steamy fumes	acid-base	$\text{NaBr} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HBr}$
	Br <sub>2</sub>	brown fumes		$2 \text{Br}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{Br}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
	SO <sub>2</sub>	colourless gas		$2 \text{Br}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{Br}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
I <sup>-</sup>	HI	steamy fumes	acid-base	$\text{NaI} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HI}$
	I <sub>2</sub>	purple fumes		
	SO <sub>2</sub>	colourless gas		
	S	yellow solid		
	H <sub>2</sub> S	gas (bad egg smell)		

halide	products	observation	reaction type	equation
Cl <sup>-</sup>	HCl	steamy fumes	acid-base	$\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$
Br <sup>-</sup>	HBr	steamy fumes	acid-base	$\text{NaBr} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HBr}$
	Br <sub>2</sub>	brown fumes		$2 \text{Br}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{Br}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
	SO <sub>2</sub>	colourless gas		$2 \text{Br}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{Br}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
I <sup>-</sup>	HI	steamy fumes	acid-base	$\text{NaI} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HI}$
	I <sub>2</sub>	purple fumes		$2 \text{I}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{I}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
	SO <sub>2</sub>	colourless gas		$2 \text{I}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{I}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
	S	yellow solid		$6 \text{I}^- + \text{H}_2\text{SO}_4 + 6 \text{H}^+ \rightarrow 3 \text{I}_2 + \text{S} + 4 \text{H}_2\text{O}$
	H <sub>2</sub> S	gas (bad egg smell)		$8 \text{I}^- + \text{H}_2\text{SO}_4 + 8 \text{H}^+ \rightarrow 4 \text{I}_2 + \text{H}_2\text{S} + 4 \text{H}_2\text{O}$

halide	products	observation	reaction type	equation
Cl <sup>-</sup>	HCl	steamy fumes	acid-base	$\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$
Br <sup>-</sup>	HBr	steamy fumes	acid-base	$\text{NaBr} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HBr}$
	Br <sub>2</sub>	brown fumes	oxidation of Br <sup>-</sup>	$2 \text{Br}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{Br}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
	SO <sub>2</sub>	colourless gas	reduction of H <sub>2</sub> SO <sub>4</sub>	$2 \text{Br}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{Br}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
I <sup>-</sup>	HI	steamy fumes	acid-base	$\text{NaI} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HI}$
	I <sub>2</sub>	purple fumes		$2 \text{I}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{I}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
	SO <sub>2</sub>	colourless gas		$2 \text{I}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{I}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
	S	yellow solid		$6 \text{I}^- + \text{H}_2\text{SO}_4 + 6 \text{H}^+ \rightarrow 3 \text{I}_2 + \text{S} + 4 \text{H}_2\text{O}$
	H <sub>2</sub> S	gas (bad egg smell)		$8 \text{I}^- + \text{H}_2\text{SO}_4 + 8 \text{H}^+ \rightarrow 4 \text{I}_2 + \text{H}_2\text{S} + 4 \text{H}_2\text{O}$

halide	products	observation	reaction type	equation
Cl <sup>-</sup>	HCl	steamy fumes	acid-base	$\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$
Br <sup>-</sup>	HBr	steamy fumes	acid-base	$\text{NaBr} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HBr}$
	Br <sub>2</sub>	brown fumes	oxidation of Br <sup>-</sup>	$2 \text{Br}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{Br}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
	SO <sub>2</sub>	colourless gas	reduction of H <sub>2</sub> SO <sub>4</sub>	$2 \text{Br}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{Br}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
I <sup>-</sup>	HI	steamy fumes	acid-base	$\text{NaI} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HI}$
	I <sub>2</sub>	purple fumes	oxidation of I <sup>-</sup>	$2 \text{I}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{I}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
	SO <sub>2</sub>	colourless gas	reduction of H <sub>2</sub> SO <sub>4</sub>	$2 \text{I}^- + \text{H}_2\text{SO}_4 + 2 \text{H}^+ \rightarrow \text{I}_2 + \text{SO}_2 + 2 \text{H}_2\text{O}$
	S	yellow solid	reduction of H <sub>2</sub> SO <sub>4</sub>	$6 \text{I}^- + \text{H}_2\text{SO}_4 + 6 \text{H}^+ \rightarrow 3 \text{I}_2 + \text{S} + 4 \text{H}_2\text{O}$
	H <sub>2</sub> S	gas (bad egg smell)	reduction of H <sub>2</sub> SO <sub>4</sub>	$8 \text{I}^- + \text{H}_2\text{SO}_4 + 8 \text{H}^+ \rightarrow 4 \text{I}_2 + \text{H}_2\text{S} + 4 \text{H}_2\text{O}$

# Reducing power trend

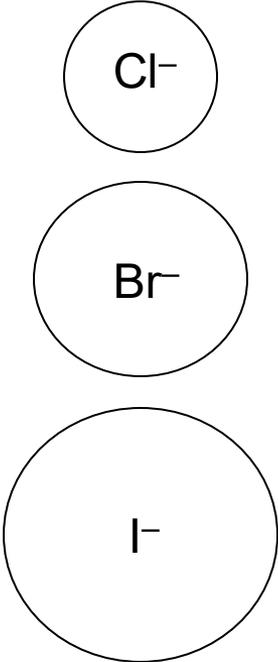
$\text{Cl}^-$  does not reduce  $\text{H}_2\text{SO}_4$

$\text{Br}^-$  reduces  $\text{H}_2\text{SO}_4$  from S(+6) to S(+4)

$\text{I}^-$  reduces  $\text{H}_2\text{SO}_4$  from S(+6) to S(-2)

# Reducing power trend: $\text{Cl}^- < \text{Br}^- < \text{I}^-$

When a halide ion acts as a reducing agent, it loses electrons (given to the reduced species).



$\text{Cl}^-$

$\text{Br}^-$

$\text{I}^-$

Down the group it becomes **easier** to lose an electron because:

ions are **larger** & there is **more shielding** (due to extra electron shell)