



# Energy Changes of Salts



## Part A $\text{CaCl}_2$ or $\text{CaCl}$ ?

Which statement helps to explain why calcium and chlorine form  $\text{CaCl}_2$  rather than  $\text{CaCl}$  ?

- ☐ More energy is released in forming chloride ions from chlorine molecules in the formation of  $\text{CaCl}_2(\text{s})$  than in the formation of  $\text{CaCl}(\text{s})$ .
- ☐ When  $\text{CaCl}(\text{s})$  is formed from its elements, more energy is released than when  $\text{CaCl}_2(\text{s})$  is formed from its elements.
- ☐ Less energy is required to remove one electron from the calcium atom than to remove two electrons.
- ☐ The lattice energy of  $\text{CaCl}(\text{s})$  is less exothermic than that of  $\text{CaCl}_2(\text{s})$ .

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## Part B Enthalpy of solution of magnesium chloride

The lattice enthalpy of magnesium chloride is  $+2493 \text{ kJ mol}^{-1}$ . The hydration enthalpy of the magnesium ion is  $-1920 \text{ kJ mol}^{-1}$  and that of the chloride ion is  $-364 \text{ kJ mol}^{-1}$ .

The enthalpy of solution (in  $\text{kJ mol}^{-1}$ ) of magnesium chloride in water is given by:

☐  $+2493 + 1920 - (2 \times 364)$

☐  $-2493 - 1920 - 364$

☐  $+2493 - 1920 - (2 \times 364)$

☐  $+2493 - 1920 - 364$

☐  $-2493 + 1920 + (2 \times 364)$

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# Decomposition of Salts

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## Part A Calcium sulfate and carbonate

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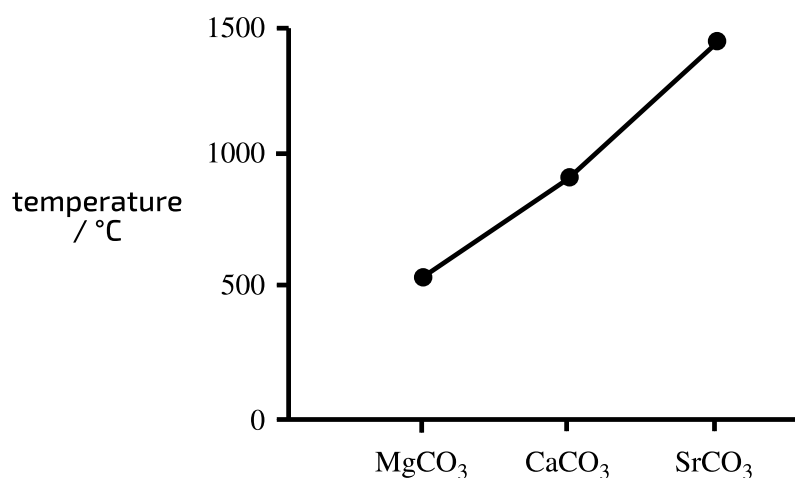
On strong heating,  $\text{CaSO}_4$  decomposes into  $\text{CaO}$  and  $\text{SO}_3$ . The compound  $\text{CaCO}_3$  decomposes at a lower temperature than  $\text{CaSO}_4$ .

Which factor best explains the greater thermal stability of  $\text{CaSO}_4$ ?

- ☐  $\text{CO}_2$  is a smaller molecule than  $\text{SO}_3$ .
  - ☐  $\text{CaCO}_3$  has a higher lattice energy than  $\text{CaSO}_4$ .
  - ☐ The charge density of  $\text{CO}_3^{2-}$  is greater than that of  $\text{SO}_4^{2-}$ .
  - ☐  $\text{CO}_3^{2-}$  ions are more easily polarised than  $\text{SO}_4^{2-}$ .
-

## Part B Group 2 carbonates

The graph shows the decomposition temperature for the Group 2 carbonates of magnesium, calcium and strontium.



**Figure 1:** Decomposition temperatures of Group 2 carbonates

Which factor makes MgCO<sub>3</sub> the least thermally stable?

- ☐ a small cation polarising a small anion
- ☐ a small cation polarising a large anion
- ☐ a large cation polarising a small anion
- ☐ a large cation polarising a large anion

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# Intermolecular Forces

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A Level

## Part A Liquid hydrogen halides

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Which quantity would best indicate the relative strengths of the hydrogen bond between the molecules in liquid hydrogen halides?

- ☐ bond dissociation energies
  - ☐ enthalpy changes of formation
  - ☐ enthalpy changes of vaporisation
  - ☐ enthalpy changes of solution
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## Part B Propanone and hexane

Propanone is much more soluble than hexane in water.

Which statement helps to account for this?

- ☐ A hydrogen bond forms between the hydrogen of the  $\text{CH}_3$  group in propanone and the oxygen of a water molecule
  - ☐ A hydrogen bond forms between the oxygen of the  $\text{C}=\text{O}$  group in propanone and the hydrogen of a water molecule
  - ☐ A hydrogen bond forms between the oxygen of the  $\text{C}=\text{O}$  group in propanone and the oxygen of a water molecule
  - ☐ A hydrogen bond forms between the hydrogen of the  $\text{CH}_3$  group in propanone and the hydrogen of a water molecule
- 

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# Ionisation Energy and Radii

## Part A Ionisation energy

The elements radon ( $\text{Rn}$ ), francium ( $\text{Fr}$ ) and radium ( $\text{Ra}$ ) have consecutive proton numbers in the Periodic Table.

What is the order of their first ionisation energies?

	least endothermic	$\longrightarrow$	most endothermic
<b>A</b>	Fr	Ra	Rn
<b>B</b>	Fr	Rn	Ra
<b>C</b>	Ra	Fr	Rn
<b>D</b>	Rn	Ra	Fr

- ☐ **A**
- ☐ **B**
- ☐ **C**
- ☐ **D**

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**Part B    Radii**

The following species contain the same number of electrons.

In which order do their radii increase?

	smallest radius	→	largest radius
<b>A</b>	Ar	$\text{K}^+$	$\text{Ca}^{2+}$
<b>B</b>	$\text{Ca}^{2+}$	Ar	$\text{K}^+$
<b>C</b>	$\text{Ca}^{2+}$	$\text{K}^+$	Ar
<b>D</b>	$\text{K}^+$	$\text{Ca}^{2+}$	Ar

☐ **A**

☐ **B**

☐ **C**

☐ **D**

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## More Periodic Trends

The graphs below show how a property of the elements Na to Cl varies with proton number.

What is the property of each trend?

### Part A Trend 1

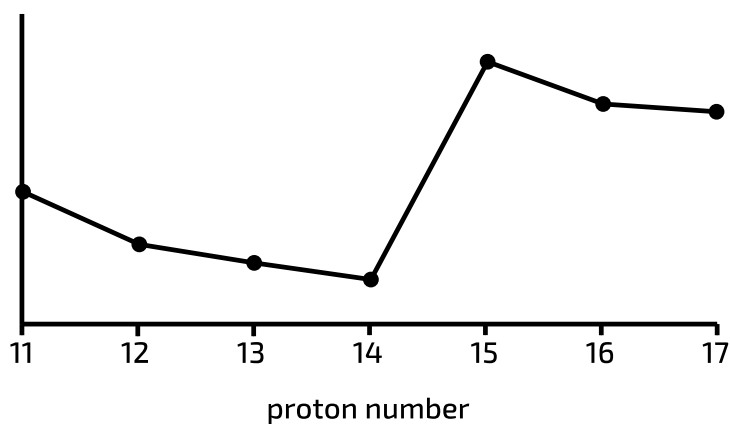
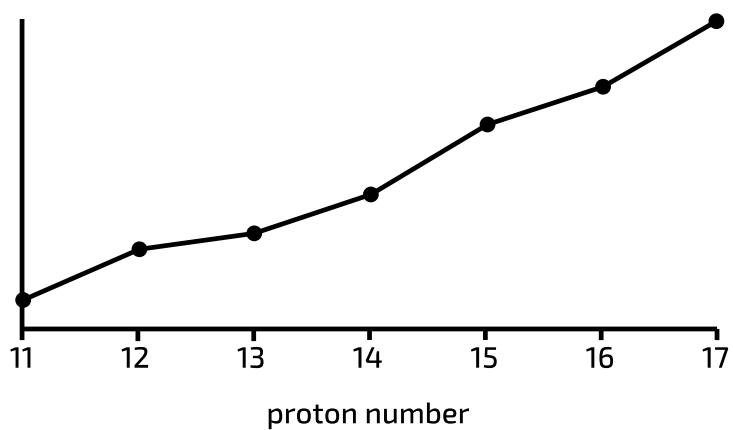


Figure 1: Trend 1 of the elements Na to Cl with proton number

What is the property?

- ☐ ionic radius
- ☐ electronegativity
- ☐ first ionisation energy
- ☐ melting point

## Part B Trend 2



**Figure 2:** Trend 2 of the elements Na to Cl with proton number

What is the property?

- ☐ ionic radius
- ☐ melting point
- ☐ first ionisation energy
- ☐ electronegativity

Part C Trend 3

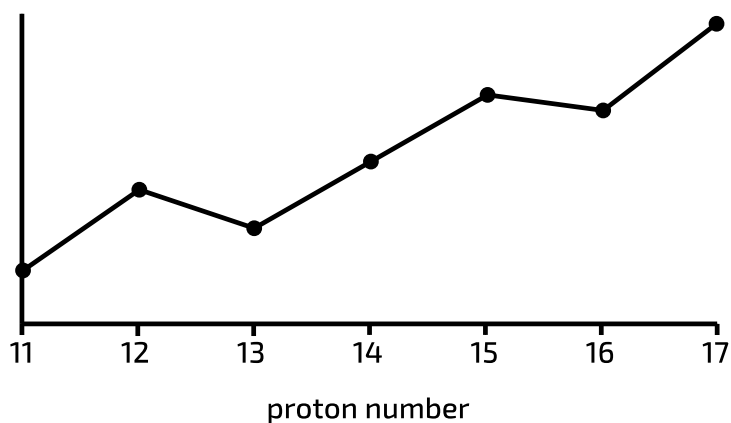


Figure 3: Trend 3 of the elements Na to Cl with proton number

What is the property?

- ☐ melting point
- ☐ first ionisation energy
- ☐ ionic radius
- ☐ electronegativity

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# Groups 1 and 2



## Part A Lithium compounds

Lithium resembles magnesium in its chemical properties.

Which property of lithium compounds is unlikely to be correct?

- ☐ Lithium oxide in water produces a solution with pH greater than 7.
- ☐ Lithium nitrate gives oxygen as the only gas on being heated.
- ☐ Lithium sulfate is soluble in water.
- ☐ Lithium carbonate decomposes to give carbon dioxide on being heated.

## Part B Group 2 trends

On descending Group 2 from magnesium to barium, which statement correctly describes the trend in properties?

- ☐ The first ionisation energy increases.
- ☐ The ionic radius decreases.
- ☐ The solubility of the sulfate increases.
- ☐ The enthalpy change of hydration of the +2 ion becomes less negative.



## Group 2 Salts

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### Part A Silver nitrate and barium chloride

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An **excess** of aqueous silver nitrate is added to aqueous barium chloride, and the precipitate is removed by filtration.

What are the main ions in the filtrate?

- ☐  $\text{Ba}^{2+}$  and  $\text{NO}_3^-$  only
  - ☐  $\text{Ag}^+$  and  $\text{NO}_3^-$  only
  - ☐  $\text{Ba}^{2+}$ ,  $\text{NO}_3^-$  and  $\text{Cl}^-$
  - ☐  $\text{Ag}^+$ ,  $\text{Ba}^{2+}$  and  $\text{NO}_3^-$
-

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## Part B Salts with dilute hydrochloric acid

When a mixture of white solids, **F**, is treated with an excess of dilute hydrochloric acid, a colourless gas is evolved and some, but not all, of the mixture dissolves.

Which mixture could be **F**?

- ☐  $\text{Ca(OH)}_2$  and  $\text{MgCO}_3$
  - ☐  $\text{CaCO}_3$  and  $\text{MgSO}_4$
  - ☐  $\text{Ba(NO}_3)_2$  and  $\text{Ca(OH)}_2$
  - ☐  $\text{BaSO}_4$  and  $\text{CaCO}_3$
- 

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# Halogen Trends

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## Part A Periodic trends

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Which statements about the trends in the properties of the halogens are correct?

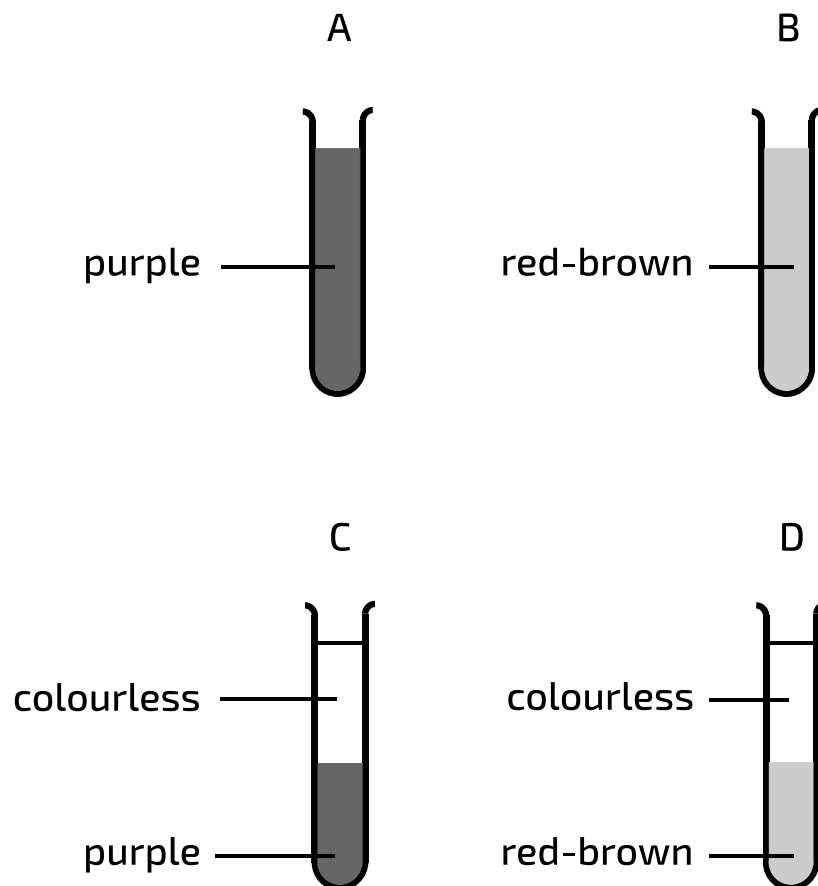
1. The electronegativity decreases on descending the group.
2. The volatility decreases on descending the group.
3. Their reactivity as oxidising agents decreases on descending the group.

- ☐ 1, 2 and 3 are correct
- ☐ 1 and 2 only are correct
- ☐ 2 and 3 only are correct
- ☐ 1 only is correct
- ☐ 3 only is correct
-

## Part B Oxidation and reduction

Aqueous chlorine is added to aqueous sodium bromide and the mixture is shaken with an equal volume of trichloroethane.

Which observation would be made?



**Figure 1:** Possible observations of aqueous chlorine with aqueous sodium bromide and an equal volume of trichloroethane

- ☐ A
- ☐ B
- ☐ C
- ☐ D





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# Halides Oxidation and Reduction



## Part A Reactions of chlorine

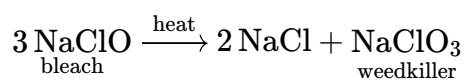
Which compound reacts with chlorine to give two products in which chlorine has different oxidation numbers?

- ☐ sodium hydroxide
- ☐ potassium iodate(V)
- ☐ ethene
- ☐ potassium iodide

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**Part B    Weedkiller from bleach**

A weedkiller can be prepared by heating a bleach solution.



What are the oxidation numbers of chlorine in these three compounds?

	NaClO	NaCl	NaClO <sub>3</sub>
<b>A</b>	−1	−1	+5
<b>B</b>	+1	−1	+5
<b>C</b>	+1	−1	+7
<b>D</b>	+2	+1	+7

☐ **A**

☐ **B**

☐ **C**

☐ **D**

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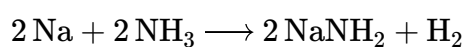


# Oxidation Numbers



## Part A Sodium with ammonia

Sodium reacts with ammonia to give hydrogen and sodamide which is ionic.



Which changes in oxidation number of the three elements involved occur?

1.  $-3$  to  $-2$

2.  $0$  to  $+1$

3.  $+1$  to  $0$

- ☐ 1, 2 and 3 are correct
- ☐ 1 and 2 only are correct
- ☐ 2 and 3 only are correct
- ☐ 1 only is correct
- ☐ 3 only is correct

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**Part B    Titanium**

Titanium is manufactured from ilmenite which is a mixture of iron(II) titanate,  $\text{FeTiO}_3$ , and iron(III) titanate,  $\text{Fe}_2(\text{TiO}_3)_3$ .

What is the oxidation number of titanium in each of these compounds?

	$\text{FeTiO}_3$	$\text{Fe}_2(\text{TiO}_3)_3$
<b>A</b>	+2	+3
<b>B</b>	+4	+2
<b>C</b>	+4	+3
<b>D</b>	+4	+4

- ☐ **A**
- ☐ **B**
- ☐ **C**
- ☐ **D**
- 

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