



Energy Changes of Salts

A Level



Part A CaCl_2 or CaCl ?

Which statement helps to explain why calcium and chlorine form CaCl_2 rather than CaCl ?

- ☐ 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 $\text{CaCl}_2(\text{s})$.
- ☐ 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 $\text{CaCl}(\text{s})$.

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 kJ mol^{-1} .

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

- ☐ $+2493 - 1920 - 364$
- ☐ $+2493 + 1920 - (2 \times 364)$
- ☐ $-2493 - 1920 - 364$
- ☐ $+2493 - 1920 - (2 \times 364)$
- ☐ $-2493 + 1920 + (2 \times 364)$

Intermolecular Forces



Part A Liquid hydrogen halides

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

- ☐ enthalpy changes of vaporisation
- ☐ bond dissociation energies
- ☐ enthalpy changes of solution
- ☐ enthalpy changes of formation

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 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 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 hydrogen of the CH_3 group in propanone and the hydrogen of a water molecule



Ionisation Energy and Radii

Part A Ionisation energy

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

What is the order of their first ionisation energies?

	least endothermic	→	most endothermic
A	Fr	Ra	Rn
B	Fr	Rn	Ra
C	Ra	Fr	Rn
D	Rn	Ra	Fr

- ☐ A
- ☐ B
- ☐ C
- ☐ D

Part B Radii

The following species contain the same number of electrons.

In which order do their radii increase?

	smallest radius	→	largest radius
A	Ar	K^+	Ca^{2+}
B	Ca^{2+}	Ar	K^+
C	Ca^{2+}	K^+	Ar
D	K^+	Ca^{2+}	Ar

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

Part A adapted with permission from UCLES, A-Level Chemistry, November 1999, Paper 3, Question 4;
Part B adapted with permission from UCLES, A-Level Chemistry, November 1999, Paper 3, Question 13

Gameboard:

STEM SMART Chemistry Week 30

All materials on this site are licensed under the **Creative Commons license**, unless stated otherwise.



Physics. You work it out.

[Home](#) [Gameboard](#) [Chemistry](#) [Inorganic](#) [Periodic Table](#) [More Periodic Trends](#)

More Periodic Trends

A Level
P P P

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

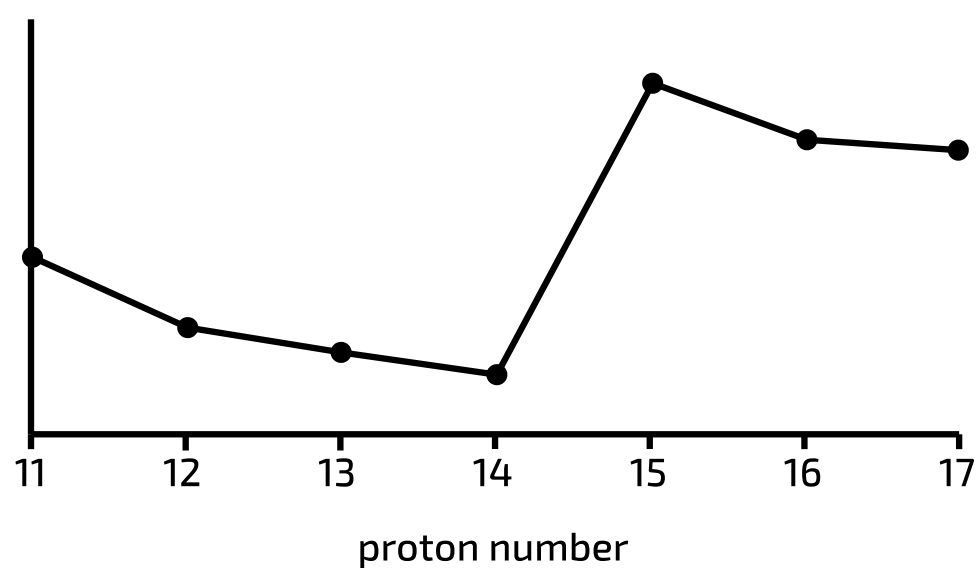


Figure 1: Trend 1 of the elements Na to Cl with proton number

What is the property?

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

Part B Trend 2

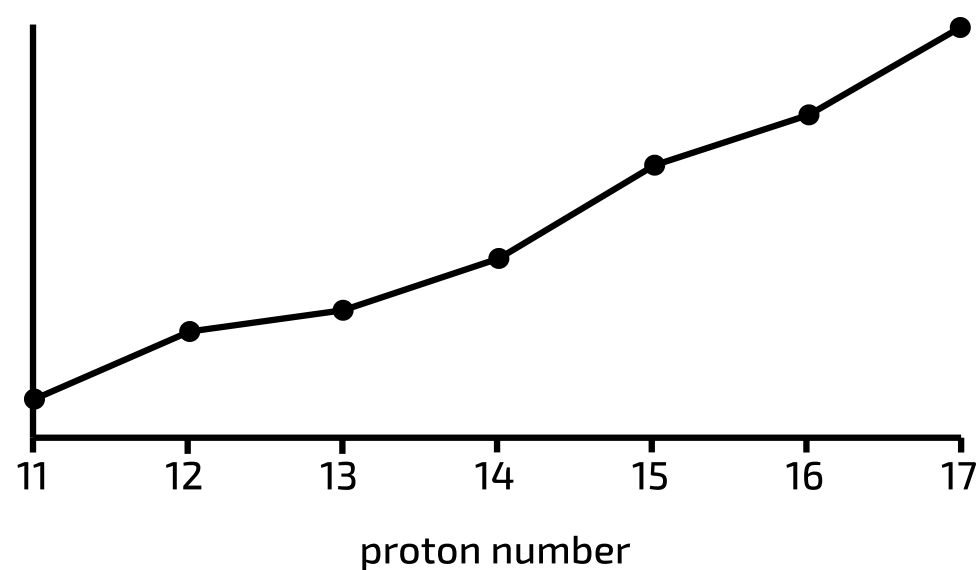


Figure 2: Trend 2 of the elements Na to Cl with proton number

What is the property?

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

Part C Trend 3

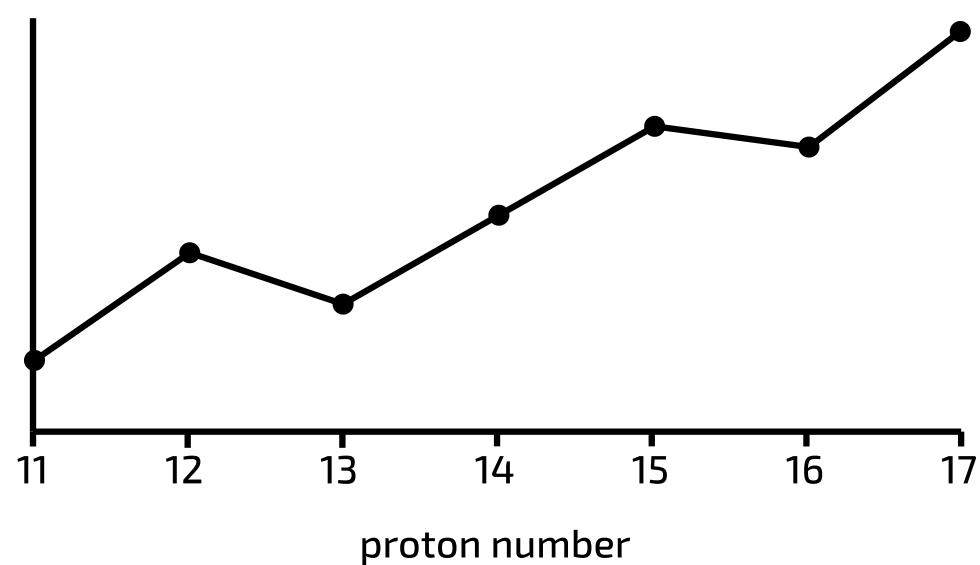


Figure 3: Trend 3 of the elements Na to Cl with proton number

What is the property?

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

Part A adapted with permission from UCLES, A-Level Chemistry, June 1996, Paper 3, Question 12;
Parts B, C created for Isaac Physics by R. Less

Gameboard:

STEM SMART Chemistry Week 30

All materials on this site are licensed under the [Creative Commons license](https://creativecommons.org/licenses/by/4.0/), unless stated otherwise.

Groups 1 and 2

A Level



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 carbonate decomposes to give carbon dioxide on being heated.
- ☐ Lithium sulfate is soluble in water.
- ☐ Lithium nitrate gives oxygen as the only gas 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 enthalpy change of hydration of the $+2$ ion becomes less negative.
- ☐ The solubility of the sulfate increases.
- ☐ The first ionisation energy increases.
- ☐ The ionic radius decreases.

Group 2 Salts

A Level



Part A Silver nitrate and barium chloride

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?

- ☐ Ag^+ , Ba^{2+} and NO_3^-
 - ☐ Ba^{2+} and NO_3^- only
 - ☐ Ag^+ and NO_3^- only
 - ☐ Ba^{2+} , NO_3^- and Cl^-
-

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**?

- ☐ $\text{Ca}(\text{OH})_2$ and MgCO_3
 - ☐ BaSO_4 and CaCO_3
 - ☐ CaCO_3 and MgSO_4
 - ☐ $\text{Ba}(\text{NO}_3)_2$ and $\text{Ca}(\text{OH})_2$
-

Halogen Trends

A Level



Part A Periodic trends

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?

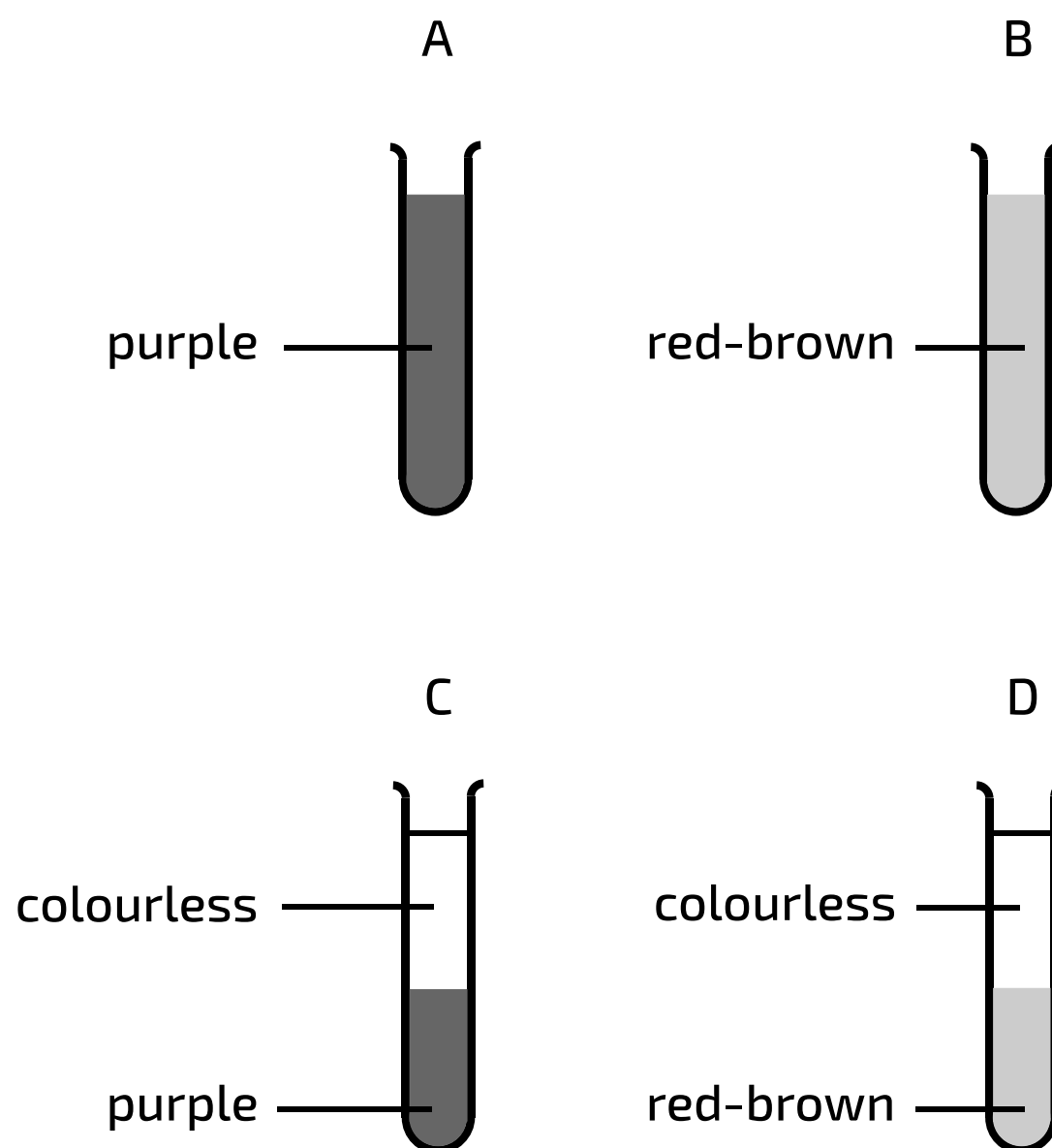


Figure 1: Possible observations of aqueous chlorine with aqueous sodium bromide and an equal volume of trichloroethane

- ☐ A
- ☐ B
- ☐ C
- ☐ D

Part A adapted with permission from UCLES, A-Level Chemistry, November 1998, Paper 3, Question 36;
Part B adapted with permission from UCLES, A-Level Chemistry, November 1996, Paper 4, Question 15

Gameboard:

STEM SMART Chemistry Week 30



Physics. *You work it out.*

[Home](#) [Gameboard](#) [Chemistry](#) [Inorganic](#) [Periodic Table](#) [Halides Oxidation and Reduction](#)

Halides Oxidation and Reduction

A Level

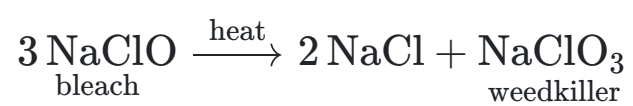

Part A Reactions of chlorine

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

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

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 ₃
A	−1	−1	+5
B	+1	−1	+5
C	+1	−1	+7
D	+2	+1	+7

- ☐ A
- ☐ B
- ☐ C
- ☐ D

Part A adapted with permission from UCLES, A-Level Chemistry, June 1996, Paper 3, Question 15;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1999, Paper 3, Question 17

Gameboard:

STEM SMART Chemistry Week 30

All materials on this site are licensed under the **Creative Commons license**, unless stated otherwise.

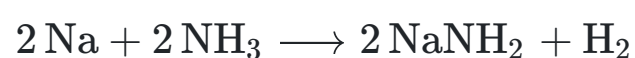
Oxidation Numbers

A Level



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

Part B Titanium

Titanium is manufactured from ilmenite which is a mixture of iron(II) titanate, 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?

	FeTiO_3	$\text{Fe}_2(\text{TiO}_3)_3$
A	+2	+3
B	+4	+2
C	+4	+3
D	+4	+4

- ☐ A
- ☐ B
- ☐ C
- ☐ D

Part A adapted with permission from UCLES, A-Level Chemistry, June 1999, Paper 3, Question 33;

Part B adapted with permission from UCLES, A-Level Chemistry, November 1997, Paper 3, Question 13

Gameboard:

STEM SMART Chemistry Week 30

All materials on this site are licensed under the [Creative Commons license](#), unless stated otherwise.

Hydroxylamine and Iron(III)

A Level

The following experiment was used to determine the equation for the reaction between hydroxylamine, NH_2OH , and iron(III) ions. 0.0370 g of hydroxylamine was dissolved in water and made up to 25.0 cm^3 . This solution was reacted with an excess of an acidified solution of an iron(III) salt. When the reaction was complete the iron(II) produced required 22.4 cm^3 of $0.0200 \text{ mol dm}^{-3}$ potassium manganate(VII) solution to oxidise the iron(II) back to iron(III).

Part A Hydroxylamine oxidation number

What is the oxidation number of nitrogen in hydroxylamine, NH_2OH ?

Part B Oxidation of iron(II)

Write down the half-equation for the oxidation of iron(II) to iron(III) ions.

Part C Reduction of manganate(VII)

Write down the half-equation for the reduction of manganate(VII) to manganese(II) ions under acidic conditions.

Part D **Ionic equation**

Deduce the ionic equation for the reaction between iron(II) ions and manganate(VII) ions under acidic conditions.

Part E **Moles of hydroxylamine**

Calculate the amount, in moles, of hydroxylamine used in the reaction.

Part F **Moles of iron(II)**

Calculate the amount, in moles, of iron(II) formed in the reaction.

Part G **Molar ratio of iron(III) to hydroxylamine**

Determine the molar ratio of iron(III) to hydroxylamine reacting together.

Part H **Oxidation number of nitrogen in the product**

Using the oxidation number of nitrogen in hydroxylamine, and the molar ratio of iron(III) to hydroxylamine, deduce the oxidation number of nitrogen in the product.

Part I Nitrogen-containing product

Which of the following possible nitrogen-containing compounds is the most likely product of the reaction?

- ☐ NO
- ☐ N₂O
- ☐ NH₃
- ☐ N₂O₄
- ☐ N₂
-

Part J Hydroxylamine and iron(III) equation

Write the equation for the reaction between hydroxylamine and iron(III) ions. State symbols are not required.

Adapted with permission from OCSEB, A-Level Chemistry, June 1995, Paper 3/4, Question 5.

All materials on this site are licensed under the [Creative Commons license](#), unless stated otherwise.