

# Electrons, Bonding & Structure

## AS & A Level

### Question Paper 1

Level	A Level
Subject	Chemistry
Exam Board	OCR
Module	Foundations in Chemistry
Topic	Electrons, Bonding & Structure
Paper	AS & A Level
Booklet	Question Paper 1

**Time allowed:** 86 minutes

**Score:** /64

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E
>85%	73%	60%	47%	34%	21%

## Question 1

This question is about compounds of Group 3 elements.

- (a) Aluminium will combine directly with fluorine.

Write the equation for the reaction between aluminium and fluorine. [1]

- (b) Solid aluminium fluoride has a giant ionic lattice structure.

- (i) Describe what is meant by the term *ionic lattice*, in terms of the type and arrangement of particles present. [2]

- (ii) Draw a '*dot-and-cross*' diagram for aluminium fluoride. [2]

Show outer electrons only.

(c) Solid boron tribromide has a simple molecular lattice structure. The atoms are held together by covalent bonds.

(i) What is meant by the term *covalent bond*? [1]

(ii) Draw a '*dot-and-cross*' diagram to show the bonding in a boron tribromide molecule.

Show outer electrons only. [1]

(d) State whether the following substances conduct electricity when solid or molten, and explain your answers in terms of the particles involved:

- aluminium
- aluminium fluoride
- boron tribromide.

*In your answer you should use appropriate technical terms, spelled correctly.* [5]

(e) Aluminium has 13 successive ionisation energies.

(i) Write the equation for the **third** ionisation energy of aluminium.

Include state symbols.

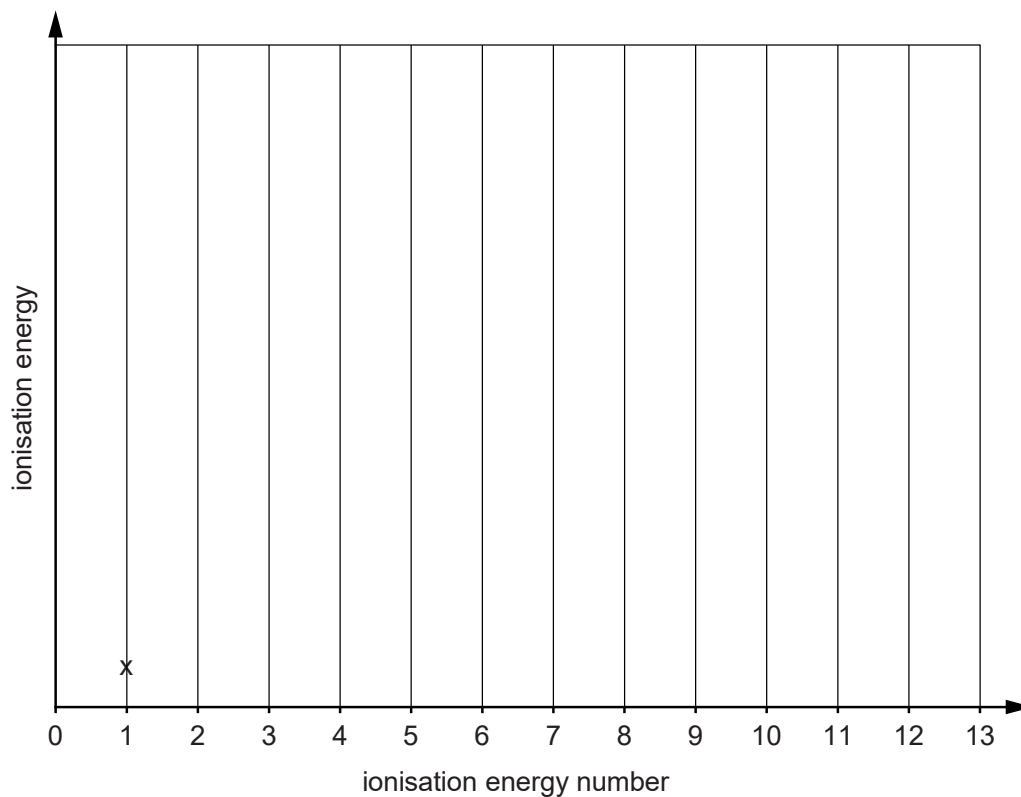
[1]

(ii) On the axes below, add crosses to show the 13 successive ionisation energies of aluminium.

The value for the first ionisation energy has been completed for you.

[2]

You do not have to join the crosses.



[Total 15 Marks]

## Question 2

Oxides can have different types of bonding.

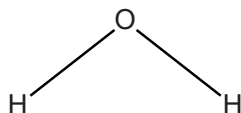
(a)  $\text{H}_2\text{O}$  has hydrogen bonding.

- (i) Complete the diagram below to show hydrogen bonding between the  $\text{H}_2\text{O}$  molecule shown and **one** other  $\text{H}_2\text{O}$  molecule.

Include relevant dipoles and lone pairs.

Label the hydrogen bond.

[2]



- (ii) State and explain **two** anomalous properties of ice caused by hydrogen bonding.

[4]

(b) Draw a 'dot-and-cross' diagram to show the bonding in  $\text{CO}_2$ .

[1]

Show outer electrons only.

(c) Silicon dioxide,  $\text{SiO}_2$ , has the same structure and bonding as diamond.

State the structure and bonding in  $\text{SiO}_2$ .

[1]

(d) Describe and explain the electrical conductivity of sodium oxide,  $\text{Na}_2\text{O}$ , and sodium in their solid and molten states.



*In your answer you should use appropriate technical terms, spelled correctly.*

[5]

[Total 13 Marks ]

### Question 3

This question is about different models of bonding and molecular shapes.

(a) Magnesium sulfide shows ionic bonding.

(i) What is meant by the term *ionic bonding*? [1]

(ii) Draw a 'dot-and-cross' diagram to show the bonding in magnesium sulfide. Show outer electron shells only. [2]

(b) 'Dot-and-cross' diagrams can be used to predict the shape of covalent molecules.

Fluorine has a covalent oxide called difluorine oxide,  $F_2O$ . The oxygen atom is covalently bonded to each fluorine atom.

(i) Draw a 'dot-and-cross' diagram of a molecule of  $F_2O$ . Show outer electron shells only. [2]

(ii) Predict the bond angle in an  $F_2O$  molecule. Explain your answer. [3]

(c) Liquid ammonia,  $NH_3$ , and water,  $H_2O$ , both show hydrogen bonding.

(i) Draw a labelled diagram to show hydrogen bonding between two molecules of liquid **ammonia**. [3]

(ii) Water has several anomalous properties as a result of its hydrogen bonding.

Describe and explain **one** anomalous property of water which results from hydrogen bonding. [2]

[Total: 13 Marks]

## Question 4

Chemists have developed models for bonding and structure which are used to explain different properties.

(a) Ammonia,  $\text{NH}_3$ , is a covalent compound.

(i) Explain what is meant by a *covalent bond*. [1]

(ii) Draw a '*dot-and-cross*' diagram to show the bonding in  $\text{NH}_3$ .

Show **outer** electrons only. [1]

(iii) Name the shape of the ammonia molecule.

Explain, using your '*dot-and-cross*' diagram, why ammonia has this shape and has a bond angle of  $107^\circ$ . [3]

(b) Ammonia reacts with hydrogen chloride,  $\text{HCl}$ , to form ammonium chloride,  $\text{NH}_4\text{Cl}$ .

$\text{NH}_4\text{Cl}$  is an ionic compound containing  $\text{NH}_4^+$  and  $\text{Cl}^-$  ions.

(i) Complete the electron configuration of the  $\text{Cl}^-$  ion.

$1s^2$  [1]

(ii) Draw a '*dot-and-cross*' diagram to show the bonding in  $\text{NH}_4^+$ .

Show **outer** electrons only. [1]

(iii) State the shape of, and bond angle in, an  $\text{NH}_4^+$  ion. [2]

(iv) A student investigated the conductivity of ammonium chloride.

She noticed that when the ammonium chloride was solid it did **not** conduct electricity. However, when ammonium chloride was dissolved in water, the resulting solution did conduct electricity.

Explain these observations. [2]

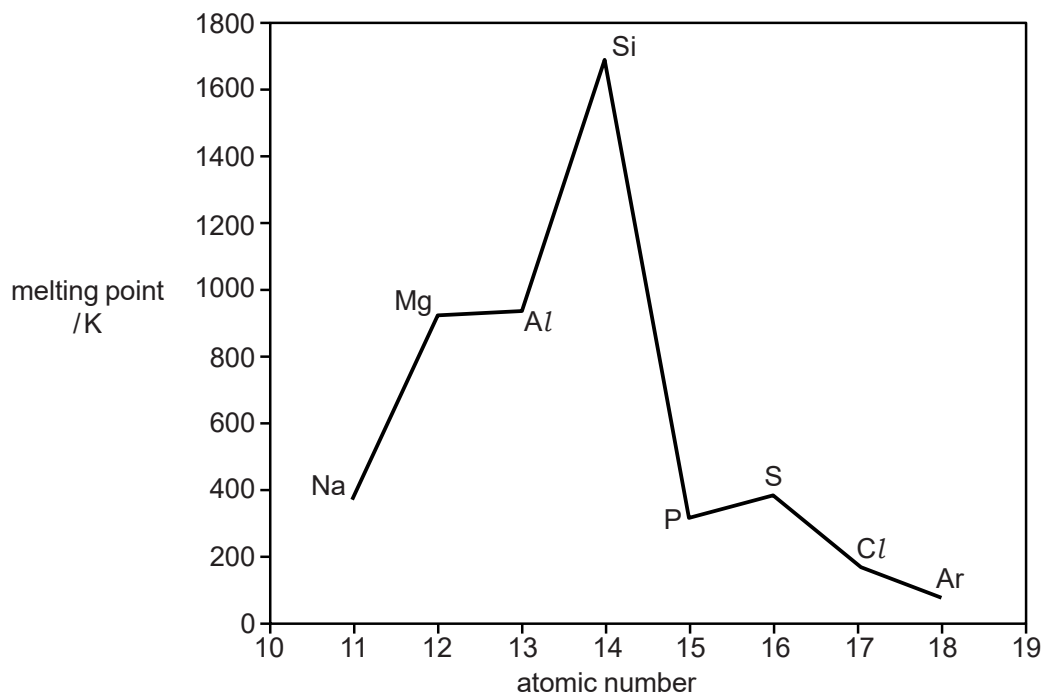


- (c) Ammonium compounds such as ammonium sulfate,  $(\text{NH}_4)_2\text{SO}_4$ , can be used as fertilisers.
- (i) Write a balanced equation to show how ammonium sulfate could be formed by the reaction between aqueous ammonia and sulfuric acid. [1]
- (ii) Ammonium sulfate is an example of a salt formed when an acid is neutralised by a base.  
Explain what is meant by the term *salt*. [1]
- (iii) Why is ammonia acting as a base in this neutralisation? [1]
- (iv) What is the relative formula mass of  $(\text{NH}_4)_2\text{SO}_4$ ?  
Give your answer to **one** decimal place. [1]

[Total: 15 Marks]

## Question 5

The graph shows the melting points of the elements in Period 3 of the periodic table.



- (a) Phosphorus and chlorine have simple molecular structures.  
More information about phosphorus and chlorine is given in the table below.

Element	Molecular formula
phosphorus	$P_4$
chlorine	$Cl_2$

Explain the differences in the melting points of phosphorus and chlorine.

[3]

- (b) Magnesium and silicon have different types of giant structures.

Describe the bonding in magnesium and in silicon.

Include the names of the particles and describe the forces between the particles in the structures.

**[4]**

- (c) Aluminium forms a sulfide,  $Al_2S_3$ .

$Al_2S_3$  reacts with water to form aluminium hydroxide and hydrogen sulfide,  $H_2S$ .

Write an equation for the reaction of  $Al_2S_3$  with water.

**[1]**

**(Total 8 marks)**