

Ionic Bonding Mark Scheme



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1. Ionic bonding is the strong electrostatic force of attraction between oppositely charged ions.

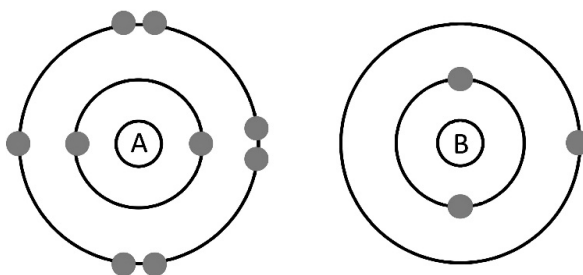
Circle the letter of the correct answer for each of the following questions.

- a) Calcium reacts with chlorine to produce calcium chloride.

What happens when a calcium ion forms during this reaction?

D – is the only correct answer.	(1)
	Total: 1 mark

The electronic structures of two atoms, A and B, are shown.



A and B combine together to form a compound.

- b) What is the type of bonding in the compound and what is the formula of the compound?

A – is the only correct answer.	(1)
	Total: 1 mark

Magnesium is in Group 2 of the periodic table and chlorine is in Group 7.

- c) What is the correct chemical formula for the ionic compound magnesium chloride?

C – is the only correct answer.	(1)
	Total: 1 mark

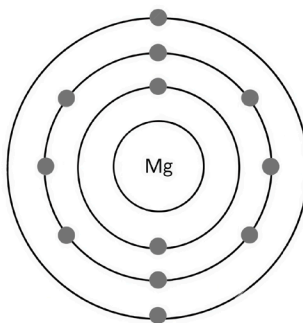
The compound magnesium nitrate has the formula $\text{Mg}(\text{NO}_3)_2$.

- d) What is the relative formula mass of magnesium nitrate?

C – is the only correct answer.	(1)
	Total: 1 mark

(Total for Question 1 is 4 marks)

2. Magnesium is in group 2 of the Periodic Table.
The figure below shows the electronic configuration of magnesium.



- a) Explain why magnesium is in group 2 of the Periodic Table.

An explanation to include:	
Magnesium has 2 electrons in the outer shell.	(1)
	Total: 1 mark

- b) Give the electron configuration of a magnesium ion.

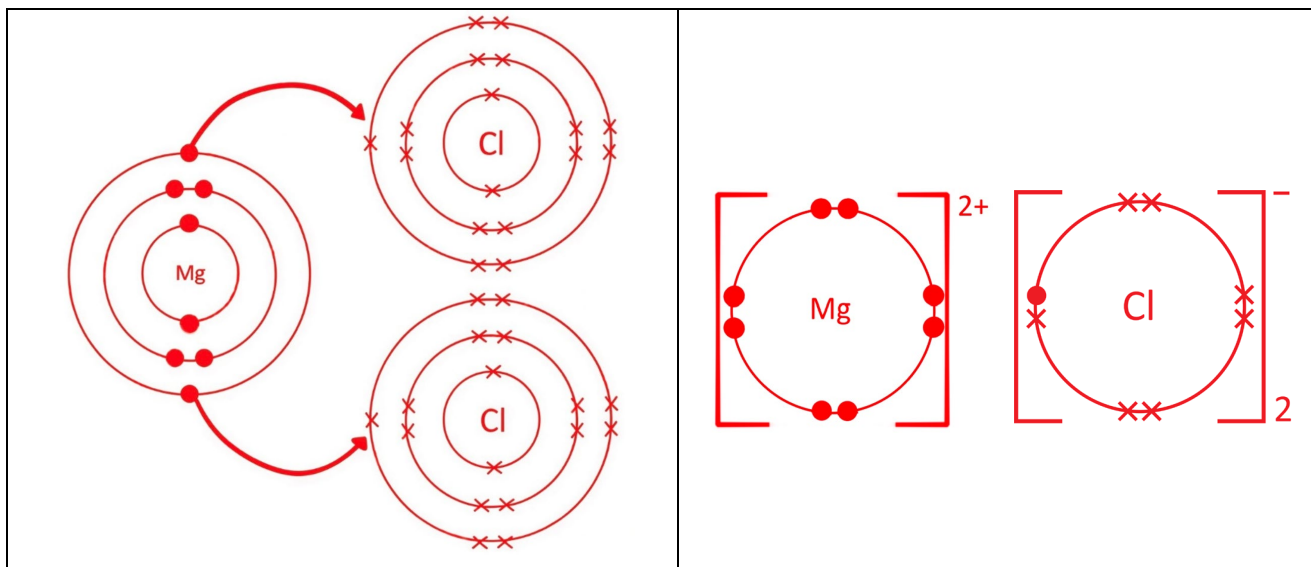
2, 8	(1)
	Total: 1 mark

Magnesium and chlorine bond to form magnesium chloride, MgCl_2 .

- c) In the space below, draw a dot-and-cross diagram to show the **transfer of electrons** from **one magnesium atom to the chlorine atoms** to form magnesium chloride.

You should show the following:

- The electrons in the outer shells only.
- The charges on the resulting ions.



Award one mark for each of the following:

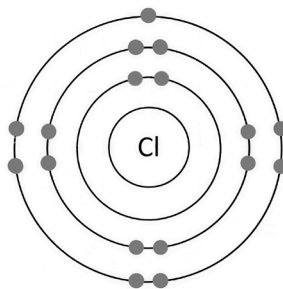
- One magnesium atom and two chlorine atoms.
- Transfer of 1 electron from Mg to **each** Cl atom.
- Magnesium ion with a 2+ charge and Chloride ions with a - charge.
- Full outer shells on all resulting ions.

Total: 4 marks

(Total for Question 2 is 6 marks)

3. Chlorine is in group 7 of the Periodic Table.

The figure below shows the electronic configuration of chlorine.



a) Explain why chlorine is in Group 7 of the Periodic Table.

An explanation to include:	
Chlorine has 7 electrons in its outer shell.	(1)
	Total: 1 mark

b) Aluminium is a metal in Group 3 of the periodic table. Chlorine is a non-metal in Group 7.

State the electronic configuration of:

i. an aluminium ion: 2, 8	(1)
ii. a chlorine ion: 2, 8, 8	(1)
	Total: 2 marks

c) In the space below, draw a dot-and-cross diagram to show the **transfer of electrons** from **one aluminium atom to the chlorine atoms** to form aluminium chloride.

You should show:

- The correct number of atoms.
- The electrons in the outer shells only.
- The charges on the resulting ions.

Award <u>one</u> mark for each of the following: • One aluminium atom and three chlorine atoms. • Transfer of 3 electrons from the aluminium. • One aluminium ion with a 3+ charge and three chloride ions with a – charge. • Full outer shells on all resulting ions.	Total: 4 marks

(Total for Question 3 is 7 marks)

4. Sodium is a metal in Group 1 of the periodic table. Fluorine is a non-metal in Group 7. They react to form the ionic compound sodium fluoride, NaF.

a) State the electronic configuration of:

i. A sodium atom : 2, 8, 1	(1)
ii. a fluorine ion : 2, 8	(1)
	Total: 2 marks

b) Sodium and fluorine form an ionic bond.

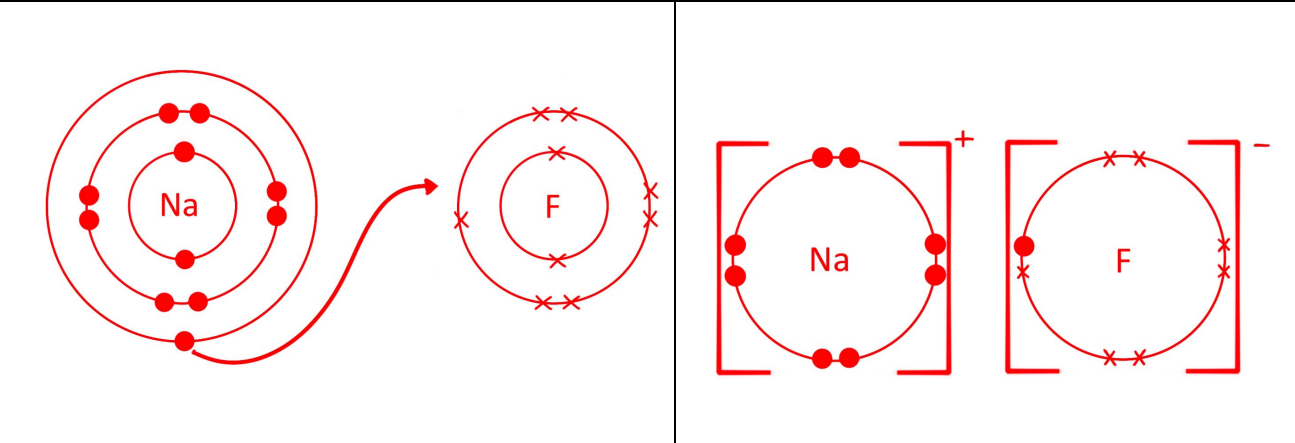
What is an ionic bond?

Electrostatic force of attraction	(1)
Between oppositely charged ions.	(1)
	Total: 2 marks

d) In the space below, draw a dot-and-cross diagram to show the **transfer of electrons** between sodium and fluorine **atoms** to form sodium fluoride, NaF.

You should show:

- The correct number of atoms.
- The electrons in the outer shells only.
- The charges on the resulting ions.

	
Award <u>one</u> mark for each of the following: • One sodium atom and one fluorine atom. • Transfer of 1 electron from the sodium atom to the fluorine atom. • Sodium ion with a + charge and a fluorine ion with a – charge. • Full outer shells on all resulting ions.	
	Total: 4 marks

(Total for Question 4 is 8 marks)

5. Magnesium reacts with oxygen to form the ionic compound magnesium oxide, MgO .
- a) In the space below, draw a dot-and-cross diagram to show how electrons are transferred from a magnesium atom to an oxygen atom to form magnesium oxide.

You should show:

- The correct number of atoms.
- The electrons in the outer shells only.
- The charges on the resulting ions.

Award <u>one</u> mark for each of the following: • One magnesium atom and one oxygen atom. • Transfer of 2 electrons from the magnesium atom to the oxygen atom. • Magnesium ion with a 2+ charge and an oxide ion with a 2- charge. • Full outer shells on all resulting ions.	
	Total: 4 marks

- b) Use your diagram from part (a) to explain why the chemical formula for magnesium oxide is MgO .

An explanation to include any two of the following:	
Magnesium needs to lose 2 electrons (to have a full outer shell)	(1)
Oxygen needs to gain 2 electrons (to have a full outer shell).	(1)
So they react in a 1:1 ratio.	(1)
	Total: 2 marks

- c) Solid magnesium oxide does not conduct electricity. Molten magnesium oxide does conduct electricity. Explain this difference in terms of the particles in magnesium oxide.

An explanation to include:	
In solid: Ions are fixed in a giant lattice / held tightly in place.	(1)
So, ions cannot move.	(1)
In molten: Ions are free to move.	(1)
So, they can carry the charge / current.	(1)
	Total: 3 marks

(Total for Question 5 is 9 marks)

6. The position of an element in the Periodic Table allows us to predict the charge on the ion it will form.

a) Complete the table below to show how different atoms form ions. The first one has been done for you.

Element	Group Number	Electrons to Lose or Gain	Formula of Ion Formed
Sodium	1	Lose 1	Na ⁺
Calcium	2	Lose 2	Ca ²⁺
Oxygen	6	Gain 2	O ²⁻
Fluorine	7	Gain 1	F ⁻
Helium	0	No gain or loss.	No ion.

Award 1 mark for each correct row.	
Marking note: for the helium row accept any correct versions of the answer above.	
	Total: 4 marks

b) Explain why helium does not form an ion.

An explanation to include:	
Helium has a full outer shell (of electrons).	(1)
So, it is stable / does not need to lose or gain electrons.	(1)
Allow: It has a stable electronic structure. Ignore: references to 'Group 0' or 'Noble gas' unless linked to stability.	
	Total: 2 marks

c) What is the electronic configuration of the original atom, X?

2, 8, 3	(1)
	Total: 1 mark

d) Identify element X.

Aluminium or Al	(1)
	Total: 1 mark

e) Explain why atom X forms an ion with a 3+ charge and not a 5- charge. Refer to energy in your answer.

An explanation to include:	
It is because it's losing 3 electrons	(1)
requires less energy than gaining 5 electrons.	(1)
	Total: 2 marks

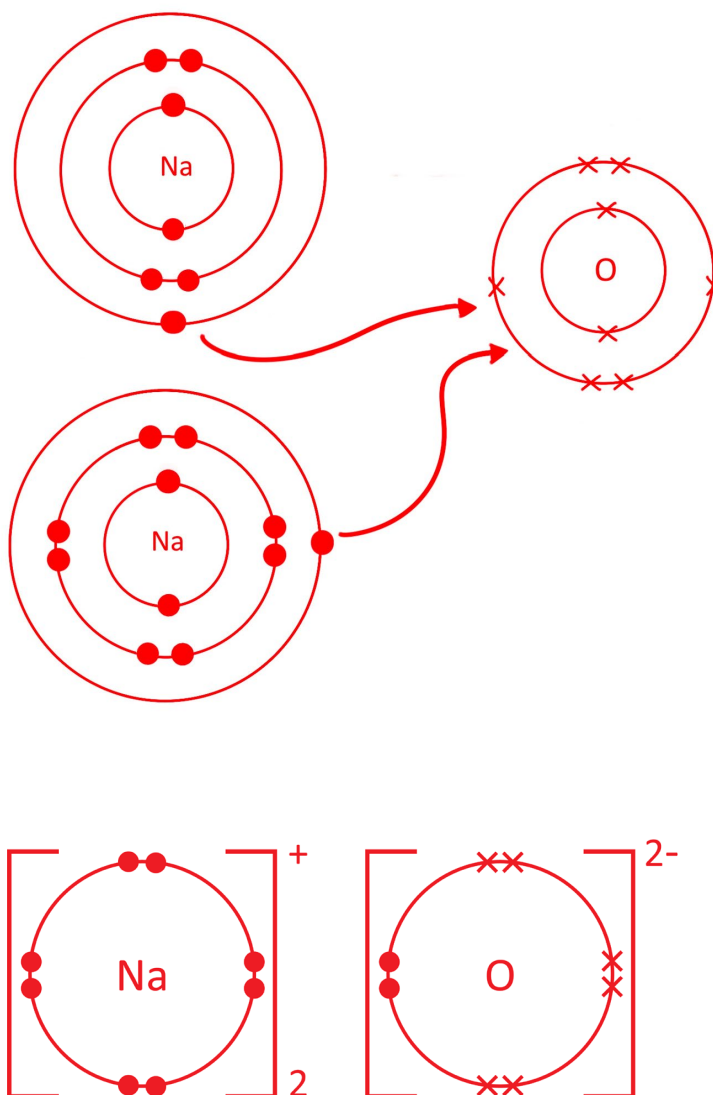
(Total for Question 6 is 10 marks)

7. Sodium reacts with oxygen to form the ionic compound sodium oxide.

a) In the space below, draw a dot-and-cross diagram to show how electrons are transferred from sodium to oxygen to form sodium oxide.

You should show:

- The correct number of atoms.
- The electrons in the outer shells only.
- The charges on the resulting ions.



Award one mark for each of the following:

- Two sodium atoms and one oxygen atom.
- Transfer of 1 electron from **each** sodium atom to the oxygen atom.
- Two sodium ions with a + charge and an oxide ion with a 2- charge.
- Full outer shells on all resulting ions.

Total: 4 marks

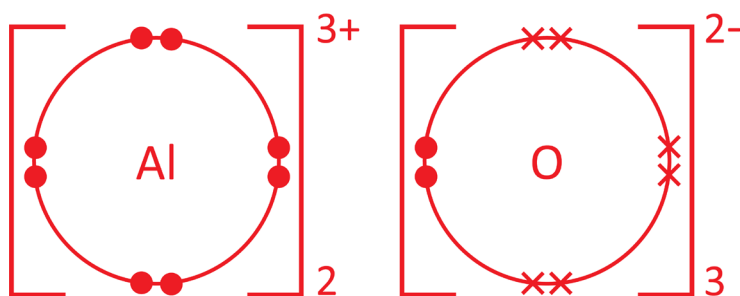
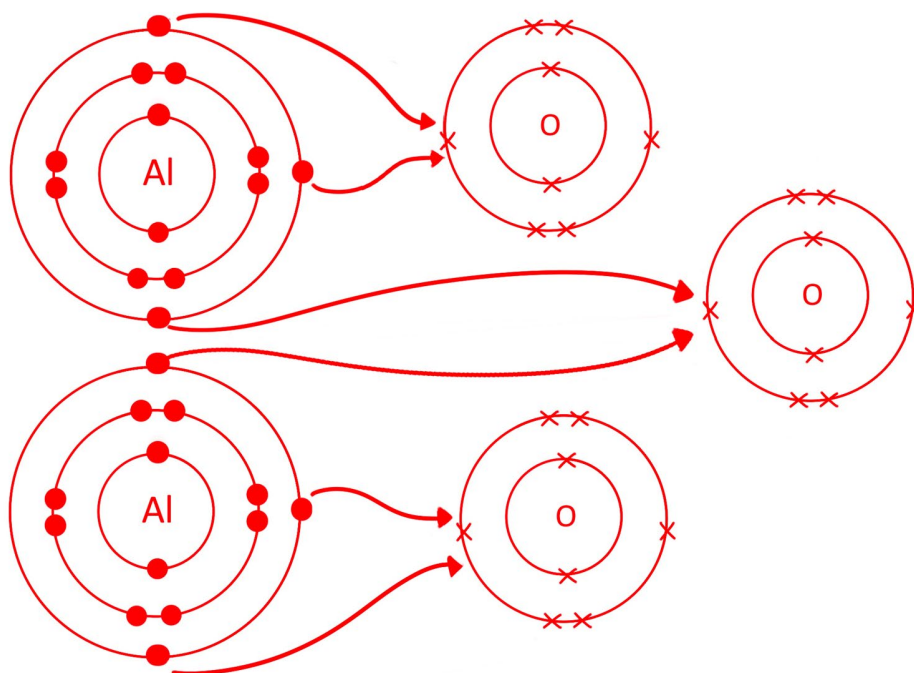
(Total for Question 7 is 4 marks)

8. Aluminium reacts with oxygen to form the ionic compound aluminium oxide.

b) In the space below, draw a dot-and-cross diagram to show how electrons are transferred from the aluminium atoms to the oxygen atoms to form aluminium oxide.

You should show:

- The correct number of atoms.
- The electrons in the outer shells only.
- The charges on the resulting ions.



Award one mark for each of the following:

- Two aluminium atoms and three oxygen atoms.
- Transfer of 3 electrons from **each** aluminium atom to the oxygen atoms.
- Two aluminium ions with a 3+ charge and three oxide ions with a 2- charge.
- Full outer shells on all resulting ions.

Total: 4 marks

(Total for Question 8 is 4 marks)

9. Most ionic compounds are formed when a metal reacts with a non-metal.

a) State the chemical formula for:

i. the ammonium ion. NH_4^+	(1)
ii. the nitrate ion. NO_3^-	(1)
Total: 2 marks	

b) Explain why ammonium nitrate is classified as an ionic compound, even though it contains no metal atoms.

An explanation to include:	
It is made of (oppositely charged) ions.	(1)
Allow: It contains positive and negative particles	
Held together by electrostatic forces (of attraction)	(1)
Allow: There is a transfer of electrons (creating ions).	
Total: 2 marks	

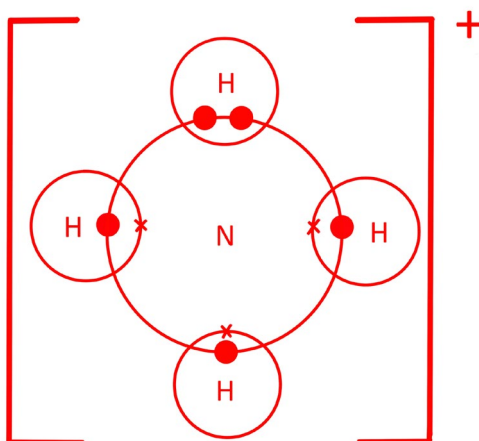
c) The ions in ammonium nitrate are polyatomic. This means they consist of several atoms joined together.

Covalent (bonding)	(1)
Total: 1 mark	

d) In the space below, draw a dot-and-cross diagram to show the bonding in an ammonium ion (NH_4^+).

You should show:

- The outer shell electrons of all atoms.
- The overall charge on the ion.



Award one mark for each of the following:	
• One nitrogen atom and four hydrogen atoms.	
• Four shared pairs of electrons (one pair between N and each H).	
• Correct representation of electron spread in the molecule.	
• Square brackets surrounding the molecule with a + charge.	
Total: 4 marks	

(Total for Question 9 is 9 marks)