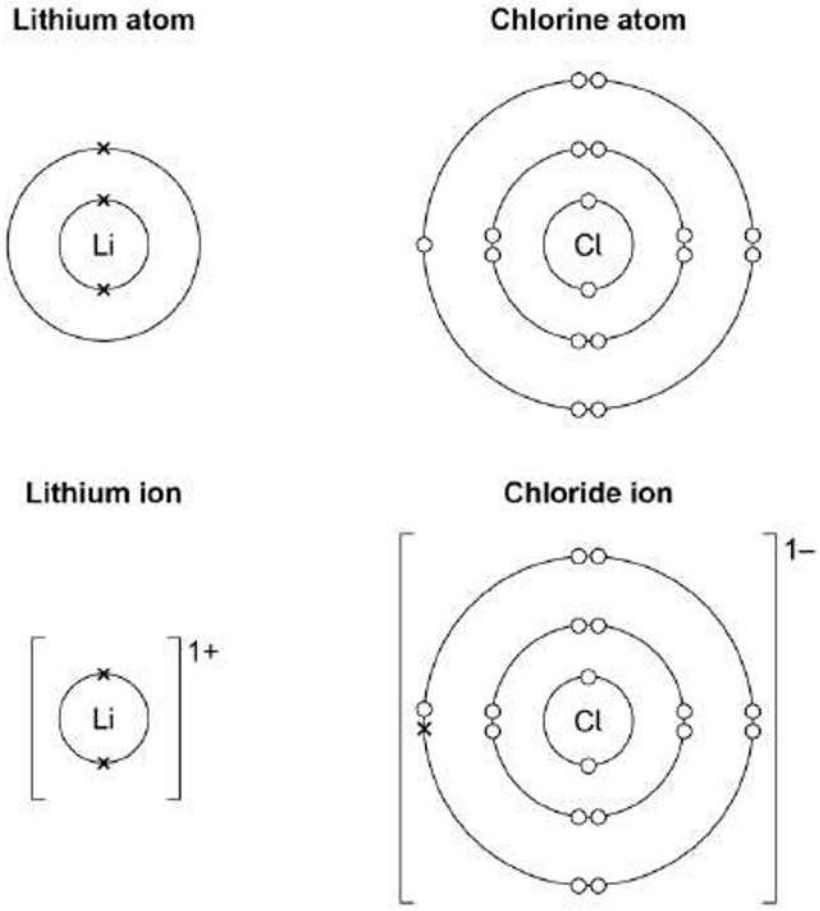
**1.** This question is about metal compounds.

(a) Lithium reacts with chlorine to produce lithium chloride.

When lithium atoms and chlorine atoms react to produce lithium chloride, lithium ions and chloride ions are formed.

The diagram shows the electronic structures of the atoms and ions.

The symbols **o** and **x** are used to represent electrons.




Describe what happens when a lithium atom reacts with a chlorine atom.

Answer in terms of electrons.

**(4)**

Zinc sulfate can be made by two methods.

The equations for the two methods are:

**Method 1**: $ZnO + H_2SO_4 \longrightarrow ZnSO_4 + H_2O$

**Method 2**: $ZnCO_3 + H_2SO_4 \longrightarrow ZnSO_4 + H_2O + CO_2$

(b) Calculate the percentage atom economy for making zinc sulfate in **Method 1**.

Use the equation:

percentage atom economy =

$$\frac{\text{relative formula mass of } ZnSO_4}{\text{relative formula mass of } ZnO + \text{relative formula mass of } H_2SO_4} \times 100$$

Give your answer to 3 significant figures.

Relative formula masses ($M_r$): $ZnO = 81$ $H_2SO_4 = 98$ $ZnSO_4 = 161$

_____

_____

_____

_____

_____

Percentage atom economy = _____ %

**(3)**

(c) **Method 1** gives a higher percentage atom economy for making zinc sulfate than **Method 2**.

Give a reason why it is important to use a reaction with a high atom economy.

_____

_____

**(1)**

(d) A student uses 50 $cm^3$ of a zinc sulfate solution of 80 $g/dm^3$

What mass of zinc sulfate is dissolved in 50 $cm^3$ of this zinc sulfate solution?

_____

_____

_____

_____

Mass = _____ g

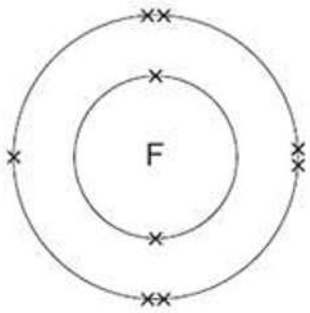
**(2)**

**(Total 10 marks)**

**2.** This question is about fluorine.

(a) **Figure 1** shows the arrangement of electrons in a fluorine atom.

**Figure 1**




(i) In which group of the periodic table is fluorine?

Group _____

**(1)**

(ii) Complete the table below to show the particles in an atom and their relative masses.

| Name of particle | Relative mass |
|---|---|
| Proton | |
| Neutron | 1 |
| | Very small |

**(2)**

(iii) Use the correct answer from the box to complete the sentence.

| | | |
|---|---|---|
| **alkalis** | **alloys** | **isotopes** |

Atoms of fluorine with different numbers of neutrons are

called _____ .

**(1)**

(b) Sodium reacts with fluorine to produce sodium fluoride.

(i) Complete the word equation for this reaction.

sodium + _____ → _____

**(1)**

(ii) Complete the sentence.

Substances in which atoms of two or more different elements are chemically

combined are called _____ .

**(1)**

(iii) The relative formula mass ($M_r$) of sodium fluoride is 42.

Use the correct answer from the box to complete the sentence.

| | | |
|---|---|---|
| **ion** | **mole** | **molecule** |

The relative formula mass ($M_r$), in grams, of sodium fluoride is one

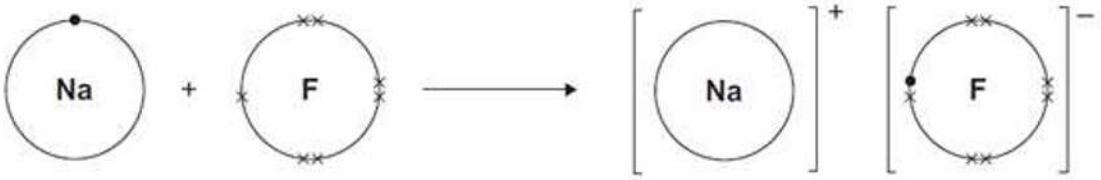
_____ of the substance.

**(1)**

(iv) **Figure 2** shows what happens to the electrons in the outer shells when a sodium atom reacts with a fluorine atom.

The dots (•) and crosses (×) represent electrons.

**Figure 2**




Use **Figure 2** to help you answer this question.

Describe, as fully as you can, what happens when sodium reacts with fluorine to produce sodium fluoride.

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

(v) Sodium fluoride is an ionic substance.

What are **two** properties of ionic substances?

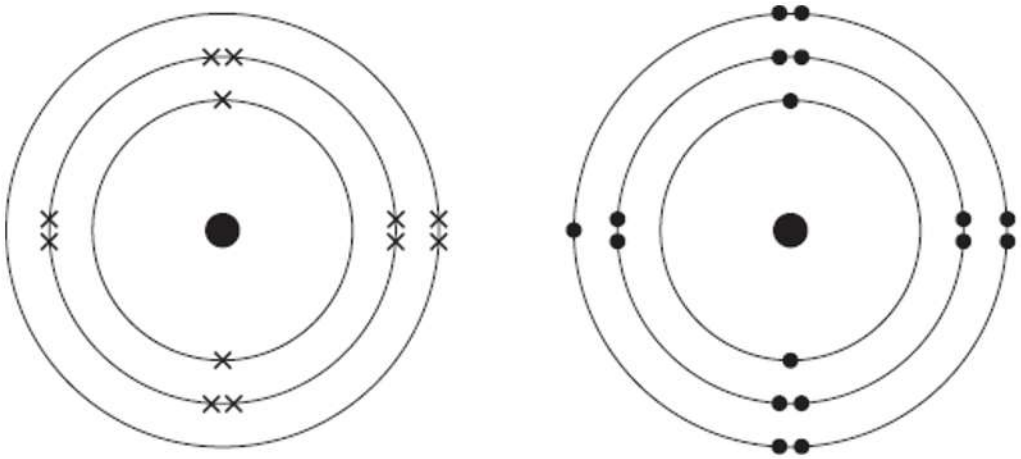
Tick (✓) **two** boxes.

| | |
|---|---|
| Dissolve in water | ☐ |
| Gas at room temperature | ☐ |
| High melting point | ☐ |
| Low boiling point | ☐ |

**(2)**

**(Total 13 marks)**

**3.** (a) The diagram shows an atom of magnesium and an atom of chlorine.



**Magnesium** **Chlorine**

Describe, in terms of electrons, how magnesium atoms and chlorine atoms change into ions to produce magnesium chloride ($MgCl_2$).

_____

_____

_____

_____

_____

_____

_____

_____

**(4)**

(b) Calculate the relative formula mass ($M_r$) of magnesium chloride ($MgCl_2$).

Relative atomic masses ($A_r$): magnesium = 24; chlorine = 35.5

_____

_____

_____

Relative formula mass ($M_r$) = _____

**(2)**

**(Total 6 marks)**

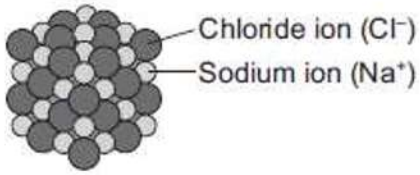
**4.**

Explain why chlorine ($Cl_2$) is a gas at room temperature, but sodium chloride (NaCl) is a solid at room temperature.

**Chlorine**

Cl — Cl

**Sodium chloride**

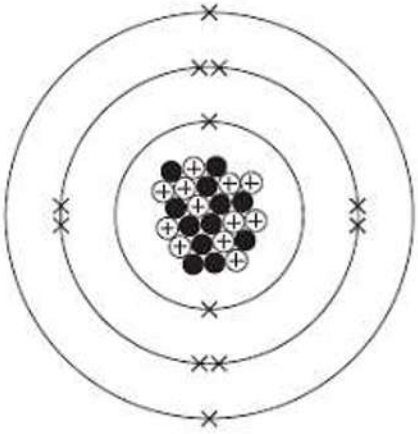



Include a description of the bonding and structure of chlorine and sodium chloride in your answer.

Extra space

**(Total 6 marks)**

**5.** The diagram represents a magnesium atom.



(a) Use words from the box to answer these questions.

| | | | |
|---|---|---|---|
| **electron** | **neutron** | **nucleus** | **proton** |

(i) What is the name of the central part of the atom? _____

**(1)**

(ii) What is the name of the particle with no charge? _____

**(1)**

(iii) What is the name of the particle with a negative charge? _____

**(1)**

(b) Use the diagram above to help you answer these questions.

(i) Draw a ring around the atomic (proton) number of this magnesium atom.

**12** **24** **36**

**(1)**

(ii) Draw a ring around the mass number of this magnesium atom.

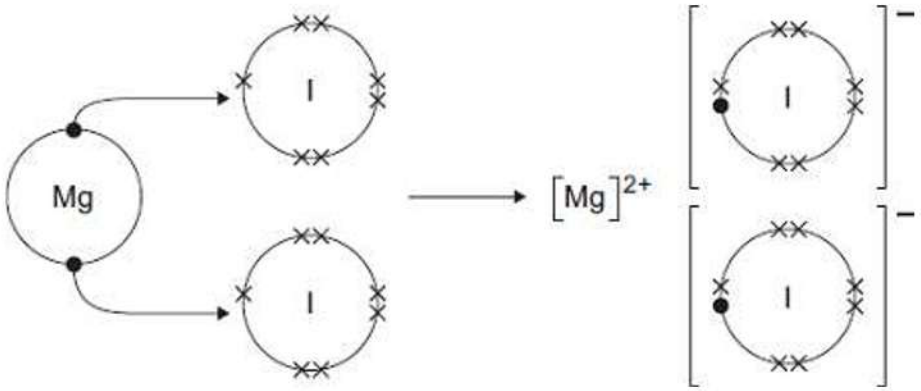
**12** **24** **36**

**(1)**

(c) The diagram shows how magnesium and iodine atoms form magnesium iodide.

Only the outer electrons are shown.

The dots (●) and crosses (×) are used to represent electrons.




**Use the diagram** to help you to answer this question.

Describe, as fully as you can, what happens when magnesium reacts with iodine to make magnesium iodide.

To gain full marks you should use the words atom, electron and ion in your answer.

_____

_____

_____

_____

_____

_____

_____

_____

_____

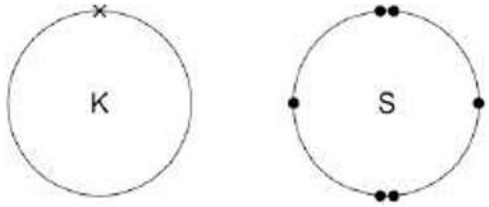
_____

**(4)**

**(Total 9 marks)**

**6.** **Figure 1** shows the outer electrons in an atom of the Group 1 element potassium and in an atom of the Group 6 element sulfur.

**Figure 1**




(a) Potassium forms an ionic compound with sulfur.

Describe what happens when **two** atoms of potassium react with **one** atom of sulfur.

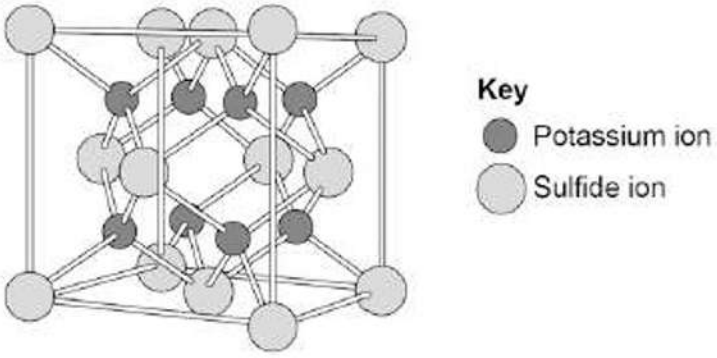
Give your answer in terms of electron transfer.

Give the formulae of the ions formed.

**(5)**

(b) The structure of potassium sulfide can be represented using the ball and stick model in **Figure 2**.

**Figure 2**




The ball and stick model is **not** a true representation of the structure of potassium sulfide.

Give **one** reason why.

_____

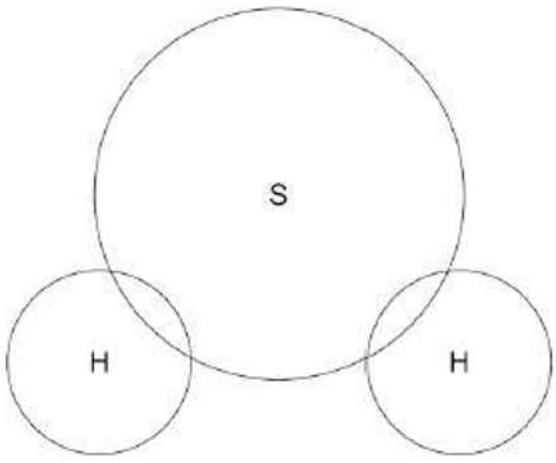
_____

**(1)**

(c) Sulfur can also form covalent bonds.

Complete the dot and cross diagram to show the covalent bonding in a molecule of hydrogen sulfide.

Show the outer shell electrons only.




**(2)**

(d) Calculate the relative formula mass ($M_r$) of aluminium sulfate $Al_2(SO_4)_3$

Relative atomic masses ($A_r$): oxygen = 16; aluminium = 27; sulfur = 32

_____

_____

_____

Relative formula mass = _____

**(2)**

(e) Covalent compounds such as hydrogen sulfide have low melting points and do **not** conduct electricity when molten.

Draw **one** line from each property to the explanation of the property.

| **Property** | **Explanation of property** |
| --- | --- |
| Low melting point | There are no charged particles free to move |
| Does not conduct electricity when molten | Weak intermolecular forces of attraction |
| | Bonds are weak |

Electrons are free to move

Ions are free to move

Bonds are strong

**(2)**

(f) Ionic compounds such as potassium sulfide have high boiling points and conduct electricity when dissolved in water.

Draw **one** line from each property to the explanation of the property.

| Property | Explanation of property |
| --- | --- |
| High boiling point | There are no charged particles free to move |
| Conduct electricity when molten | Ions are free to move |
| | Weak intermolecular forces of attraction |
| | Bonds are weak |
| | Bonds are strong |
| | Electrons are free to move |

**(2)**

**(Total 14 marks)**