

# Atomic Structure 4

Name: \_\_\_\_\_

Class: \_\_\_\_\_

Date: \_\_\_\_\_

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Time: **72 minutes**

Marks: **66 marks**

Comments:

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1.

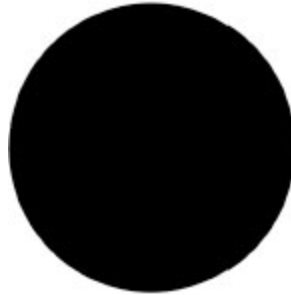
This question is about atoms and ions.

The model of the atom has changed over time.

- (a) In an early model, scientists thought the atom was a tiny sphere that could **not** be divided.

**Figure 1** represents this early model of the atom.

**Figure 1**



The discovery of a subatomic particle led to a change in the model in **Figure 1**.

Which was the first subatomic particle to be discovered?

Tick (✓) **one** box.

Electron

Neutron

Proton

(1)

- (b) In a later model of the atom, most of the mass was concentrated in the centre of the atom.

What is the name of the centre of an atom?

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(1)

(c) Atoms contain three types of subatomic particle.

Draw **one** line from each subatomic particle to the relative charge of the particle.

Subatomic particle	Relative charge of the particle
Electron	+1
Neutron	0
Proton	-1

(2)

(d) What is meant by the 'atomic number of an atom'?

Tick (✓) **one** box.

The number of neutrons only

The number of protons only

The number of neutrons + the number of protons

(1)

(e) The table below shows information about two isotopes of an element.

	Mass number	Percentage (%) abundance
Isotope A	10	19.7
Isotope B	11	80.3

Calculate the relative atomic mass ( $A_r$ ) of the element.

Use the equation:

$$A_r = \frac{(\text{mass number} \times \text{percentage}) \text{ of isotope A} + (\text{mass number} \times \text{percentage}) \text{ of isotope B}}{100}$$

Give your answer to 1 decimal place.

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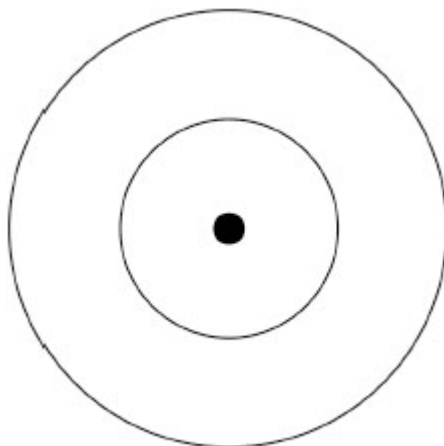
$A_r$  (1 decimal place) = \_\_\_\_\_

(3)

(f) An oxygen atom has eight electrons.

Complete **Figure 2** to show the electronic structure of an oxygen atom.

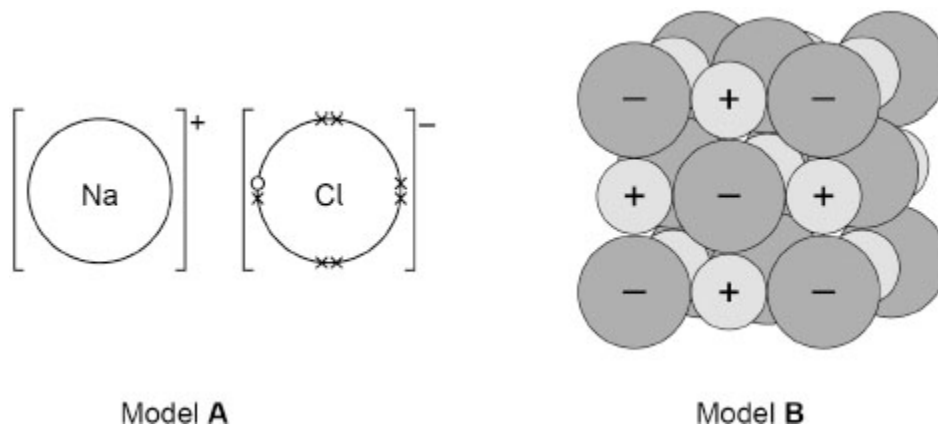
**Figure 2**



(1)

(g) **Figure 3** represents two models of sodium chloride.

**Figure 3**



What are **two** advantages of model **B** compared with model **A**?

Tick (✓) **two** boxes.

Model **B** shows the 3D arrangement of the ions.

Model **B** shows the charges on the ions.

Model **B** shows the electronic structures of the ions.

Model **B** shows the relative sizes of the ions.

Model **B** shows which elements are present.

(2)

(Total 11 marks)

2.

Lithium, carbon, nitrogen, fluorine and neon are elements in the same row of the periodic table.

(a) What is the chemical symbol of lithium?

Use the periodic table.

\_\_\_\_\_

(1)

(b) Lithium has metallic bonding.

Which electrons are involved in metallic bonding?

Tick (✓) **one** box.

Delocalised electrons from the inner shell

Delocalised electrons from the outer shell

Fixed electrons in the inner shell

Fixed electrons in the outer shell

(1)

(c) Lithium reacts with fluorine to produce lithium fluoride.

Draw **one** line from each substance to the particle diagram that represents the substance.

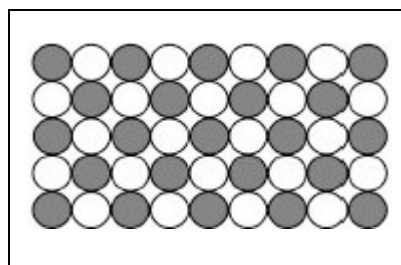
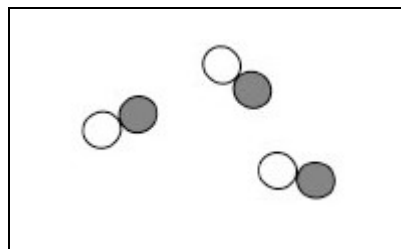
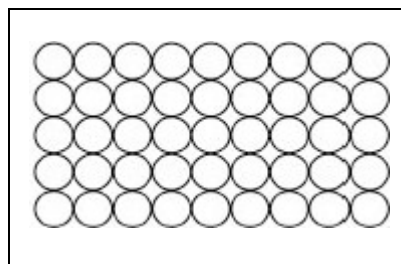
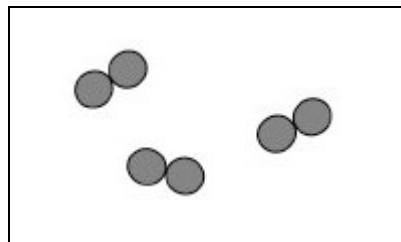
**Substance**

**Particle diagram**

Lithium solid

Fluorine gas

Lithium fluoride solid



(3)

(d) The table below shows the electrical conductivity of three substances.

Substance	Electrical conductivity when solid	Electrical conductivity when liquid
C	Poor	Poor
D	Poor	Good
E	Good	Good

Lithium fluoride is an ionic compound.

Which substance is lithium fluoride?

Tick (✓) **one** box.

C

D

E

(1)

(e) Carbon can exist in different forms.

**Figure 1** represents one form of carbon.

**Figure 1**



What is the name of the form of carbon in **Figure 1**?

Tick (✓) **one** box.

Buckminsterfullerene

Diamond

Graphite

(1)

- (f) Carbon and fluorine form a compound with the formula  $\text{CF}_4$

Calculate the relative formula mass ( $M_r$ ) of  $\text{CF}_4$

Relative atomic masses ( $A_r$ ): C = 12 F = 19

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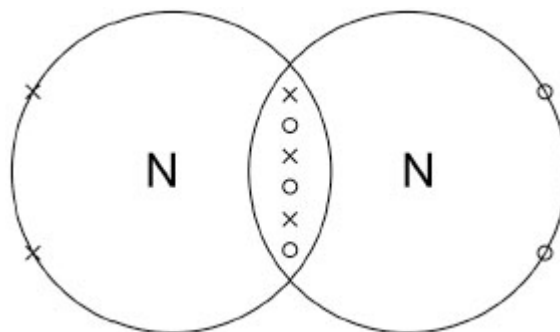
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Relative formula mass ( $M_r$ ) = \_\_\_\_\_

(2)

- (g) **Figure 2** represents a molecule of nitrogen.

**Figure 2**



What is the total number of shared electrons in the covalent bond shown in **Figure 2**?

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(1)

(h) Lithium and nitrogen form a compound with the formula  $\text{Li}_3\text{N}$

Complete the sentence.

Choose the answer from the box.

<b>nitrate</b>	<b>nitride</b>	<b>nitrogen</b>
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The name of the compound with the formula  $\text{Li}_3\text{N}$  is lithium

\_\_\_\_\_.

(1)

(i) Neon does **not** react with other elements to form compounds.

Why is neon unreactive?

Tick (✓) **one** box.

Neon has a stable arrangement of electrons.

Neon is a gas at room temperature.

Neon is a non-metallic element.

(1)

(Total 12 marks)

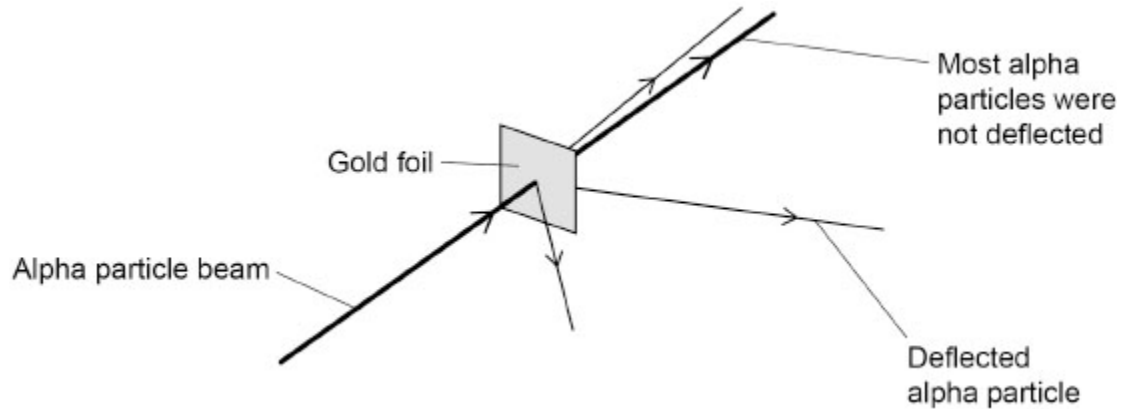
3.

This question is about atoms, ions and elements.

(a) The figure below shows the results of the alpha particle scattering experiment.

In the experiment, alpha particles were fired at gold foil.

Alpha particles are positively charged.



What **two** conclusions were made from the results?

Tick (✓) **two** boxes.

Atoms are very small.

Atoms have a charged nucleus.

Electrons orbit the nucleus at specific distances.

Isotopes of an element have a different number of neutrons.

The mass of an atom is concentrated in the nucleus.

(2)

Particle **X** consists of:

- 35 protons
- 44 neutrons
- 36 electrons.

(b) Why is particle **X** not an atom?

Answer in terms of subatomic particles.

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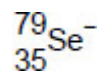
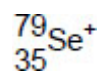
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(1)

(c) Which is the correct representation of particle **X**?

Use the periodic table.

Tick (✓) **one** box.



(1)

Group 7 elements are known as the halogens.

(d) The table below shows the boiling points of some Group 7 elements.

Element	Boiling point in °C
Fluorine	-188
Chlorine	-35
Bromine	59
Iodine	184

Explain the increase in the boiling points of the Group 7 elements going down the group.

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(3)

(e) Chlorine reacts with fluorine to form a compound with the formula ClF<sub>3</sub>

What is the type of bonding in the compound ClF<sub>3</sub>?

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(1)

(f) Chlorine reacts with a solution of sodium bromide.

Complete the word equation for the reaction.

chlorine + sodium bromide → \_\_\_\_\_ + \_\_\_\_\_

(1)

(g) Explain why Group 7 elements become less reactive going down the group.

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(3)  
(Total 12 marks)

4.

Potassium is in Group 1 of the periodic table.

(a) What name is given to Group 1 elements?

Tick (✓) **one** box.

Alkali metals

Halogens

Noble gases

(1)

(b) A potassium atom is very small.

What is the radius of a potassium atom?

Tick (✓) **one** box.

0.2 cm

0.2 mm

0.2 nm

(1)

(c) What name is given to the number of protons in an atom?

Tick (✓) **one** box.

Atomic number

Group number

Mass number

(1)

(d) **Table 1** shows the name and the relative charge of the particles in a potassium atom.

**Table 1**

Name of particle	Relative charge
Proton	
	0
Electron	-1

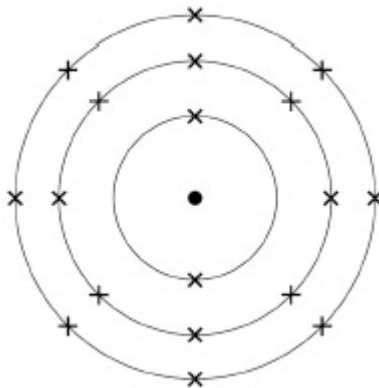
Complete **Table 1**.

(2)

(e) The electronic structure of a potassium atom is 2,8,8,1

**Figure 1** represents the electronic structure of a potassium ion.

**Figure 1**



What is the charge on a potassium **ion**?

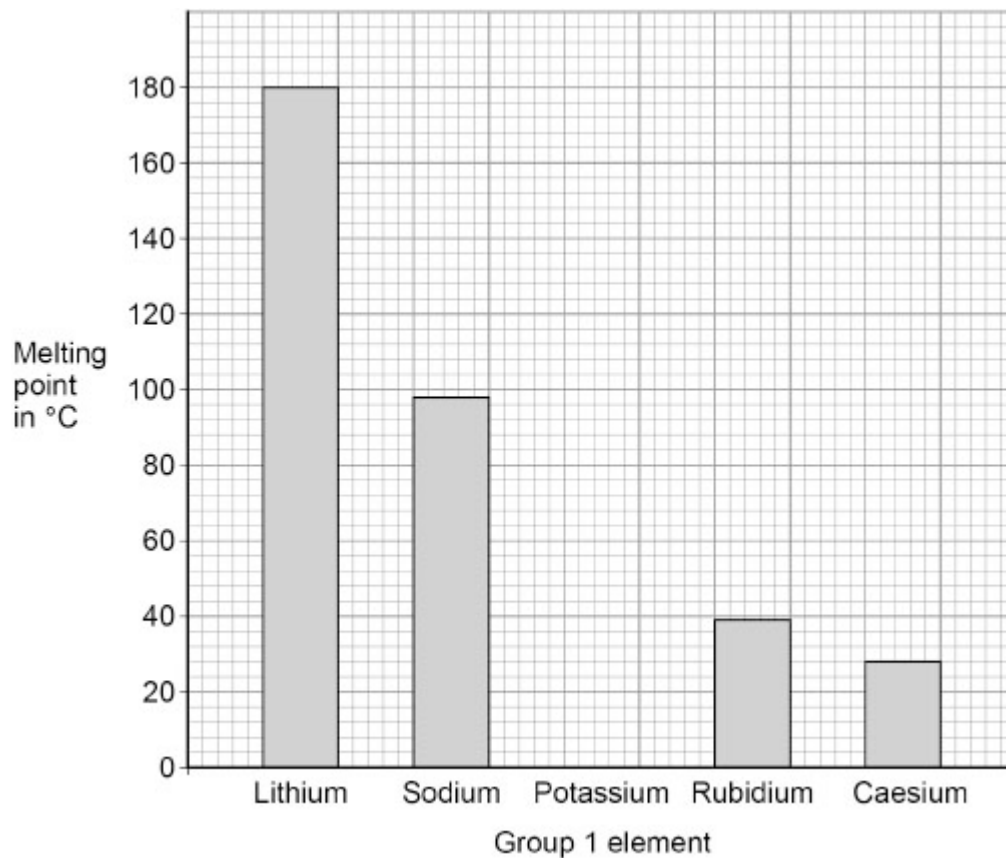
Tick (✓) **one** box.

-1       0       +1

(1)

(f) **Figure 2** shows the melting points of some Group 1 elements.

**Figure 2**



Predict the melting point of potassium.

Melting point = \_\_\_\_\_ °C

(1)

(g) Potassium has two isotopes.

**Table 2** shows the percentage (%) abundance of the two isotopes.

**Table 2**

Isotope	Percentage (%) abundance
$^{39}_{19}\text{K}$	93
$^{41}_{19}\text{K}$	7

How is the relative atomic mass ( $A_r$ ) of potassium calculated?

Tick (✓) **one** box.

$$A_r = \frac{(39 \times 7) + (41 \times 93)}{100}$$

$$A_r = \frac{(39 \times 93) + (41 \times 7)}{100}$$

$$A_r = \frac{(39 \times 41) + (93 \times 7)}{100}$$

(1)

(Total 8 marks)

5.

Group 7 elements are known as the halogens.

All atoms of Group 7 elements contain protons, neutrons and electrons.

(a) What is the order of discovery of the proton, neutron and electron?

Tick (✓) **one** box.

electron → neutron → proton

electron → proton → neutron

neutron → proton → electron

proton → electron → neutron

(1)

(b) **Table 1** shows the mass of a proton and of an electron.

**Table 1**

Name of particle	Mass in kg
Proton	$1.673 \times 10^{-27}$
Electron	$9.109 \times 10^{-31}$

Calculate how many times heavier a proton is than an electron.

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Times heavier a proton is than an electron = \_\_\_\_\_

(2)

A bromine atom can be represented as  $^{81}_{35}\text{Br}$ .

(c) What is the number of neutrons in this bromine atom?

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(1)

(d) What is the number of electrons in a bromide **ion**?

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(1)

(e) Chlorine has two isotopes.

**Table 2** shows the percentage abundance of the two isotopes of chlorine.

**Table 2**

Isotope	Percentage (%) abundance
$^{35}_{17}\text{Cl}$	75.77
$^{37}_{17}\text{Cl}$	24.23

Calculate the relative atomic mass ( $A_r$ ) of chlorine.

Give your answer to 2 decimal places.

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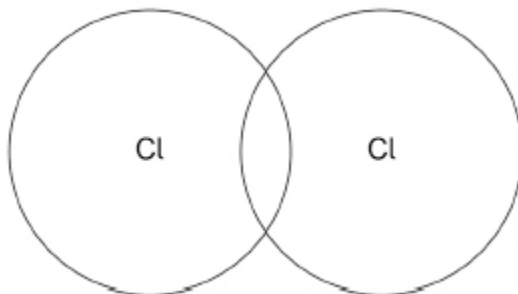
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Relative atomic mass (2 decimal places) = \_\_\_\_\_

(3)

- (f) The figure below shows the outer shells in one molecule of chlorine ( $\text{Cl}_2$ ).  
Complete the dot and cross diagram to show the electrons in the outer shells.



(2)  
(Total 10 marks)

6. This question is about Group 1 elements.

- (a) What are the Group 1 elements known as?

Tick (✓) **one** box.

Alkali metals

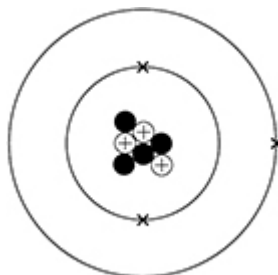
Halogens

Noble gases

(1)

- (b) **Figure 1** shows a lithium atom.

**Figure 1**



What is the number of electrons and neutrons in the atom of lithium?

Number of electrons \_\_\_\_\_

Number of neutrons \_\_\_\_\_

(2)

(c) What is the relative charge on a lithium ion?

Tick (✓) **one** box.

+1

0

-1

(1)

(d) Lithium is heated and then cooled in an experiment.



Two physical changes happen in the experiment.

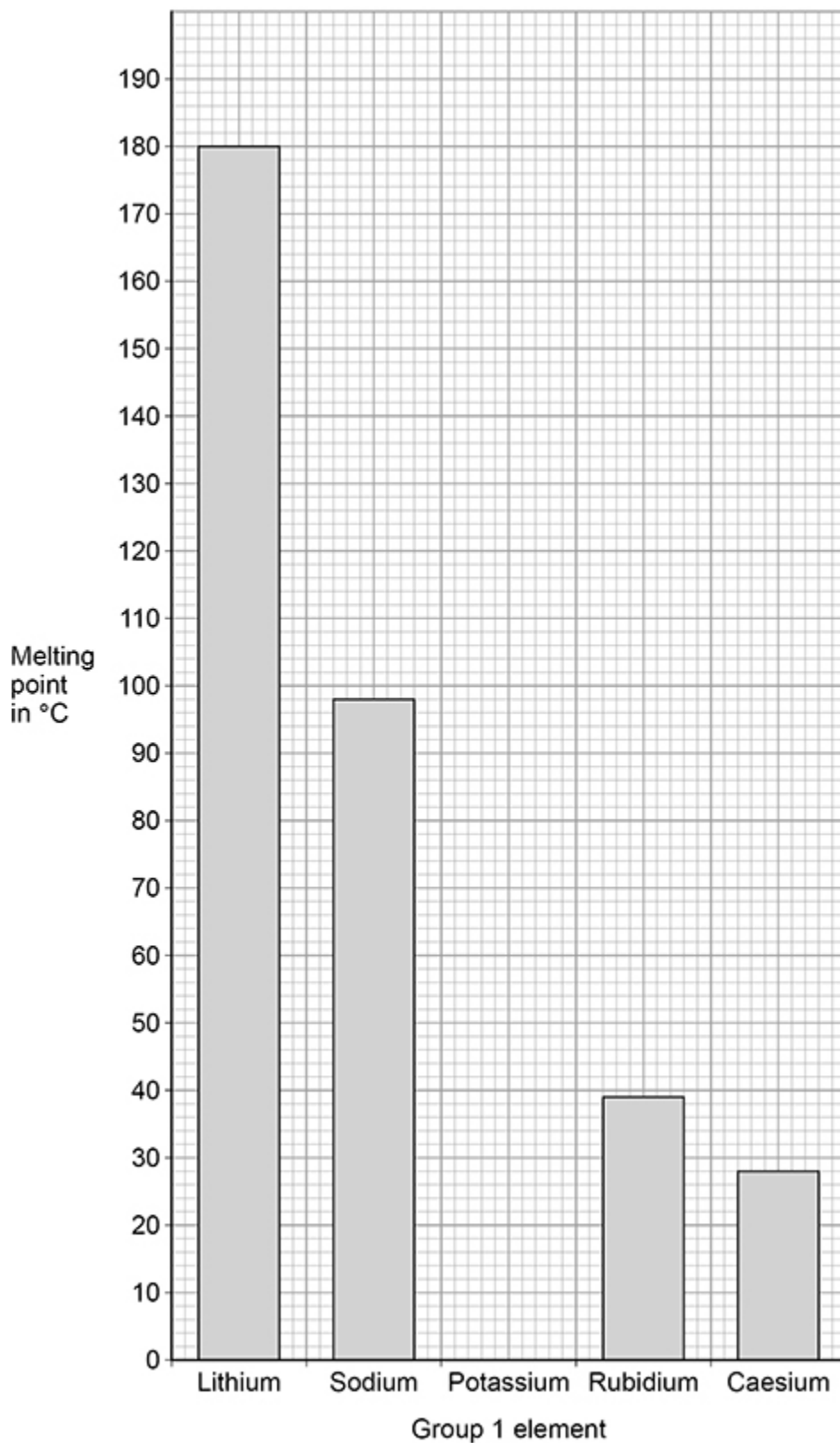
Draw **one** line from each stage to the physical change that happens in that stage.

Stage	Physical change
	Boiling
Stage 1	Condensing
	Dissolving
Stage 2	Freezing
	Melting

(2)

Figure 2 represents the melting points of some Group 1 elements.

Figure 2



(e) What is the melting point of caesium?

Use **Figure 2**.

Melting point = \_\_\_\_\_ °C

(1)

(f) The melting point of potassium is 63 °C

Draw a bar for the melting point of potassium on **Figure 2**.

(1)

(g) Describe the trend of the melting points of the Group 1 elements in **Figure 2**.

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(3)

(h) The boiling point of sodium is 883 °C

What is the state of sodium at 150 °C?

Use **Figure 2**.

Tick (✓) **one** box.

Gas

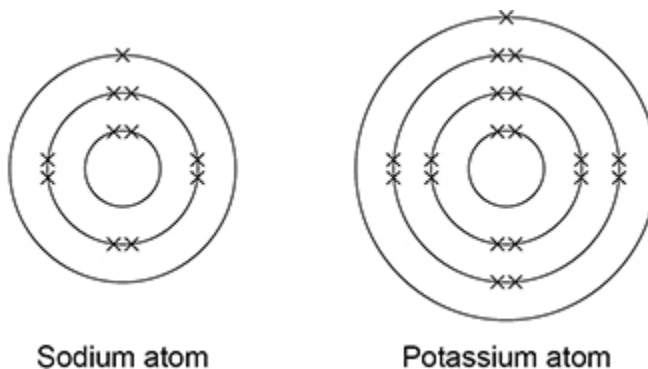
Liquid

Solid

(1)

(i) **Figure 3** represents the electronic structure of a sodium atom and of a potassium atom.

**Figure 3**



Complete the sentence.

Choose the answer from the box.

<b>gains an electron</b>	<b>loses an electron</b>	<b>shares an electron</b>
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Potassium is more reactive than sodium because potassium more easily \_\_\_\_\_.

(1)  
(Total 13 marks)

## Mark schemes

1.

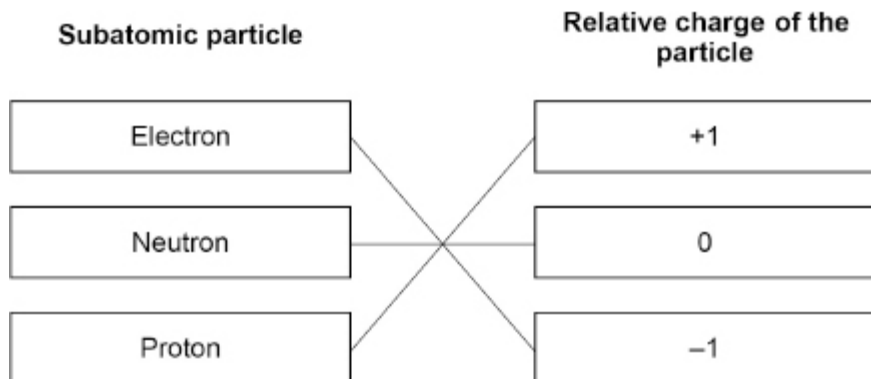
(a) electron

1

(b) nucleus

1

(c)



allow 1 mark for 1 or 2 correct

do **not** accept more than one line from a box on the left

2

(d) the number of protons only

1

(e)

$$(A_r =) \frac{(10 \times 19.7) + (11 \times 80.3)}{100}$$

allow

$$(A_r =) \frac{197 + 883.3}{100}$$

allow

$$(A_r =) \frac{1080.3}{100}$$

1

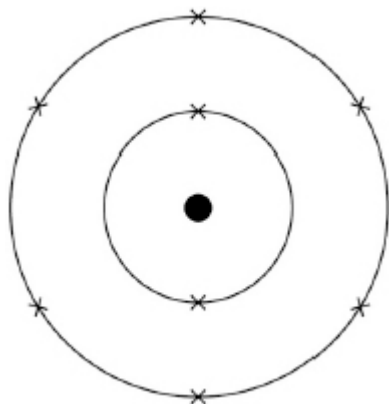
$$= 10.803$$

1

$$= 10.8$$

1

(f)



allow any combination of x, o, e<sup>(-)</sup>, • for electrons

(g) model **B** shows the 3D arrangement of the ions

model **B** shows the relative sizes of the ions

1

1

1

[11]

2.

(a) Li

(b) delocalised electrons from the outer shell

(c)

Substance	Particle diagram
Lithium solid	
Fluorine gas	
Lithium fluoride solid	

1

1

do **not** accept more than one line from a box on the left

3

- (d) **D** 1
- (e) diamond 1
- (f) (relative formula mass =)  
 $12 + (19 \times 4)$   
 = 88 1
- (g) 6  
*allow 3 pairs* 1
- (h) nitride 1
- (i) neon has a stable arrangement of electrons 1
- 3.** (a) atoms have a charged nucleus 1
- the mass of an atom is concentrated in the nucleus 1
- (b) (particle **X**) has more electrons than protons  
*allow (particle X) has a different number of protons and electrons*  
*allow because atoms have the same number of protons and electrons*  
*do **not** accept (particle X) has a different number of neutrons* 1
- (c)  
 ${}_{35}^{79}\text{Br}^-$  1
- (d) (going down the group) molecules increase in size  
*allow (going down the group) atoms increase in size* 1
- (so the) forces between the molecules increase  
**or**  
 (so the) intermolecular forces increase 1
- (so) more energy is needed to break the intermolecular forces  
*allow (so) more energy is needed to separate the molecules* 1

[12]

(e) covalent

*ignore intermolecular forces*

1

(f) chlorine + sodium bromide → bromine + sodium chloride

*allow Br<sub>2</sub> for bromine*

*allow NaCl for sodium chloride*

1

(g) (going down the group the) the outer shell / electrons become further from the nucleus

*allow energy level for shell*

*allow the atoms become larger*

*allow the atoms have more shells*

1

(so) there is less (electrostatic) attraction between the nucleus and the outer electron(s)

*allow (so) there is more shielding between the outer electron(s) and the nucleus*

1

(so) gaining an electron is more difficult

1

[12]

4.

(a) alkali metals

1

(b) 0.2 nm

1

(c) atomic number

1

(d)

Name	Relative charge
Proton	+(1)
Neutron	0
Electron	-1

1

1

(e) +1

1

(f) 63 (°C)

*allow a value in the range 50-80 (°C)*

1

(g)

$$A_r = \frac{(39 \times 93) + (41 \times 7)}{100}$$

1

**[8]**

**5.**

(a) electron → proton → neutron

1

(b) (times heavier =)

$$\frac{1.673 \times 10^{-27}}{9.109 \times 10^{-31}}$$

1

$$= 1837$$

*allow 1836.645076 correctly rounded to at least 3 significant figures*

1

(c) 46

1

(d) 36

1

(e) ( $A_r$  =)

$$\frac{(35 \times 75.77) + (37 \times 24.23)}{100}$$

1

$$= 35.4846$$

1

$$= 35.48$$

*allow an answer correctly calculated to 2 decimal places from an incorrect calculation which uses the values in the question*

1

(f) one shared pair in overlap

1

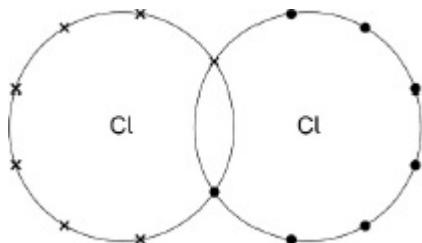
each chlorine atom with 6 non-bonded electrons (on outer shell)

*ignore any inner shell electrons*

1

*allow any combination of circles, dots, crosses, e<sup>(-)</sup> for electrons*

*the diagram below scores 2 marks*



[10]

6.

(a) alkali metals

1

(b) 3 / three

1

4 / four

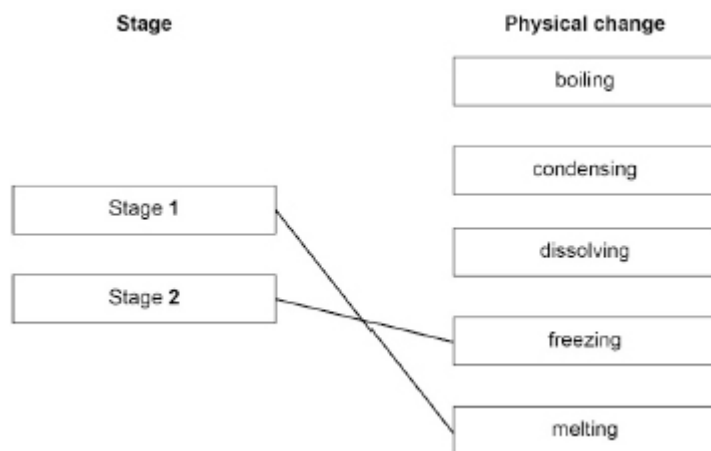
1

*must be in this order*

(c) +1

1

(d)



*do not accept more than one line from a box on the left*

2

(e) 28 (°C)

1

(f) bar plotted at 63 °C

*allow tolerance of ± ½ a small square*

1

(g) (melting point) decreases as go down Group 1

*ignore boiling points*

*allow 1 mark for (melting point) decreases*

2

(and the) differences get smaller

**or**

initial drop is largest

1

*allow converse in terms of increasing melting point*

(h) liquid

1

(i) loses an electron

1

**[13]**