Chemical patterns – 2021/20 GCSE 21st Chemistry Combined Science B

1. Nov/2021/Paper_J260/02/No.1

Mendeleev organised elements into the first Periodic Table.

(a) (i) What information did Mendeleev use to help him decide the order of the elements?

Tick (✓) **one** box.

Alphabetical order	☐
Colour	☐
Date discovered	☐
Relative atomic mass	☐

[1]

(ii) Mendeleev left gaps in the table.

Give **one** reason why he needed to leave gaps.

.....

..... **[1]**

(b) (i) **Fig. 1.1** shows the electron arrangement in a lithium atom.

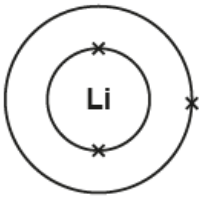


Fig. 1.1

Draw lines to connect each statement about the number and arrangement of electrons in a lithium atom with the correct information in the Periodic Table.

Number and arrangement of electrons in a lithium atom	**Information in the Periodic Table**
Number of electrons in the outer shell	Atomic number
Number of electron shells	Group number
Total number of electrons	Period number

[2]

(ii) The properties of an element depend on the arrangement of electrons in its atoms.

Lithium and fluorine have different arrangements of electrons, and different properties.

Fig. 1.2 shows the electron arrangement of fluorine.

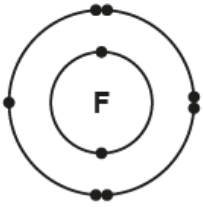


Fig. 1.2

Complete the table about the properties of lithium and fluorine.

Put a (ring) around the correct answers.

Lithium – Group 1	Fluorine – Group 7
Metal / non-metal	**Metal / non-metal**
Loses / gains electrons to form ions	**Loses / gains** electrons to form ions
Forms **positive / negative** ions	Forms **positive / negative** ions

[2]

2. Nov/2021/Paper_J260/02/No.2

Ideas about the structure of the atom have developed over time.

(a) (i) Draw lines to connect each scientist with their idea about the structure of the atom.

Scientist	Idea
Bohr	Atoms contain a nucleus.
Rutherford	Electrons are arranged in shells.
Thomson	An atom is like a 'plum pudding'.

[2]

(ii) Give **one** reason why scientists needed to develop new ideas about the structure of the atom over time.

.....

..... **[1]**

(b) Scientists now know that the atom contains electrons, protons and neutrons.

(i) Complete the table by giving the charge of each of these particles.

Particle	Charge
Electron	.....
Proton	.....
Neutron	.....

[1]

(ii) Electrons are arranged in shells around the outside of the atom.

Give the location of the other particles in the atom.

..... **[1]**

(iii) How many electrons, protons and neutrons are there in an atom of phosphorus?

Use the Data Sheet.

Electrons .....

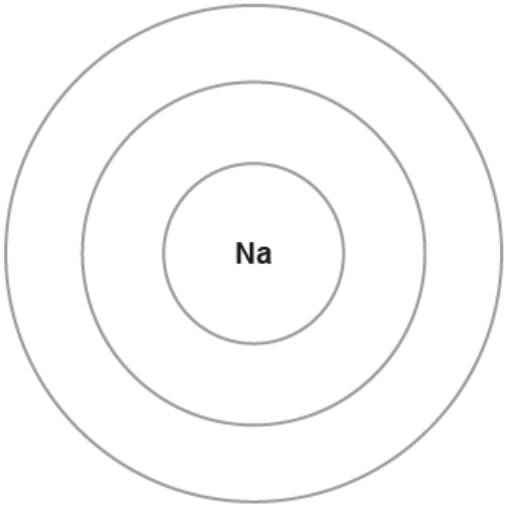
Protons .....

Neutrons .....

[2]

(c) Sodium is in Group 1 of the Periodic Table.

Complete the diagram to show the arrangement of electrons in a sodium atom.
Use the Data Sheet.



[2]

3. Nov/2021/Paper_J260/04/No.7

(a) Krypton is a Group 0 element.

Which **two** statements are properties of krypton?

Tick (✓) **two** boxes.

It forms positive ions when reacting. ☐

It is a gas at room temperature. ☐

It is a liquid at room temperature. ☐

It has a low melting point. ☐

It reacts with Group 1 elements. ☐

It reacts with water. ☐

[2]

(b) The table shows some properties of the Group 1 elements.

Complete the table by predicting the reaction of caesium with water, and the melting point of rubidium.

Group 1 element	Reaction with water	Melting point (°C)
Lithium	slow fizzing	181
Sodium	melts, rapid fizzing	98
Potassium	melts, burns and pops	64
Rubidium	explosive	.....
Caesium	.....	29

[2]

(c) Potassium reacts with oxygen to form potassium oxide, K_2O.

Calculate the relative formula mass of potassium oxide.

Use the Data Sheet.

Relative formula mass of potassium oxide = ... **[3]**

(d) Sodium has an atomic number of 11 and a relative atomic mass of 23.

Complete the table to show the number of protons, neutrons and electrons in a sodium **ion**, Na^+.

Number of protons	.....
Number of neutrons	.....
Number of electrons	.....

[2]

(e) Which scientist developed the Periodic Table?

Tick (✓) **one** box.

Dalton ☐

Thomson ☐

Mendeleev ☐

Rutherford ☐

[1]

4. Nov/2020/Paper_J260/02/No.1

Atoms contain protons, neutrons and electrons.

(a) (i) Complete the table to give information about protons, neutrons and electrons.

	Relative mass	Relative Charge	Location in the atom
Proton	1	+1	.....
Neutron	.....	.....	.....
Electron	.....	.....	in shells

[3]

(ii) The Periodic Table shows information about atoms of sulfur.

What is the group number and period number for sulfur?

Use the Data Sheet.

Group number = ...

Period number = ...

[2]

(b) The diameter of an atom is approximately 0.1 nm.

The diameter of a bacterium is approximately 10 000 times bigger than the diameter of an atom.

Estimate the diameter of a bacterium, in **mm**.

1 mm = 1 000 000 nm

Diameter of bacterium = ... mm **[2]**

5. Nov/2020/Paper_J260/02/No.3

Sodium chloride is an ionic compound.

(a) Complete the sentences about the structure and bonding of ionic compounds.

Put a (ring) around the correct words to complete each sentence.

Ions are formed when **electrons / protons** are **shared / transferred**.

The forces holding the ions together are **electrostatic / magnetic**.

Ions are held together in a **lattice / molecule**.

[3]

(b) **Fig. 3.1** and **Fig. 3.2** show two ways of representing the structure and bonding of sodium chloride NaCl.

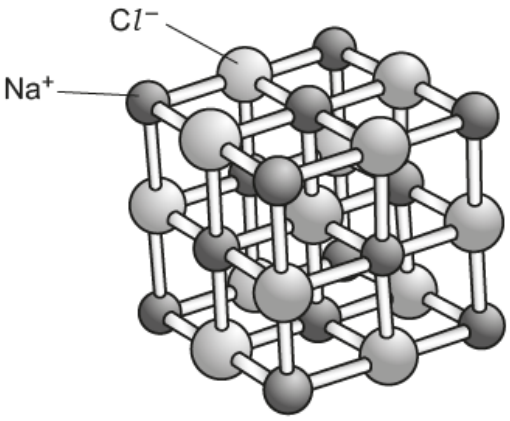


Fig. 3.1

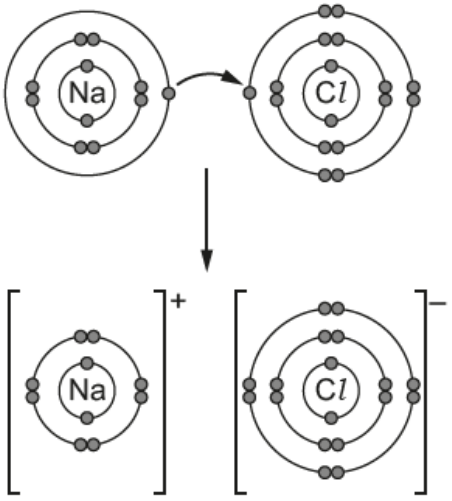


Fig. 3.2

Complete the table to identify what is shown in **Fig. 3.1** and **Fig. 3.2**.

Tick (✓) at least **one** box in each row.

Statement	**Fig. 3.1**	**Fig. 3.2**
How the ions are arranged.		
How the ions are formed.		
The charge on each ion.		

[3]

(c) **(i)** Explain why sodium chloride conducts electricity when it is molten but does **not** conduct electricity when it is solid.

.....

.....

..... **[2]**

(ii) When electricity passes through molten sodium chloride it decomposes.

Name the **two** products formed when molten sodium chloride decomposes.

..... and .....

[2]

(d) Sodium chloride is soluble in water.

Sodium chloride crystals can be made from a solution of sodium chloride in water by the process of **crystallisation**.

Which **two** steps are needed to **produce** large sodium chloride crystals from a pure solution of sodium chloride?

Tick (✓) **two** boxes.

Add universal indicator. ☐

Add more water to the solution. ☐

Heat the solution until most of the solution has evaporated. ☐

Heat the solution until all the water has evaporated. ☐

Leave hot solution to cool slowly. ☐

[2]

(e) Sea water contains dissolved sodium chloride. It can be used as a source of drinking water if the dissolved sodium chloride is removed.

Which **two** methods can be used to **remove** dissolved sodium chloride from sea water?

Tick (✓) **two** boxes.

Chromatography ☐

Distillation ☐

Filtration ☐

Membrane filtration ☐

Titration ☐

[2]

6. Nov/2020/Paper_J260/02/No.9

Elements in the Periodic Table are arranged in order of atomic number.

(a) The atomic number and relative atomic mass of an element can be used to work out the number of protons, electrons and neutrons in its atoms and ions.

Complete the table.

Use the Data Sheet.

Symbol	Na **atom**	F^- **ion**
Atomic number	.....	9
Number of protons	11	9
Number of electrons	.....	.....
Number of neutrons	.....	.....

[3]

(b) **(i)** Magnesium is a metal and phosphorus is a non-metal.

They have different electron arrangements.

	Electron arrangement
Magnesium	2.8.2
Phosphorus	2.8.5

How do the electron arrangements of magnesium and phosphorus show that they are in the same **period** but in different **groups**?

Same period .....

.....

Different groups .....

.....

[2]

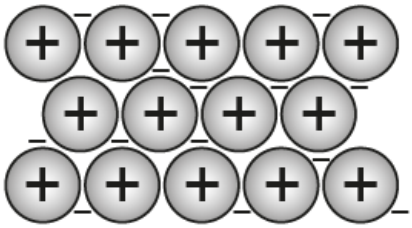
(ii) The electron arrangement of argon is 2.8.8.

What does this tell you about the reactivity of argon?

.....

..... **[1]**

(c) The diagram shows how the particles in magnesium metal are arranged.



(i) Complete the key to the diagram.

Key

+	
–	

[1]

(ii) The structure of metals explains why their properties are different from those of non-metals.

Draw lines to connect each metal property with its explanation.

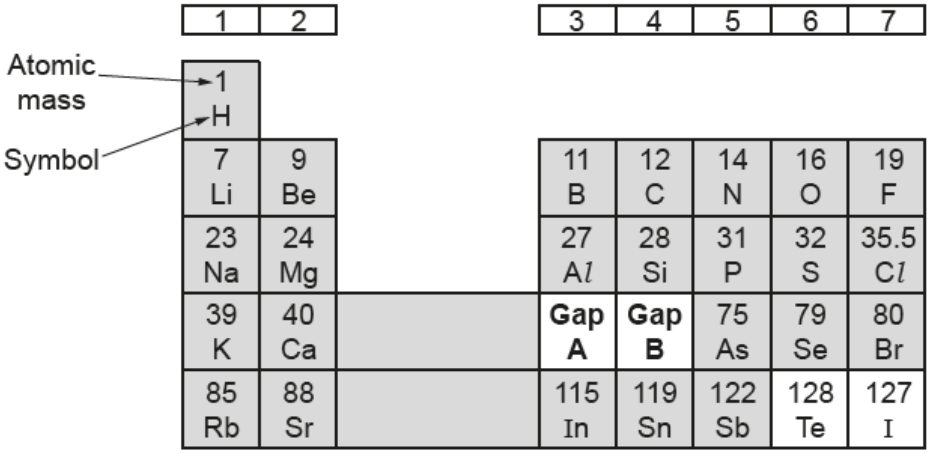
Metal Property	Explanation
	Metal ions can slide over each other
Malleable	
	Metal ions have positive charges
Solid metal conducts electricity	
	Outer shell electrons move freely
High melting point	
	Strong attraction between charged particles in the metal structure

[2]

7. Nov/2021/Paper_J260/06/No.3

Mendeleev developed an early Periodic Table based on the elements that were known about at the time. He put these elements in order of increasing atomic mass.

Here is part of Mendeleev's table.



1	2		3	4	5	6	7
1 H							
7 Li	9 Be		11 B	12 C	14 N	16 O	19 F
23 Na	24 Mg		27 Al	28 Si	31 P	32 S	35.5 Cl
39 K	40 Ca		**Gap A**	**Gap B**	75 As	79 Se	80 Br
85 Rb	88 Sr		115 In	119 Sn	122 Sb	128 Te	127 I

(a) Mendeleev left gaps in positions **A** and **B** in his table.

(i) How did leaving these gaps help him to arrange the other elements into groups?

Use ideas about properties of elements in your answer.

.....

..... **[1]**

(ii) How did the work of later scientists show that he was correct to leave gaps?

.....

.....

.....

..... **[2]**

(iii) What is unusual about the positions of **Te** and **I**?

.....

..... **[1]**

(b) The modern Periodic Table is organised in order of the atomic number of the elements.

(i) **Fig. 4.1** shows the arrangement of electrons in lithium and fluorine.

Fig. 4.1

How does the arrangement of electrons in **lithium** relate to its atomic number, group and period?

Atomic number .....

.....

Group .....

.....

Period .....

.....

[3]

(ii) Lithium is a metal and fluorine is a non-metal.

Explain how **and** why metals and non-metals form different types of ions.

Use **Fig. 4.1** to support your answer.

.....

.....

.....

.....

.....

..... **[3]**

8. Nov/2021/Paper_J260/06/No.7

Layla investigates the trend in reactivity of the Group 7 elements, using these solutions:

Chlorine water	Potassium chloride
Iodine water	Potassium iodide
Bromine water	Potassium bromide

Describe what **experiments** she should do, what **observations** she should expect and explain how her observations can be used to **show** the trend in reactivity of the Group 7 elements.

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..... **[6]**

9. Nov/2021/Paper_J260/08/No.5

Group 1 elements react with Group 7 elements.

(a) Complete the sentences to explain how the reaction between potassium and bromine is related to their electron arrangements.

Use the words and numbers.

You can use each word and each number once, more than once, or not at all.

–1 –2 +1 +2 atom electron ions

isotopes neutron one proton two

Potassium loses one ..... from the outer shell of its atoms to form

..... with a charge of ..... Bromine gains one

..... to fill the outer shell of its atoms to form ..... with a charge of

..... .

[3]

(b) Give **one** property of Group 1 elements and **one** property of Group 7 elements.

Property of Group 1 elements .....

.....

Property of Group 7 elements .....

.....

[2]

10. Nov/2020/Paper_J260/06/No.2

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Complete the table.

Use the Data Sheet.

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.....

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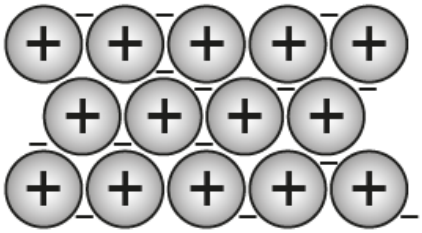

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Key

+	
–	

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Malleable	
	Metal ions have positive charges
Solid metal conducts electricity	
	Outer shell electrons move freely
High melting point	
	Strong attraction between charged particles in the metal structure

[2]

11. Nov/2020/Paper_J260/06/No.4

Atoms contain protons, neutrons and electrons.

(a) (i) Complete the table to show the relative masses and charges of these particles.

Particle	Relative mass	Relative charge
Proton	.....	.....
Neutron	.....	.....
Electron	.....	.....

[2]

(ii) Describe how these **three** particles are arranged in an atom.

.....

.....

.....

..... **[2]**

(b) James builds a model of an atom.

He uses a golf ball with a diameter of 43 mm to represent the nucleus in his model.

The diameter of an atom is 1×10^5 times larger than the diameter of its nucleus.

What diameter should James use for his model of the atom?

Give your answer in **metres**.

Diameter of model of atom = ... m **[2]**

12. Nov/2020/Paper_J260/08/No.4

(a) Sodium is an element in Group 1 of the Periodic Table.

Write the **balanced symbol** equation for the reaction of sodium with chlorine.

Include state symbols.

..... **[3]**

(b) **Table 4.1** shows some Group 2 elements and their reaction with water.

Element	Reaction with water
Beryllium	No reaction
Magnesium	Reacts with steam
Calcium	Reacts slowly with cold water
Strontium	

Table 4.1

(i) Predict the reaction of strontium with water.

.....

..... **[1]**

(ii)* **Table 4.2** shows the melting point of some Group 2 oxides.

Oxide	Melting point (°C)
Magnesium oxide	2852
Calcium oxide	2572
Strontium oxide	2531
Barium oxide	1923

Table 4.2

Table 4.3 shows the ionic radius of Group 2 ions, and the oxide ion.

Element	Ion	Ionic radius (nm)
Magnesium	Mg^{2+}	0.072
Calcium	Ca^{2+}	0.100
Strontium	Sr^{2+}	0.118
Barium	Ba^{2+}	0.135
Oxygen	O^{2}	0.140

Table 4.3

Explain the trend in melting points for the Group 2 oxides shown in **Table 4.2**.

Use data from **Table 4.2** and **Table 4.3**, and your knowledge of ionic bonding, to support your answer.

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..... **[6]**