Chemical patterns – 2022 GCSE 21st Chemistry B

1. May /2022/Paper_ J258/01/No.2

(a) Complete the sentence to describe how Mendeleev placed elements in the Periodic Table.

Use words from the list.

atomic	**colour**	**molecular**	**properties**	**size**

Mendeleev organised the elements based on their ..... and their relative ..... masses.

[2]

(b) **Table 2.1** shows the properties of some elements.

Name	Atomic number	Melting point (°C)	Appearance	Electrical conductivity
Lithium	3	181	shiny when cut	good
Boron	5	2076	black	poor
Magnesium	12	650	shiny	good
Phosphorus	15	44	white/yellow	poor

Table 2.1

(i) Which **two** elements in **Table 2.1** are metals?

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

(ii) Which **column** in **Table 2.1** did you use to work out your answer to **(b)(i)**?

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

(iii) The elements in **Table 2.1** are all solids at room temperature (25 °C).

How does the data in the table show that this is true?

.....

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

(iv) What does atomic number tell you about the nucleus of an atom?

.....

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

(c) Iodine and chlorine are halogens in Group 17 (Group 7).

(i) Draw lines to connect each **halogen** with its correct **appearance** at room temperature (25 °C).

Halogen	Appearance
Chlorine	Grey solid
Iodine	Purple gas
	Green gas
	Brown liquid

[2]

(ii) Sodium iodide solution reacts with chlorine.

Complete the word equation for this reaction.

sodium iodide + chlorine → iodine + ...

[1]

2. May /2022/Paper_ J258/02/No.1

Fig. 1.1 shows a model for the arrangement of ions in an ionic compound when it is a solid and when it is a liquid.

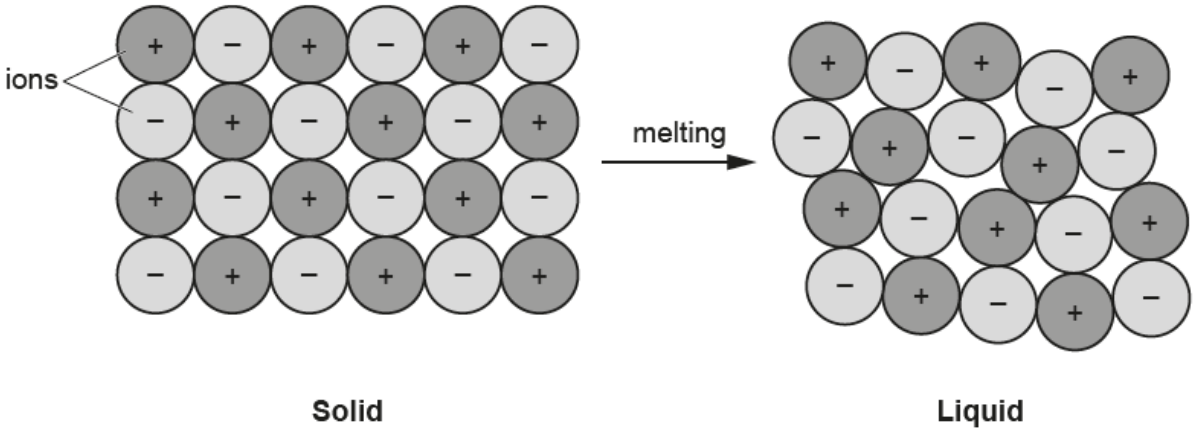


Fig. 1.1

(a) Which of the following statements are true only for the solid, which are true only for the liquid and which are true for both?

Tick (✓) **one** box in each row.

	True only for the solid	True only for the liquid	True for both
The ions are close together.			
The ions are attracted by opposite charges.			
The ions are in a regular arrangement.			
The ions can move over each other.			

[2]

(b) Sodium chloride and magnesium chloride are ionic compounds.

The melting points of sodium chloride and magnesium chloride are shown in the table.

	Melting point (°C)
Sodium chloride	801
Magnesium chloride	714

(i) What is the state of sodium chloride and of magnesium chloride at 750 °C?

Put a (ring) around **one** word to complete each sentence.

At 750 °C, sodium chloride is a **solid / liquid / gas**.

At 750 °C, magnesium chloride is a **solid / liquid / gas**.

[1]

(ii) A limitation of the model shown in **Fig. 1.1** is that it does **not** show the reasons why different compounds have different melting points.

Which **two** statements describe the reasons why compounds have different melting points?

Tick (✓) **two** boxes.

Ions in different compounds have different chemical symbols. ☐

Ions in different compounds have different charges. ☐

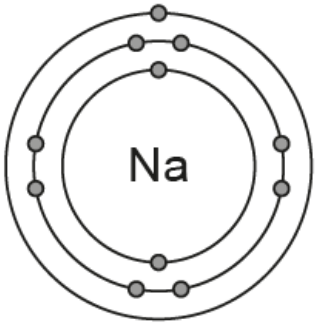
Ions in different compounds have different colours. ☐

The force of attraction between ions is different in different compounds. ☐

[2]

(c) Sodium chloride contains sodium ions, Na^+, with a single positive charge.

Fig. 1.2 shows the arrangement of electrons in a sodium atom.



Electron arrangement: 2,8,1

Fig. 1.2

(i) Which information from the Periodic Table shows us that a sodium atom contains a total of 11 electrons?

Tick (✓) **one** box.

the atomic number	☐
the chemical symbol for the element	☐
the group number	☐
the relative atomic mass	☐

[1]

(ii) Use ideas about electrons to explain why sodium atoms form an ion with a +1 charge.

.....

.....

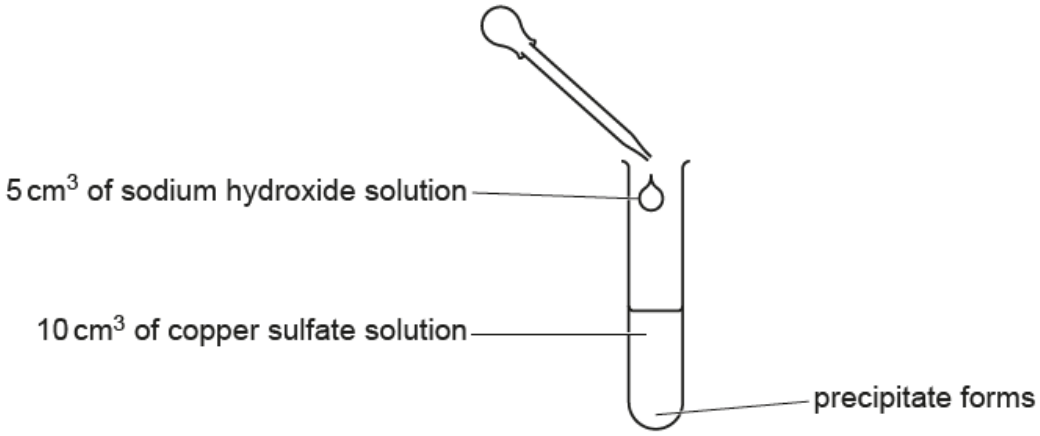
..... **[2]**

3. May /2022/Paper_ J2580/2/No.2

Jane does an experiment.

She puts 10 cm^3 of copper sulfate solution in a boiling tube.

She adds 5 cm^3 of sodium hydroxide solution. A precipitate of copper hydroxide forms.



(a) What are the correct state symbols for copper sulfate and copper hydroxide in this experiment?

Tick (✓) **one** box in each row.

Substance	State symbol		
	(s)	(aq)	(l)
copper sulfate solution			
copper hydroxide precipitate			

[2]

(b) At the end of the reaction, the boiling tube contains a mixture of a precipitate of copper hydroxide in a solution.

Describe how Jane can separate pure, dry copper hydroxide from this mixture.

.....

.....

.....

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

(c) Jane does more experiments.

She adds a different volume of sodium hydroxide solution to 20 cm^3 of copper sulfate solution each time.

She records the mass of dry copper hydroxide that forms in each experiment.

Table 2.1 shows her results.

Volume of copper sulfate solution (cm^3)	Volume of sodium hydroxide solution added (cm^3)	Mass of dry copper hydroxide formed (g)
20	5	0.18
20	10	0.52
20	15	0.58
20	20	0.78
20	25	0.98
20	30	0.98
20	35	0.98

Table 2.1

(i) Describe the pattern shown by the results in **Table 2.1**.

.....

.....

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

(ii) Jane wants to change her experiment to make more than 1.00 g of dry copper hydroxide.

Jane and Alex talk about the results.

Jane says, 'To make more copper hydroxide we need to add more than 35 cm^3 of sodium hydroxide solution.'

Alex says, 'To make more copper hydroxide we need to add more than 20 cm^3 of copper sulfate solution.'

Who is right?

Jane ☐

Alex ☐

Use information from **Table 2.1** to explain your choice.

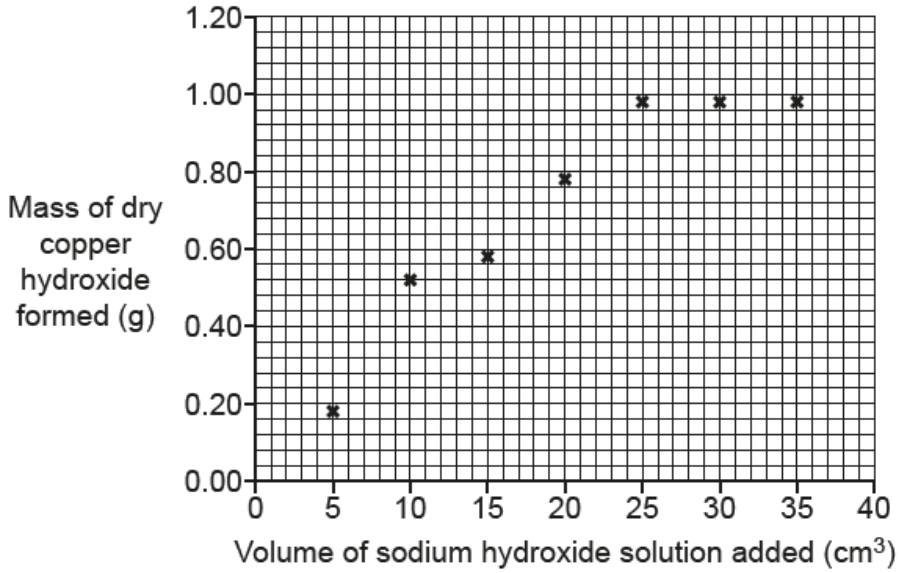
.....

.....

.....

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

(d) Jane plots her results on a graph.



Jane thinks that one of her results is an outlier.

(i) Draw lines of best fit on the graph. **[1]**

(ii) Put a (ring) around the outlier on the graph. **[1]**

(iii) Suggest what the correct mass reading for the outlier should be.

correct mass reading = ... g **[1]**

(iv) What is the most likely reason for the outlier?

Tick (✓) **one** box.

Jane did not add enough sodium hydroxide solution. ☐

Some of the copper hydroxide was lost before weighing. ☐

The copper hydroxide contained water when Jane weighed it. ☐

The reaction had not finished. ☐

[1]

4. May /2022/Paper_ J258/03/No.5

Iodine is a halogen. It is an element in Group 17 (7) of the Periodic Table.

(a) Which property shows iodine is a non-metal?

Tick (✓) **one** box.

It is a shiny grey solid. ☐

It does not conduct electricity. ☐

It is unreactive. ☐

Its density is higher than water. ☐

[1]

(b) $1.00\,cm^3$ of iodine has a mass of 4.93 g.

Calculate the volume of 1.00 mol of I_2.

Use the equation: number of moles = $\frac{\text{mass of substance (g)}}{\text{relative formula mass (g)}}$

Give your answer to **1** decimal place.

Volume = ... cm^3 **[3]**

(c) Sodium iodide solution reacts with chlorine. This is a symbol equation for the reaction:

$2NaI(aq) + Cl_2(aq) \rightarrow 2NaCl(aq) + I_2(aq)$

(i) What would you **see** when this reaction happens?

.....

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

(ii) What information does this reaction show about the reactivity of the halogens?

.....

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

(d) An isotope of iodine has a mass number of 127.

How many neutrons and electrons does an atom of this isotope have?

Use the Data Sheet.

Number of neutrons = ...

Number of electrons = ...

[2]

(e) Phosphorus reacts with iodine to form a compound.

The compound contains 7.5% by mass of phosphorus. The rest of the compound is iodine.

Determine the formula of the compound.

Use the equation: number of moles = $\frac{\text{mass of substance (g)}}{\text{relative formula mass (g)}}$

Formula = ... **[3]**

5. May /2022/Paper_ J258/03/No.8(b, c)

Magnesium reacts with iron sulfide. This is a symbol equation for the reaction:

$Mg + FeS \longrightarrow Fe + MgS$

(b) Magnesium sulfide, MgS is an ionic compound which contains the ions Mg^{2+} and S^{2-}.

Explain why magnesium sulfide has a high melting point.

.....

.....

.....

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

(c) Complete **Fig. 8.1** to show the 'dot and cross' diagrams for an Mg^{2+} ion and an S^{2-} ion.

Show **all** the electrons.

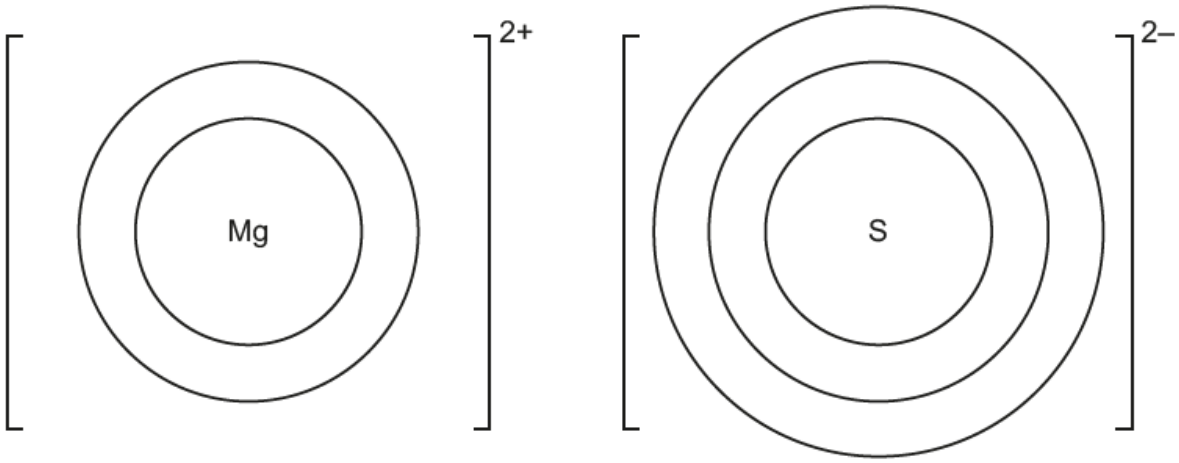


Fig. 8.1

[2]

6. May /2022/Paper_ J258/04/No.6

Fig. 6.1 shows the particle model for solids, liquids and gases.

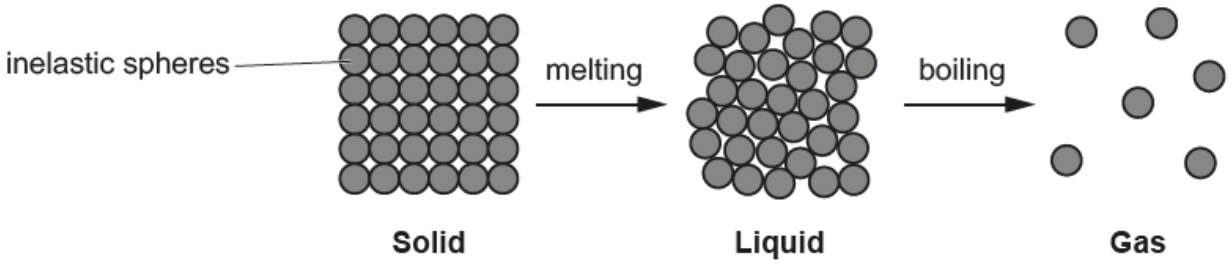


Fig. 6.1

(a) Neon is a gas in Group 18 (0) of the Periodic Table.

Use the particle model in **Fig. 6.1** to describe what happens to the arrangement and movement of the atoms when neon changes from a liquid to a gas.

.....

.....

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

(b) Sodium atoms form sodium ions with a single positive charge.

Neon atoms do not form ions.

Use ideas about electrons to explain these statements.

.....

.....

.....

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

(c)* Sodium chloride contains sodium ions, Na^+, and chloride ions, Cl^-.

Fig. 6.2 shows the ionic model for solid and liquid sodium chloride.

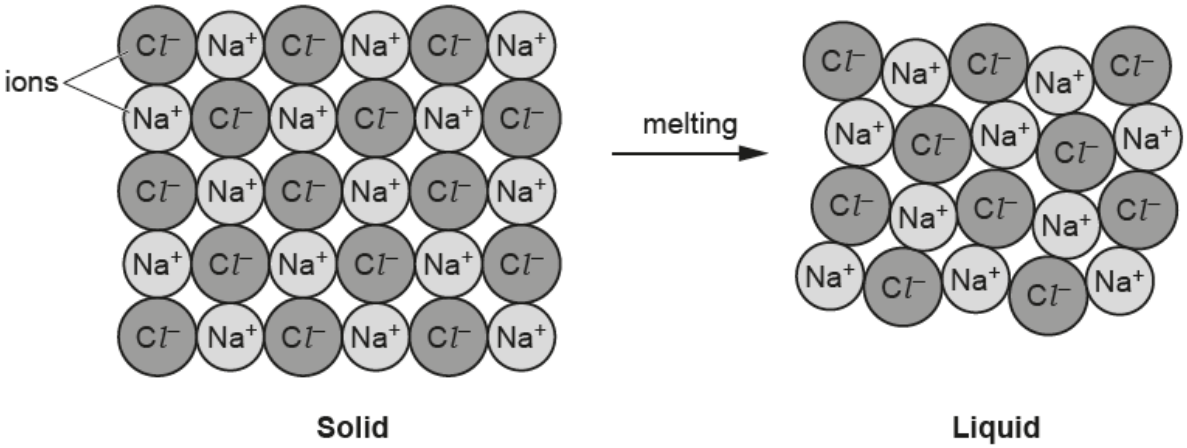


Fig. 6.2

The melting points of neon and sodium chloride are shown in the table.

	Melting point (°C)
neon	–249
sodium chloride	801

Describe the similarities and differences in how melting is represented by the models in **Fig. 6.1 and Fig. 6.2** and explain why both models are needed to explain the differences in the melting points shown in the table.

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