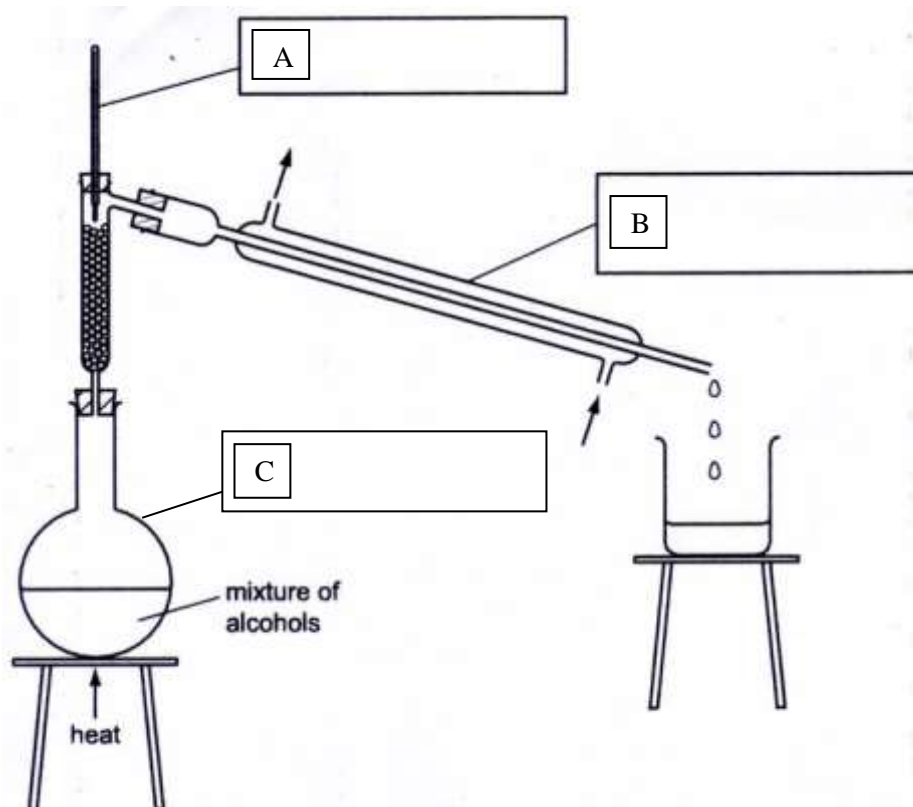


4-1 / 5-1 Atomic structure and the periodic table – Chemistry and Trilogy

1.0 A student separated a mixture of two alcohols, ethanol (boiling point 78 °C) and butanol (boiling point 118 °C).

The apparatus is shown in **Figure 1**.

Figure 1



1.1 Complete the boxes in **Figure 1** to identify the pieces of apparatus labelled A, B and C
[3 marks]

1.2 What is the name of this separation process?
[1 mark]

1.3 Suggest why the first liquid to collect in the beaker is ethanol.
[1 mark]

- 1.4 Alcohols are flammable.
Suggest how the mixture of alcohols should be safely heated so that ethanol can be collected

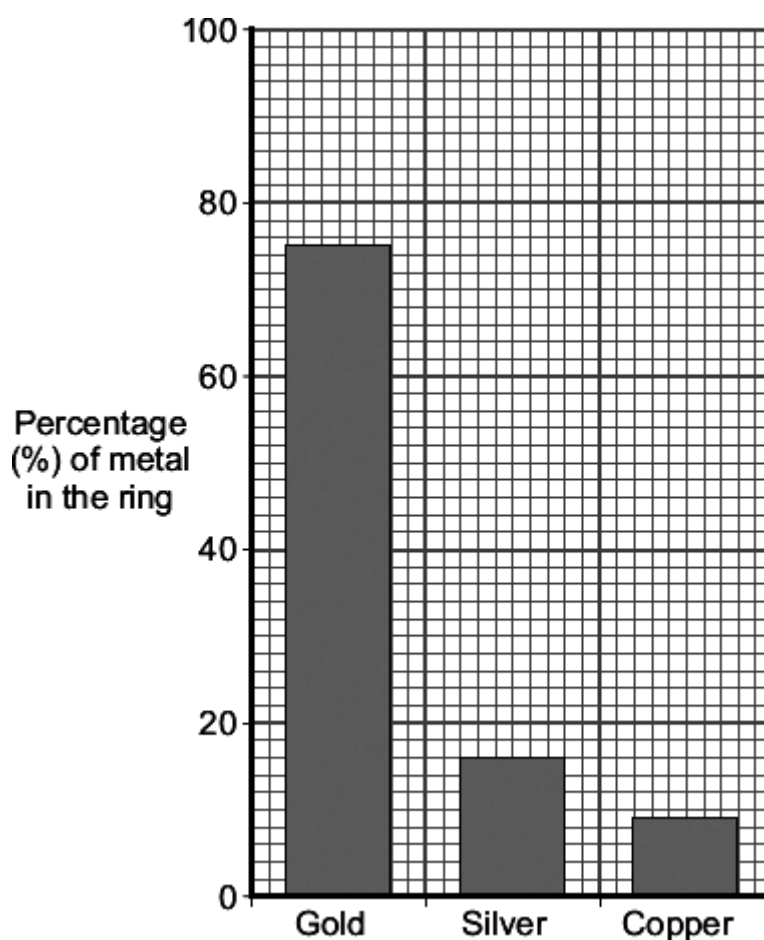
[1 mark]

- 2.0 The picture shows a pair of gold rings.
Gold rings are made from alloys of gold.



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The bar chart shows the composition of the alloy of gold used in the ring.



2.1 State the composition of the alloy used to make the ring.

[3 marks]

2.2 An atom of gold can be represented as ${}_{79}^{197}\text{Au}$.

This shows that a gold atom has an atomic number of 79 and a mass number of 197.

Complete the table to show the numbers of each sub-atomic particle in this gold atom.

[3 marks]

| Name | Number |
|----------|--------|
| Proton | |
| Electron | |
| Neutron | |

3.0 A student is given a mixture of salt and sand.

Describe a method the student could use to separate the mixture.

The student should obtain:

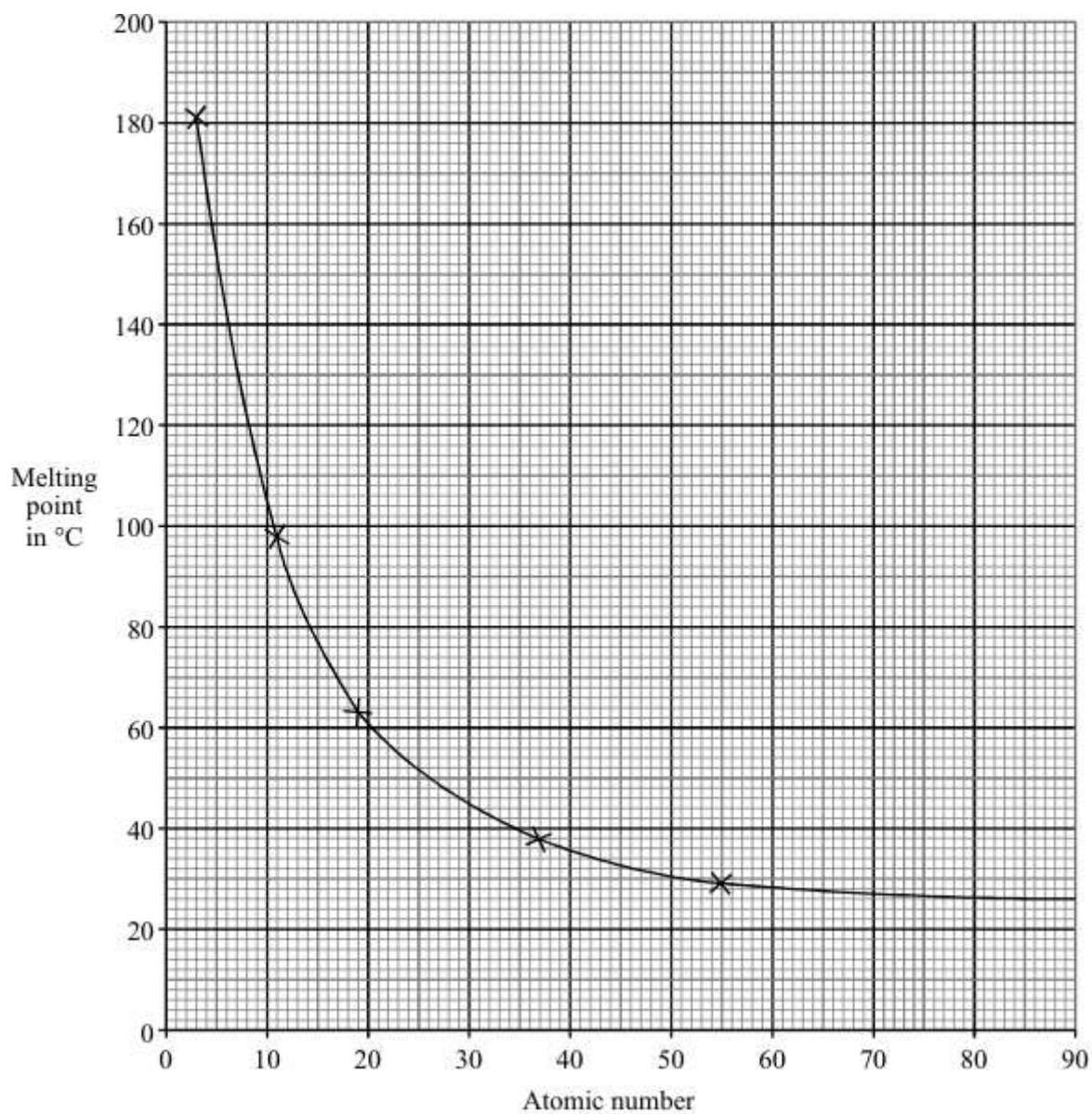
- salt crystals
- dry sand

In your method you should name all of the apparatus you will use.

[6 marks]

4.0 The **Graph 1** shows the melting points of the Group 1 metals plotted against their atomic numbers.

Graph 1



4.1 Give **two** conclusions that can be drawn from the graph.

[2 marks]

4.2 The alkali metal francium has an atomic number of 87.

Estimate the melting point of francium.

[1 mark]

Melting point of francium = _____ °C

4.3 Lithium has 3 electrons. Draw a diagram to show the electronic structure of lithium.

[1 mark]

4.4 Describe what you would see when sodium is added to water.

[3 marks]

4.5 Complete the balanced equation for the reaction of sodium with water.

[2 marks]



4.6 Describe the trend in reactivity of group 1 metals with water.

[1 mark]

4.7 Explain the trend in reactivity of group 1 metals with water.

[3 marks]

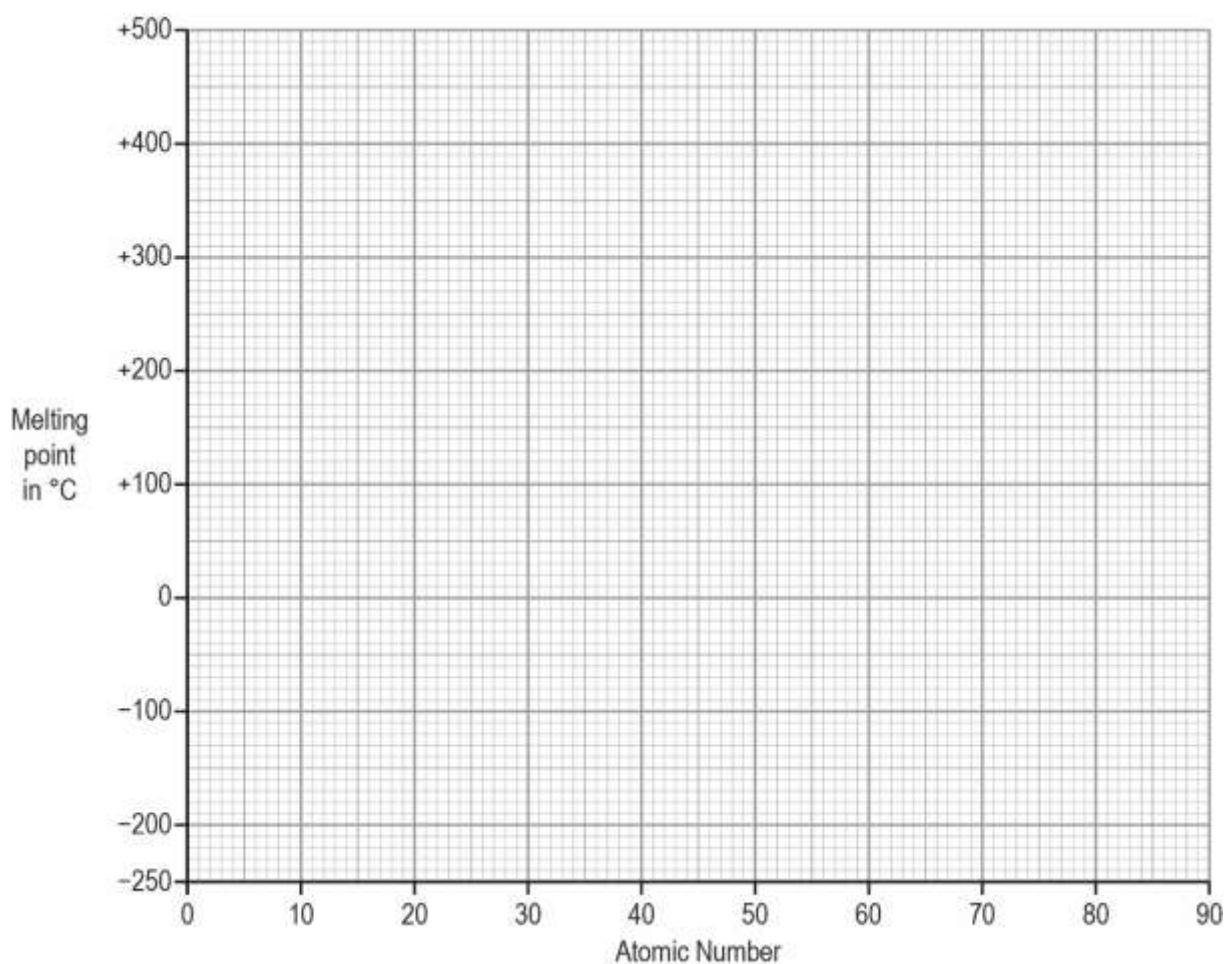
5.0 The table gives the melting points of some of the elements of Group 7.

| Element | Atomic number | Melting point in °C |
|----------|---------------|---------------------|
| Fluorine | 9 | -220 |
| Chlorine | 17 | |
| Bromine | 35 | -7 |
| Iodine | 53 | 114 |
| Astatine | 85 | 301 |

5.1 Plot a graph of the melting point against atomic number.

Draw a line of best fit.

[2 marks]



5.2 Estimate the melting point of chlorine

[1 mark]

_____ °C

5.3 What is the state of iodine at 25 °C?

[1 mark]

5.4 Chlorine has two isotopes ${}_{17}^{35}\text{Cl}$ and ${}_{17}^{37}\text{Cl}$

Why do these two isotopes have a different mass number?

[2 marks]

5.5 The relative formula mass of chlorine is 35.5.

Explain why this is not a whole number.

[1 mark]

6.0 Dmitri Mendeleev was one of the first chemists to classify the elements. Mendeleev arranged the elements in order of their atomic weight in a table. Part of his table is shown below.

Use the periodic table and the information in the table below to help you to answer the questions.

| | Group | | | | | | | |
|----------|---------|----------|--------|---------|---------|----------|----------|----------|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Period 1 | H | | | | | | | |
| Period 2 | Li | Be | B | C | N | O | F | |
| Period 3 | Na | Mg | Al | Si | P | S | Cl | |
| Period 4 | K Cu | Ca Zn | — — | Ti — | V As | Cr Se | Mn Br | Fe Co Ni |

6.1 Which group of the modern periodic table is missing from Mendeleev's table?

[1 mark]

6.2 Mendeleev placed hydrogen at the top of Group 1 in his version of the periodic table. The modern periodic table does not show hydrogen in Group 1. State one **similarity** between hydrogen and the elements in Group 1.

[1 mark]

6.3 Mendeleev changed the position of iodine in his version of the periodic table so it was in the same group as chlorine. Give **two** reasons why he put iodine in the same group as chlorine.

[2 marks]

- 6.4** Protons and electrons were discovered after Mendeleev proposed his version of the periodic table.
Describe how the numbers of protons and electrons in atoms are used to place elements in the modern periodic table.

[2 marks]

MARK SCHEME

| Qu No. | | Extra Information | Marks |
|--------|--|----------------------------------|-------|
| 1.1 | A thermometer | | 1 |
| | B (Liebig) condenser | | 1 |
| | C (round bottomed) flask | allow conical flask | 1 |
| 1.2 | (fractional) distillation | | 1 |
| 1.3 | has the lowest boiling point | | 1 |
| 1.4 | heat the mixture(in C) using a water bath/electric heater | accept description of water bath | 1 |

| Qu No. | | Extra Information | Marks |
|--------|---------------|---|-------|
| 2.1 | 75 % gold | | 1 |
| | 16 % silver | Allow chemical symbols | 1 |
| | 9 % copper | | 1 |
| | | If no other mark obtained, allow 1 mark for gold, silver and copper | |
| 2.2 | (proton) 79 | | 1 |
| | (electron) 79 | | 1 |
| | (neutron) 118 | | 1 |

| Qu No. | Extra Information | Marks |
|--|--|-------|
| Level 3: | A coherent method is described with relevant detail, which demonstrates a broad understanding of the relevant scientific techniques and procedures. The steps in the method are logically ordered with the dependent and control variables correctly identified. The method would lead to the production of valid results. | 5–6 |
| Level 2: | The bulk of a method is described with mostly relevant detail, which demonstrates a reasonable understanding of the relevant scientific techniques and procedures. The method may not be in a completely logical sequence and may be missing some detail. | 3–4 |
| Level 1: | Simple statements are made which demonstrate some understanding of some of the relevant scientific techniques and procedures. The response may lack a logical structure and would not lead to the production of valid results. | 1–2 |
| Level 0 | No relevant content | 0 |
| Indicative content | | |
| <p>Named apparatus</p> <ul style="list-style-type: none"> • stirring rod • spatula • beaker • filter funnel and filter paper • evaporating basin • Bunsen burner • tripod and gauze • bench mat • beaker • oven <p>Method</p> <ul style="list-style-type: none"> • place mixture in a beaker • add water to the mixture • stir • filter the mixture • residue is sand • dry residue in a warm oven • evaporate some of the water from the filtrate (using a water bath) • allow solution (to cool and) to form crystals • remove and dry crystals | | |

| Qu No. | | Extra Information | Marks |
|--------|---|---|---------------------|
| 4.1 | any two from: <ul style="list-style-type: none"> group 1 melting points decrease as their atomic number increases the decrease in melting point decreases as the atomic number increases the decrease in melting point levels off | | 2 |
| 4.2 | 26 °C | Allow 25 – 27 °C | 1 |
| 4.3 | Diagram showing an electronic structure of 2.1 | | 1 |
| 4.4 | any three from: <ul style="list-style-type: none"> fizzes/ effervescence floats moves (on surface) melts dissolves / disappears | Allow gas given off Allow gets smaller | 3 |
| 4.5 | $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$ | Allow correct multiples Allow 1 mark for $\text{Na} + \text{H}_2\text{O} \rightarrow$ | 2 |
| 4.6 | Get more reactive down the group | Allow converse | 1 |
| 4.7 | Outer shell electron further from the nucleus (Outer shell) electron less tightly held by nucleus (Outer shell) electron more easily lost | Allow (Outer shell) Electron more shielded | 1 1 1 |

| Qu No. | | Extra Information | Marks |
|--------|--|--|------------|
| 5.1 | Points correctly plotted Line of best fit drawn | Allow tolerance of $\pm \frac{1}{2}$ a square | 1 1 |
| 5.2 | -101 °C | allow value from their graph $\pm \frac{1}{2}$ square | 1 |
| 5.3 | Solid | | 1 |
| 5.4 | (Isotopes have) different numbers of neutrons $^{35}_{17}\text{Cl}$ has 18 neutrons and $^{37}_{17}\text{Cl}$ has 20 neutrons | If neutrons calculated but incorrect award 1 mark as long as they are different Allow $^{37}_{17}\text{Cl}$ has more neutrons or $^{35}_{17}\text{Cl}$ has fewer neutrons | 1 1 |
| 5.5 | Answer: It's an average (that takes account of isotope abundance) | | 1 |

| Qu No. | | Extra Information | Marks |
|--------|--|---|-------|
| 6.1 | Group 0 | Allow noble gases | 1 |
| 6.2 | Any one from: <ul style="list-style-type: none"> one electron in outer shell / energy level forms ions with a 1+ charge | | 1 |
| 6.3 | Any two from: <ul style="list-style-type: none"> iodine has similar properties to other elements in the same group / group 7 iodine has similar reactivity to other elements in the same group / group 7 iodine reacts with metals iodine is diatomic | Ignore references to electrons Allow any correct named property e.g. low melting point / boiling point | 2 |
| 6.4 | (elements) placed in order of atomic / proton number | | 1 |
| | (elements in) same group have same number of <u>outer</u> electrons | | 1 |