AQA

SPECIMEN MATERIAL

GCSE
COMBINED SCIENCE: TRILOGY

F

Foundation Tier Paper 3: Chemistry 1F

Specimen 2018 Time allowed: 1 hour 15 minutes

Materials

For this paper you must have:
- a ruler
- a calculator
- the periodic table (enclosed)

Instructions
- Answer all questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- There are 70 marks available on this paper.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.
- When answering questions 02.4, 03.4 and 05 you need to make sure that your answer:
  - is clear, logical, sensibly structured
  - fully meets the requirements of the question
  - shows that each separate point or step supports the overall answer.

Advice
- In all calculations, show clearly how you work out your answer.

Please write clearly, in block capitals.

Centre number ☐☐☐☐☐ Candidate number ☐☐☐☐

Surname ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

Forename(s) ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

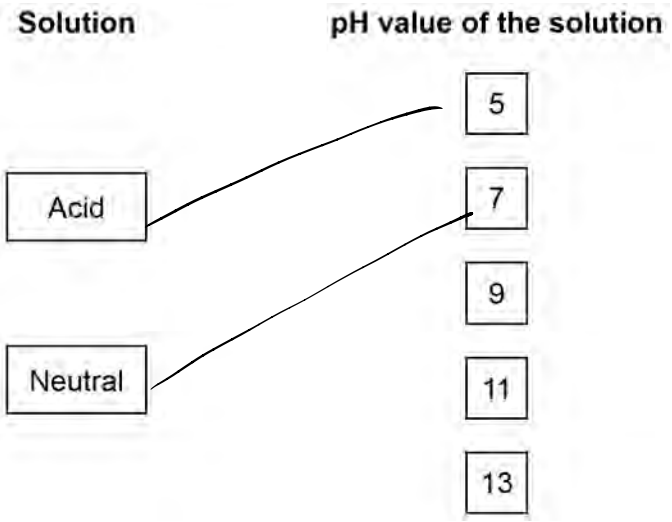
Candidate signature _____

There are no questions on this page

0 1 The pH scale is a measure of the acidity or alkalinity of a solution.

0 1 . 1 Draw one line from each solution to the pH value of the solution.

[2 marks]



0 1 . 2 Which ion in aqueous solution causes acidity?

[1 mark]

Tick **one** box.

- H^+ ☑
- Na^+ ☐
- O^{2-} ☐
- OH^- ☐

Examples of Acids

$HCl \Rightarrow H^+ + Cl^-$

$H_2SO_4 \Rightarrow 2H^+ + SO_4^{2-}$

$HNO_3 \Rightarrow H^+ + NO_3^-$

Question 1 continues on the next page

When sulfuric acid is added to sodium hydroxide a reaction occurs to produce two products.

The equation is:

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

0 1 . 3 How many elements are in the formula H_2SO_4?

[1 mark]

Tick **one** box.

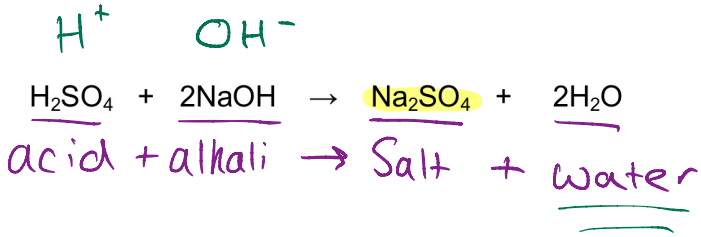
- 3 ☑
- 4 ☐
- 6 ☐
- 7 ☐

0 1 . 4 What is this type of reaction?

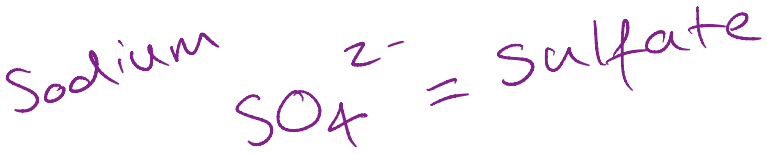
[1 mark]

Tick **one** box.

- Decomposition ☐
- Displacement ☐
- Neutralisation ☑
- Reduction ☐



0 1 . 5 Name the salt produced.



[1 mark]

Sodium sulfate

0 1 . 6 Describe how an indicator can be used to show when all the sodium hydroxide has reacted with sulfuric acid.

[3 marks]

Acid + Alkali → Salt + Water

($H^+ + OH^- \rightarrow H_2O$) Neutralisation

- Add universal indicator to Sodium hydroxide solution
- Add the sulfuric acid gradually.
- Colour change to green (pH = 7)

OR

- add indicator to sulfuric acid
- then add Sodium hydroxide gradually.

0 2 John Newlands arranged the known elements into a table in order of atomic weight.

Figure 1 shows part of Newlands' table.

Figure 1

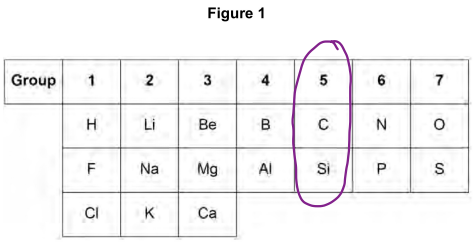
Group	1	2	3	4	5	6	7
	H	Li	Be	B	C	N	O
	F	Na	Mg	Al	Si	P	S
	Cl	K	Ca				

0 2 . 1 What are the names of the elements in Group 5 of Newlands' table?

[1 mark]

Tick **one** box.

- Calcium and sulfur ☐
- Carbon and silicon ☑
- Chlorine and silver ☐
- Chromium and tin ☐



0 2 . 2 In what order is the modern periodic table arranged?

no of protons

atomic number

[1 mark]

Tick **one** box.

- Atomic mass ☐
- Atomic number ☑
- Atomic size ☐
- Atomic weight ☐

0 2 . 3 Give **two** differences between Group 1 of Newlands' table and Group 1 of the periodic table.

[2 marks]

- H/F/Cl are not in group 1 on the periodic table. (not in the same group)
- Li/Na/K are in group 1 on the periodic table.

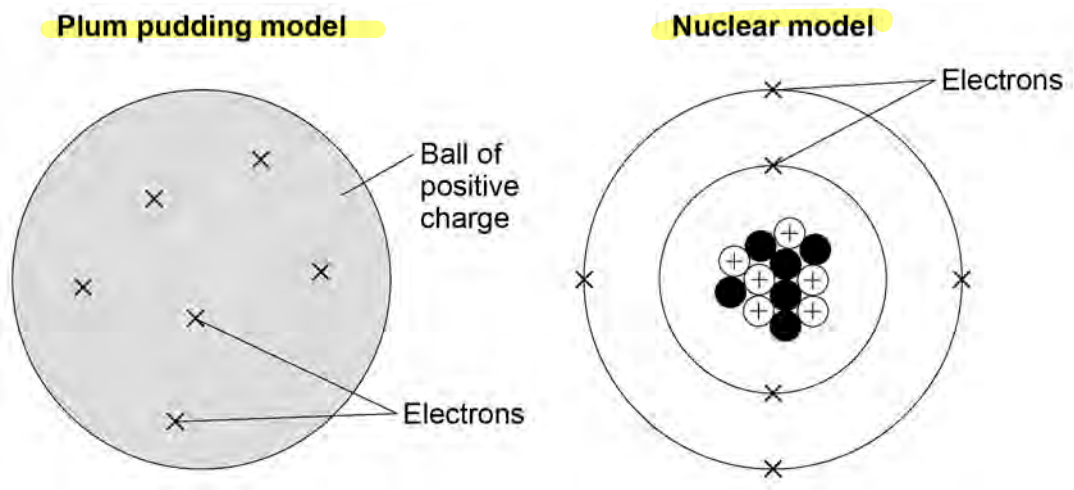
Question 2 continues on the next page

0 2 . 4 In 1864, atoms were thought to be particles that could not be divided up into smaller particles.

By 1898, the electron had been discovered and the plum pudding model of an atom was proposed.

Figure 2 shows the plum pudding model of an atom of carbon and the nuclear model of an atom of carbon.

Figure 2



Compare the position of the subatomic particles in the plum pudding model with the nuclear model.

[4 marks]

difference Similarities Protons neutrons electrons

(1) - Plum pudding model is a sphere of positive charge, nuclear model has positive nucleus.

(2) - Plum pudding has no nucleus, nuclear model does.

(3) - Plum pudding has no neutrons, nuclear model has neutrons inside the nucleus.

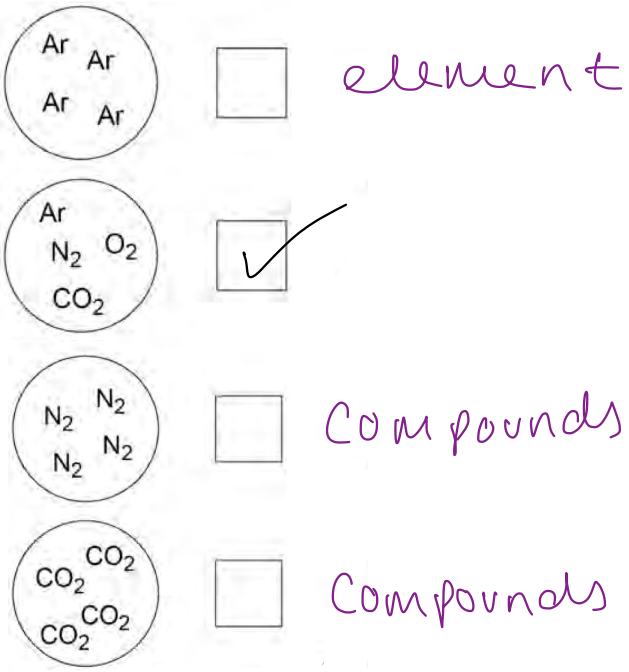
(4) - Plum pudding has electrons in random positions, nuclear model has electrons in fixed shells.

0 2 . 5 Models are used to show the differences between elements, compounds and mixtures.

Which circle shows a model of a mixture? not chemically bonded

Tick **one** box.

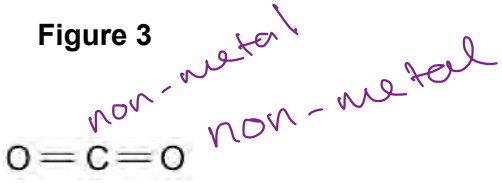
[1 mark]



Question 2 continues on the next page

Figure 3 shows a model of carbon dioxide.

Figure 3



0 2 . 6 What does each line between the atoms in **Figure 3** represent?

[1 mark]

Tick **one** box.

- Covalent bond ☑
- Intermolecular force ☐
- Ionic bond ☐
- Metallic bond ☐

0 3 Some students investigated the reactivity of four unknown metals, **W**, **X**, **Y** and **Z**.

The letters are not the symbols of these elements.

The students used metal salt solutions of copper nitrate, magnesium sulfate and zinc chloride.

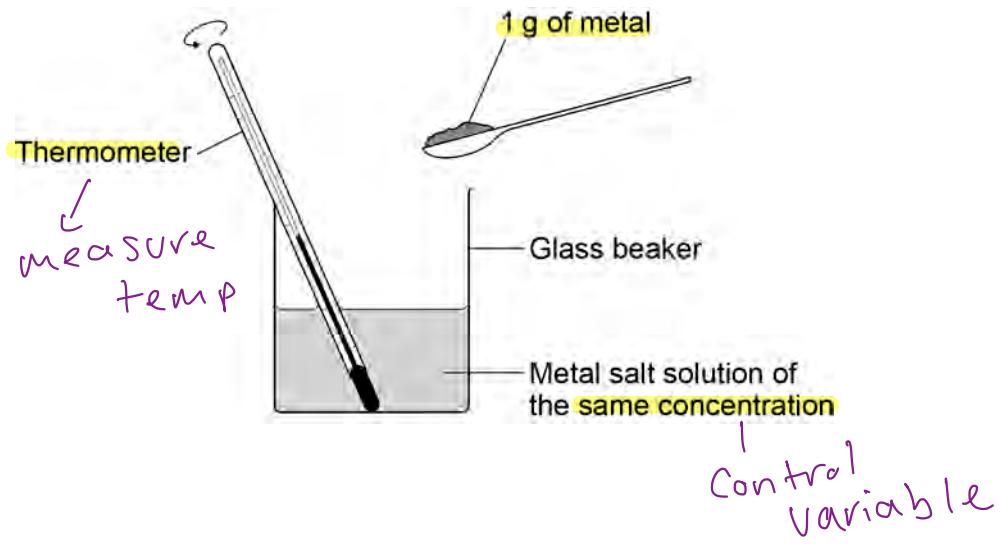
This is the method used.

1. Pour a solution of a metal salt into a glass beaker.
2. Measure the temperature of the solution.
3. Add 1 g of metal to the solution.
4. Measure the temperature of the solution.
5. Calculate the temperature increase.

The students did the experiment using each salt solution with each metal.

Figure 4 shows the apparatus the students used.

Figure 4



Question 3 continues on the next page

Table 1 shows the students' results.

Table 1

	Temperature increase in °C			
Solution	**Metal W**	**Metal X**	**Metal Y**	**Metal Z**
Copper nitrate	46	10	29	No change
Magnesium sulfate	No change	No change	No change	No change
Zinc chloride	15	No change	No change	No change

Which metal is **least** reactive?

[1 mark]

Tick **one** box.

Metal W ☐

Metal X ☐

Metal Y ☐

Metal Z ☑

Metal Z was not able to displace any of the metals in the compounds.

How do the results show that magnesium is **more** reactive than the metals **W**, **X**, **Y and Z**?

[1 mark]

Magnesium sulfate does not react with any of the metals. OR there is no temp change with any of the metals.

Table 1

	Temperature increase in °C			
Solution	**Metal W**	**Metal X**	**Metal Y**	**Metal Z**
Copper nitrate	46	10	29	No change
Magnesium sulfate	No change	No change	No change	No change
Zinc chloride	15	No change	No change	No change

0 3 . 3 How do the results show that the reaction between metal **Y** and copper nitrate solution is exothermic?

[1 mark]

give off heat

Temperature increase

0 3 . 4 One student said that the investigation was not valid (a fair test).

Write a plan for the investigation that includes improvements to the method and apparatus.

[4 marks]

Control Variables

- Same amount
- Same concentration

- Pour a fixed volume of the metal salt solution into a polystyrene cup.
- for each experiment, add the same amount / conc of solution.
- Measure the temperature of the solution.
- Add 1g of metal to the solution.
- Stir the solution.
- Measure the temperature of solution after a set time.
- Calculate the temperature increase.
- Repeat the experiment and calculate a mean.

From earlier in the question…

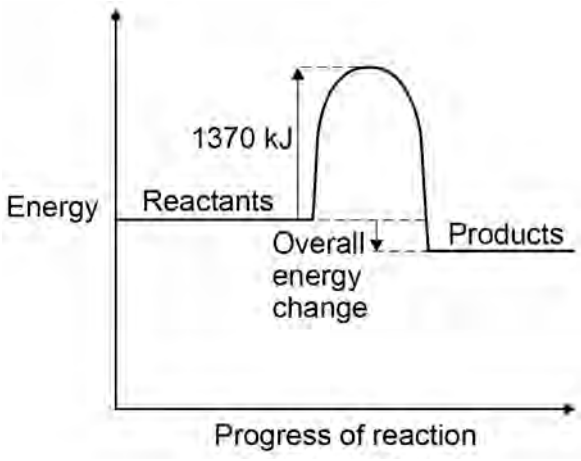
This is the method used.

1. Pour a solution of a metal salt into a glass beaker.
2. Measure the temperature of the solution.
3. Add 1 g of metal to the solution.
4. Measure the temperature of the solution.
5. Calculate the temperature increase.

how much? insulation? all has reacted? after how long? Repeat? Calculate a mean?

Figure 5 shows the reaction profile of an exothermic reaction.

Figure 5



0 3 . 5 What does the energy value of 1370 kJ represent?

[1 mark]

Tick **one** box.

the minimum energy required for a reaction to take place.

- Activation energy ☑
- Products energy ☐
- Reactants energy ☐
- Released energy ☐

0 3 . 6 The overall energy change is 386 kJ.

What percentage of 1370 kJ is this?

Give your answer to two significant figures.

[2 marks]

$\frac{386}{1370} \times 100 = 28.175$ (1)

Percentage = 28 (1) %

Turn over for the next question

0 4 The three states of matter are solid, liquid and gas.

0 4 . 1 Lithium reacts with water to produce lithium hydroxide solution and hydrogen.

Use the correct state symbols from the box to complete the chemical equation.

[2 marks]

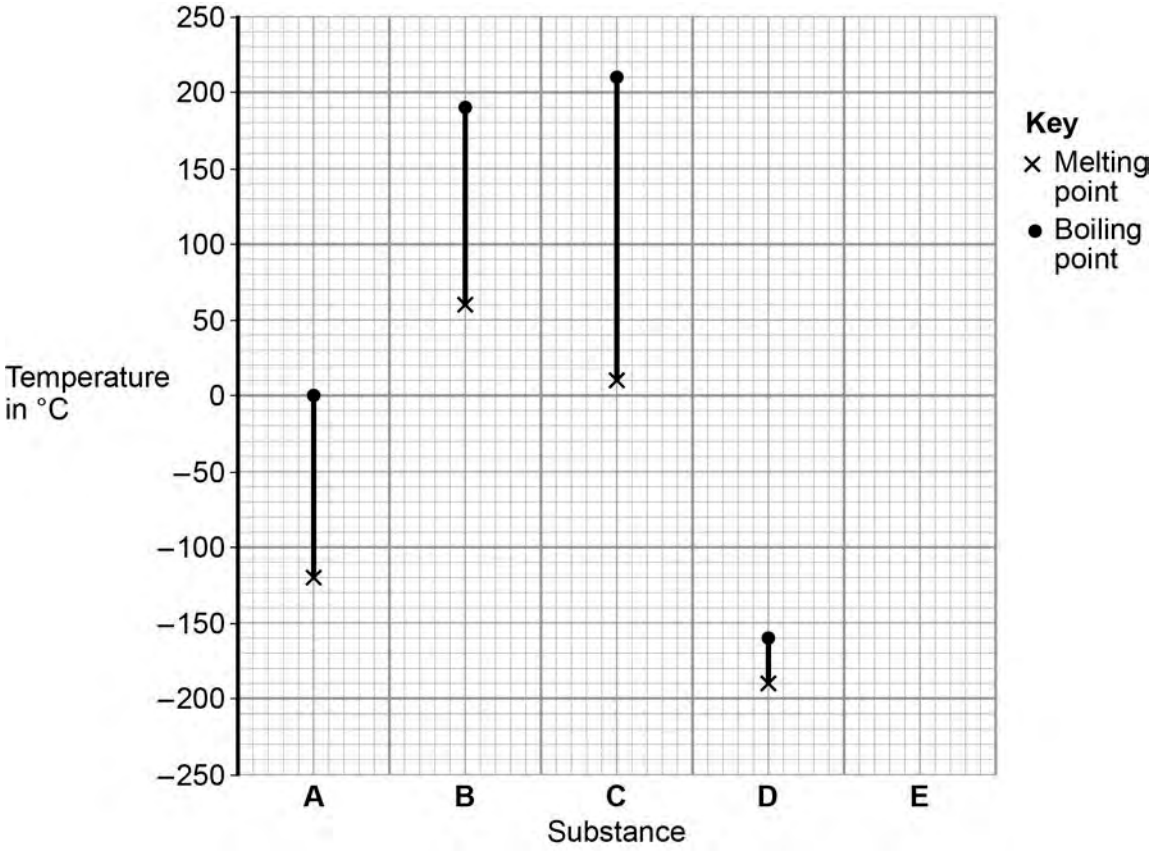
aq	g	l	s

$$2Li(s) + 2H_2O(l) \rightarrow 2LiOH(aq) + H_2(g)$$

lithium + water → lithium hydroxide + hydrogen

Figure 6 shows the melting points and the boiling points of four substances, **A**, **B**, **C** and **D**.

Figure 6



0 4 . 2 Which substance is liquid over the greatest temperature range?

[1 mark]

Tick **one** box.

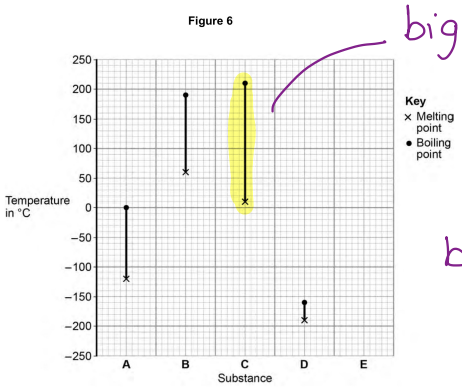
A ☐

B ☐

C ☑

D ☐

Figure 6



biggest difference between melting and boiling points.

0 4 . 3 Which **two** substances are gases at 50 °C?

[1 mark]

Tick **one** box.

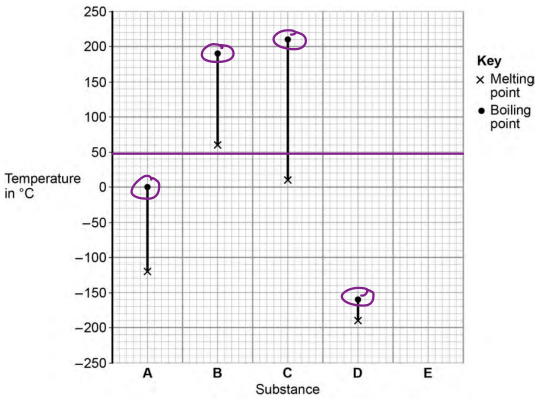
A and **B** ☐

B and **C** ☐

C and **D** ☐

A and **D** ☑

Figure 6



0 4 . 4 A different substance, **E**, has:

- a melting point of -50 °C
- a boiling point of +120 °C

Plot these two values on **Figure 6**.

[2 marks]

Figure 6

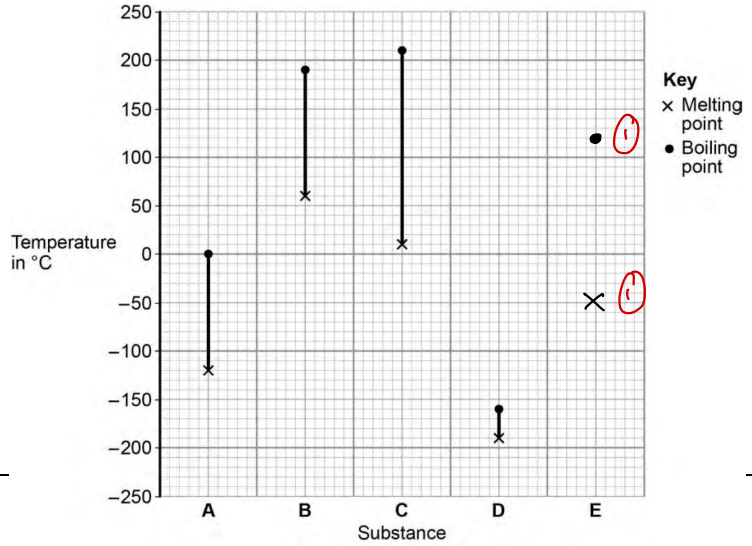
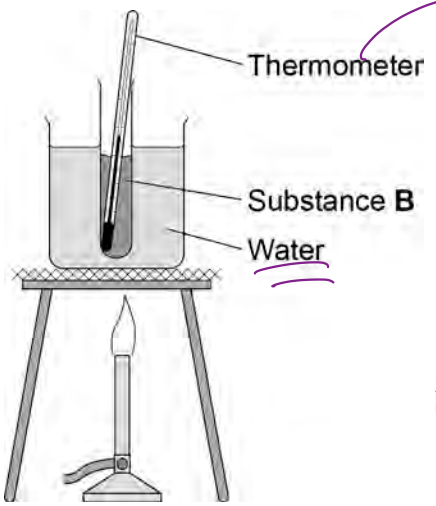


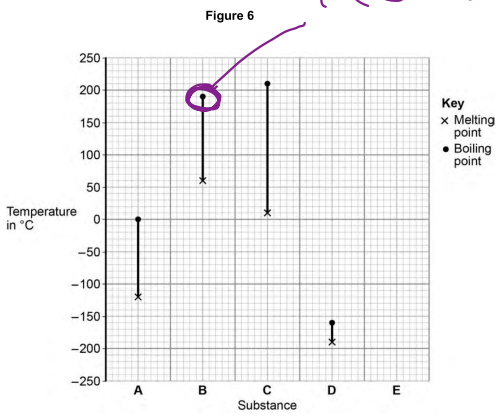
Figure 7 shows the apparatus a student used to determine the melting point and the boiling point of substance **B** in **Figure 6**.

Figure 7

temp



190°C



0 4 . 5 Explain why the student could not use this apparatus to determine the boiling point of substance **B**.

[2 marks]

- BP of B is 190 °c ✓ (1)

- BP of Water is 100 °c ✓ (1)

Suggest **one** reason why the student could not use this apparatus to determine the exact melting point of substance **B**.

[1 mark]

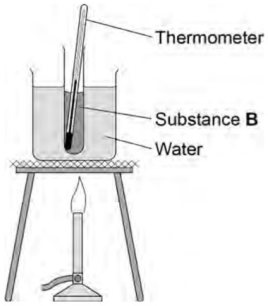
0 4 . 6 There is too much substance B to melt instantly.

OR

- thermal conductivity?

- temp gradient from the wall of the test tube to the thermometer?

Figure 7

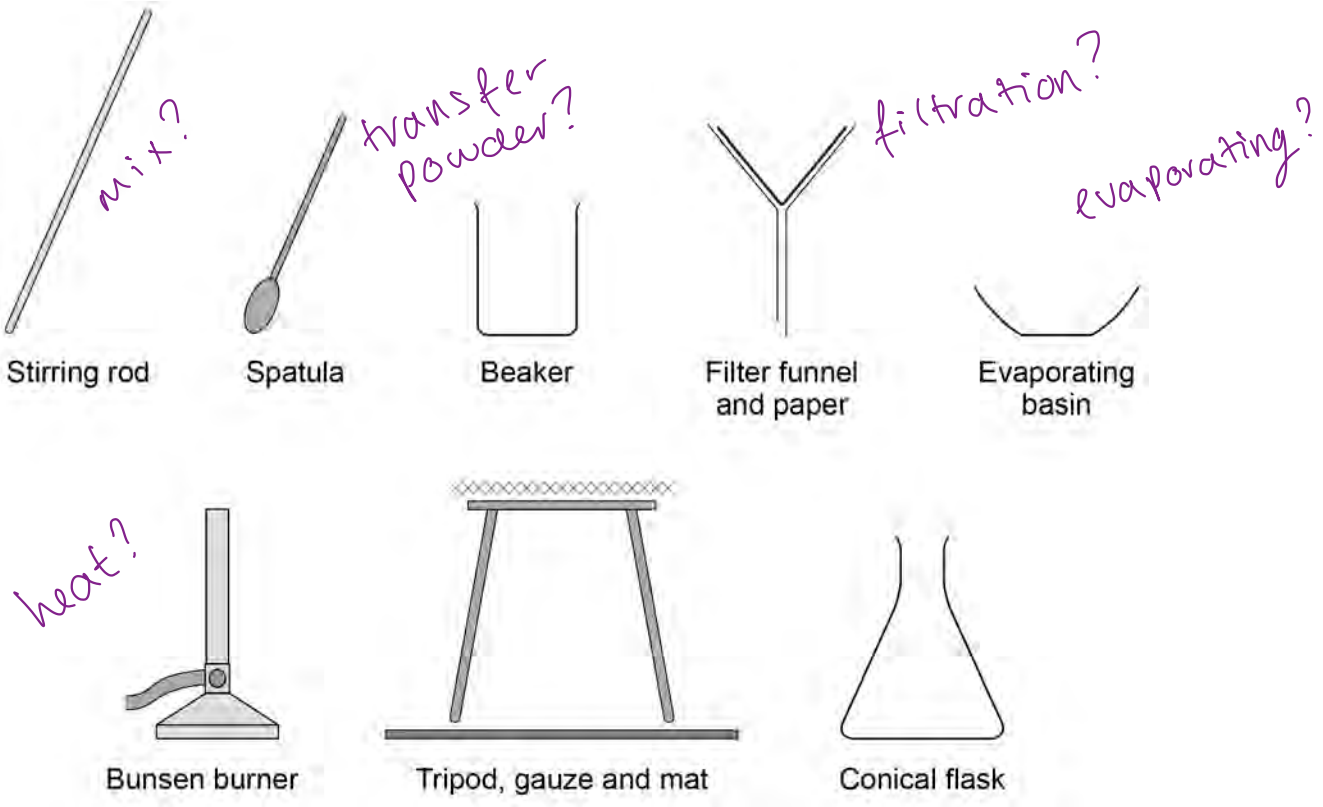


Turn over for the next question

0 5 This question is about making copper salts.

Figure 8 shows the apparatus given to a student.

Figure 8



Outline a safe plan the student could use to make pure, dry, crystals of the soluble salt copper sulfate from the insoluble metal oxide and dilute acid.

[6 marks]

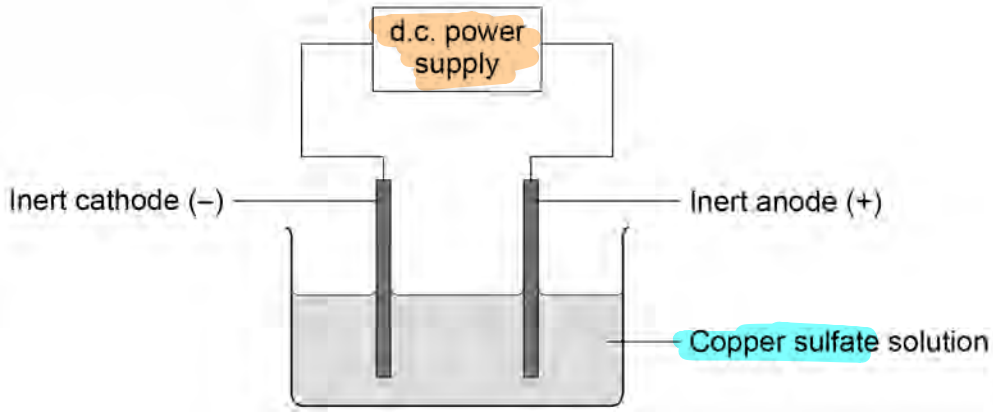
1. Add excess copper oxide to sulfuric acid into a beaker.
2. Stir together using a stirring rod.
3. Heat the mixture over the Bunsen burner.
4. Filter the mixture using a filter funnel and paper into an evaporating basin
5. Evaporate off the remaining water in the filtrate (e.g. using a water bath)
6. Leave the filtrate in a warm place to dry and crystallize.
7. Remove and dry the crystals.

- Wear safety goggles
- Don't touch the hot beaker, use tongs when filtering.

Turn over for the next question

0 6 **Figure 9** shows an apparatus to produce elements from a solution of an ionic compound.

Figure 9



0 6 . 1 What is the name of the process in **Figure 9**?

[1 mark]

Tick **one** box.

- Combustion ☐
- Crystallisation ☐
- Distillation ☐
- Electrolysis ☑

Splitting a compound using electricity.

Table 2 shows the products formed from three experiments using different compounds and the apparatus shown in **Figure 9**.

Table 2

negative charge positive charge

Compound	State	Product at cathode	Product at anode
Copper chloride	Molten	Copper	Chlorine
Copper chloride	Aqueous solution	Copper	Chlorine
Potassium bromide	Molten	Potassium	Bromine

0 6 . 2 Use **Table 2** to name the products formed at each electrode if using an aqueous solution of potassium bromide.

H^+ OH^- K^+ Br^-

[2 marks]

At cathode Hydrogen At anode Bromine

-ve charge +ve charge

0 6 . 3 Explain why copper is formed at the cathode during the electrolysis of its salts.

[2 marks]

- Copper forms positive ions. (1)

- Cathode is negatively charged, therefore the copper ions will be attracted to it. (1)

0 7 This question is about calcium.

Ca^{2+} O^{2-}

0 7 . 1 What type of compound is calcium oxide?

CaO

[1 mark]

Tick **one** box.

- An acid ☐
- A base ☑
- A carbonate ☐
- A salt ☐

$CaO + H_2O \rightarrow Ca(OH)_2$ (OH^-)

base

0 7 . 2 Ionic compounds, such as calcium oxide, have high melting points.

Complete the sentences. Use words from the box.

[1 mark]

ionic covalent metallic push/pull lattice

bonds	forces	ions	layers

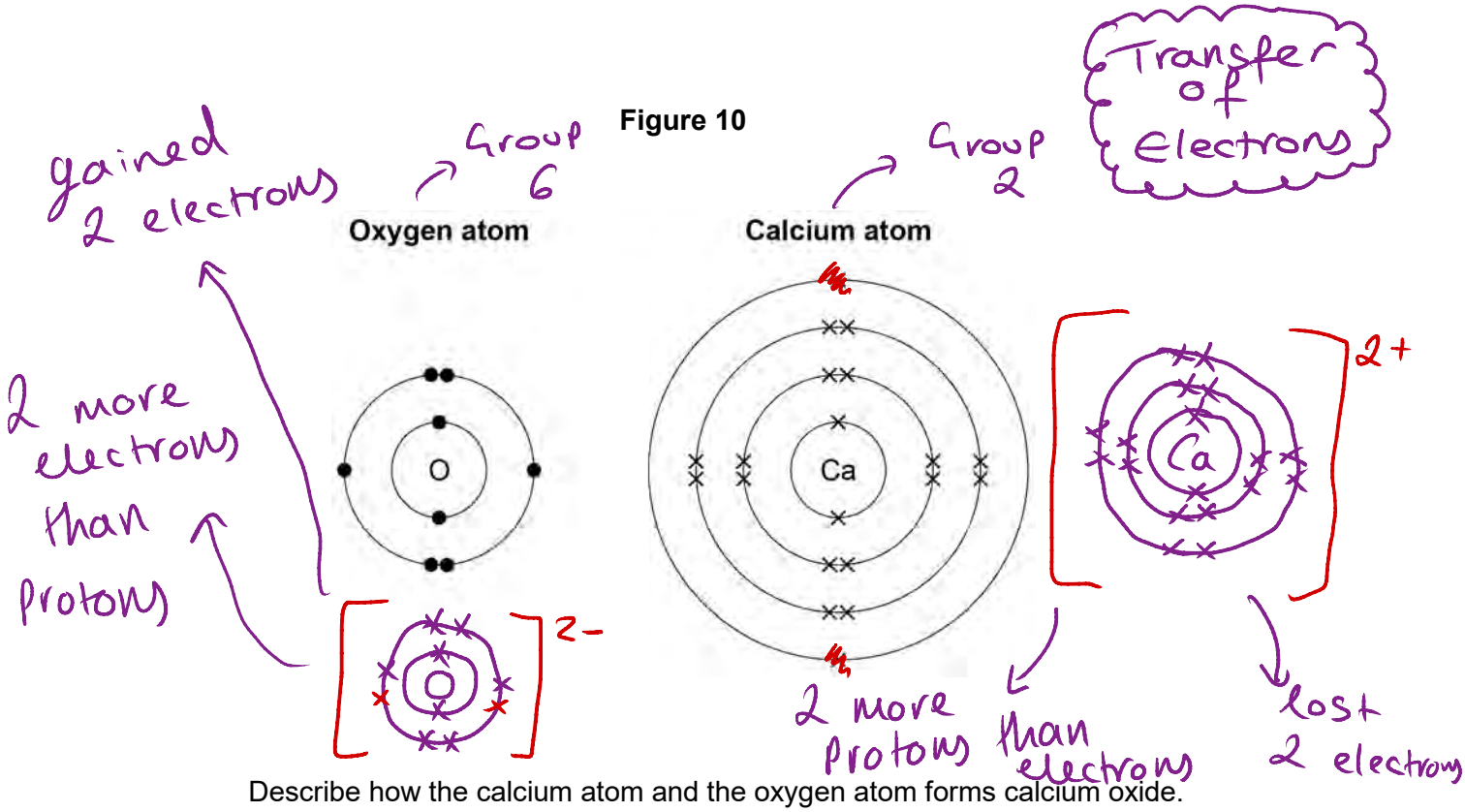
+ve −ve

Calcium oxide has a giant ionic lattice in which there are strong electrostatic forces of attraction in all directions.

these are between the Ca^{2+} and O^{2-} ions.

0 7 . 3 **Figure 10** shows the electronic structure of an oxygen atom and a calcium atom.

Figure 10



Describe how the calcium atom and the oxygen atom forms calcium oxide.

You should give the charge on each ion formed.

[4 marks]

- 2 electrons are transferred (1) from Ca to O.

(1)

- This means that Ca has lost 2 electrons, therefore gains a 2+ charge. (1)

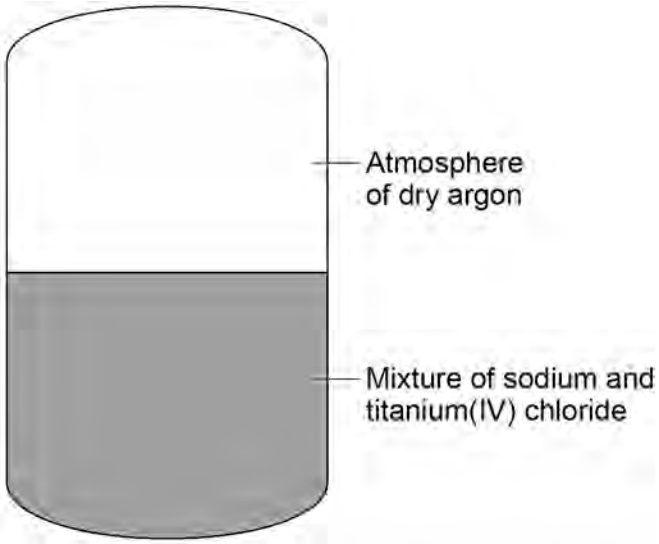
- O gains 2 electrons, therefore has a 2- charge. (1)

Turn over for the next question

There are no questions printed on this page

0 8 **Figure 12** shows a reactor used to produce titanium from titanium(IV) chloride.

Figure 12



The chemical equation for the reaction of titanium(IV) chloride with sodium is:

$$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$$

titanium(IV) chloride + sodium → titanium + sodium chloride

1615 kg + 782 kg = ? + 1989 kg

For one reaction:

- 1615 kg titanium(IV) chloride reacted completely with 782 kg sodium
- 1989 kg sodium chloride was produced.

Calculate the mass of titanium produced from this reaction.

[1 mark]

2397 = ? + 1989

? = 2397 − 1989

Mass of titanium = 408 kg

0 8 . 2 **Table 3** shows the solubility of sodium chloride in 100 cm^3 of aqueous solution at different temperatures.

Table 3

Solubility of sodium chloride in g per 100cm^3	Temperature in °C
35.72	10
35.89	20
36.09	30
37.37	40
36.69	50
37.04	60

Table 3

Solubility of sodium chloride in g per 100cm^3	Temperature in °C
35.72	10
35.89	20
36.09	30
37.37	40
36.69	50
37.04	60

On **Figure 13**:

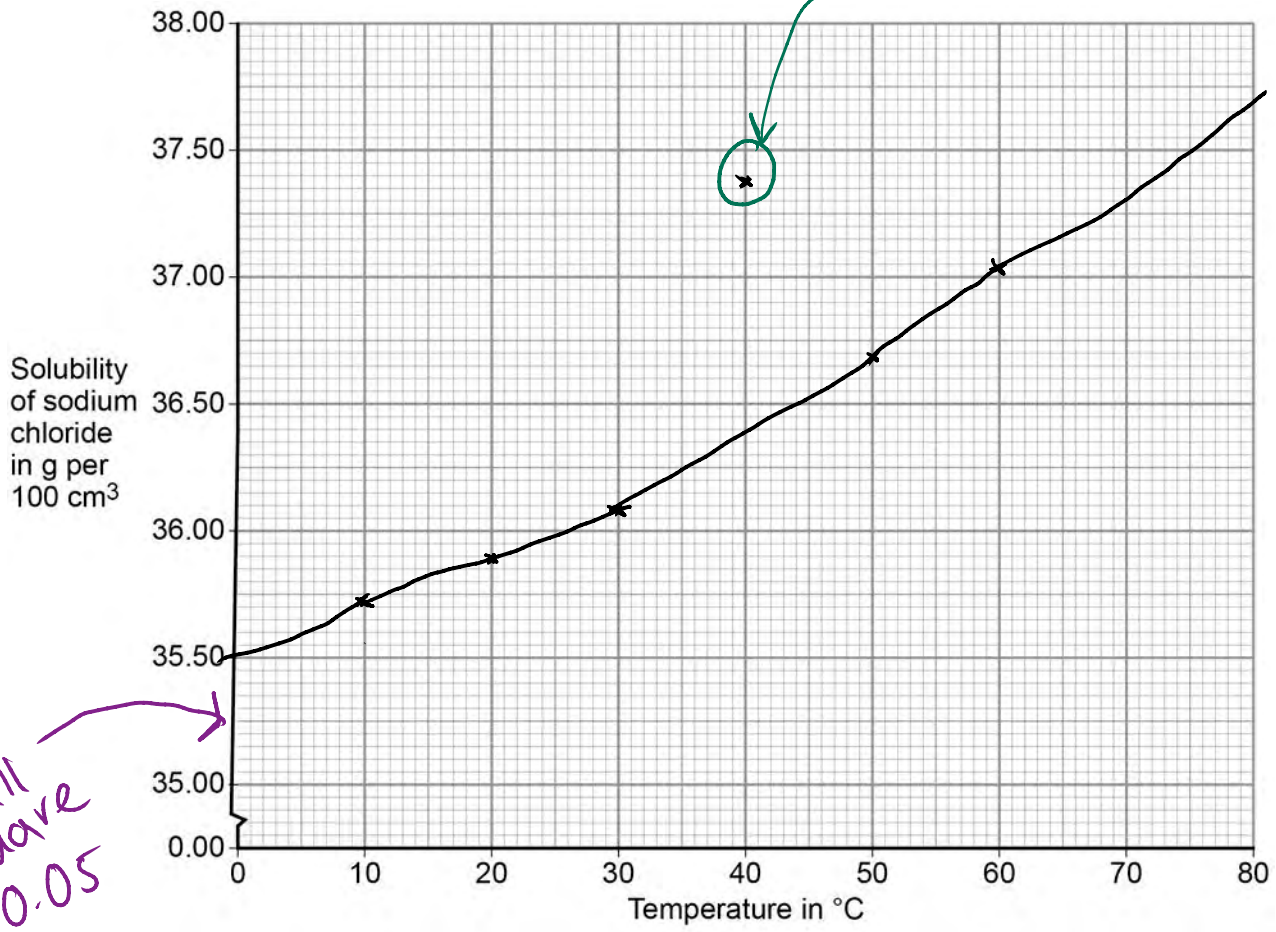
- plot this data on the grid
- draw a line of best fit.

[3 marks]

(2) plotting points

(1) best fit line

Figure 13



Question 8 continues on the next page

0 8 . 3 The product sodium chloride is dissolved in water to separate it from titanium.

At 30 °C the solubility of sodium chloride is 36 kg per 100 dm^3.

Calculate the minimum volume of water in dm^3, at 30 °C, needed to dissolve 1989 kg sodium chloride.

[2 marks]

30°c : 36 kg per 100 dm^3 (×55.25)

30°c : 1989 kg per —— dm^3 ✓ (1)

1989 ÷ 36 = 55.25 → 100 × 55.25

1989 × 100 / 36

Volume of water = 5525 ✓ (1) dm^3

Calculate the percentage by mass of titanium in titanium(IV) chloride ($TiCl_4$).

Give your answer to 3 significant figures.

TiCl4

Relative atomic masses (A_r): Cl = 35.5; Ti = 48

[3 marks]

$\frac{Ar \text{ of } Ti}{Mr \text{ of } TiCl_4} \times 100 = \frac{48}{48 + 4(35.5)} \times 100 = \frac{48}{190} \times 100$ ✓ (1)

$= 25.2631\ldots$ ✓ (1)

Percentage of titanium by mass = 25.3 ✓ (1) %

Group 8 / Group 0

0 8 . 5 Suggest why the reaction is done in an atmosphere of dry argon instead of air containing water vapour.

mixture

[3 marks]

$TiCl_4 + 4Na \rightarrow Ti + 4NaCl$

- Argon is unreactive ✓ (1) has a full outer shell

(1)

- Water vapour would react with $TiCl_4$ OR Na.

- Air contains oxygen that could react with reactants OR products. (1)

Explain why titanium conducts electricity.

metal

[3 marks]

- Titanium has delocalised electrons, from the outer shells. (1)

- These delocalised electrons are free to move (1) around the whole structure and carry charge. (1)

END OF QUESTIONS

There are no questions printed on this page