SPECIMEN MATERIAL

GCSE
COMBINED SCIENCE: TRILOGY

H

Higher Tier Paper 3: Chemistry 1H

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 03.4, 05.2 and 06.3 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 ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

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Candidate signature _____

There are no questions on this page

0 1 This question is about calcium.

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

[1 mark]

Tick **one** box.

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

0 1 . 2 Ionic compounds, such as calcium oxide, have high melting points.

Complete the sentences. Use words from the box.

[1 mark]

bonds	**forces**	**ions**	**layers**

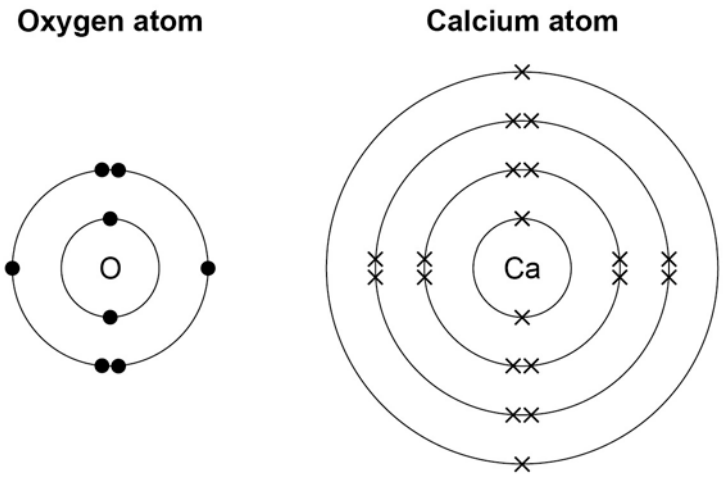
Calcium oxide has a giant ionic lattice in which there are strong

electrostatic _____ of attraction in all directions.

Question 1 continues on the next page

0 1 . 3 **Figure 1** shows the electronic structure of an oxygen atom and a calcium atom.

Figure 1



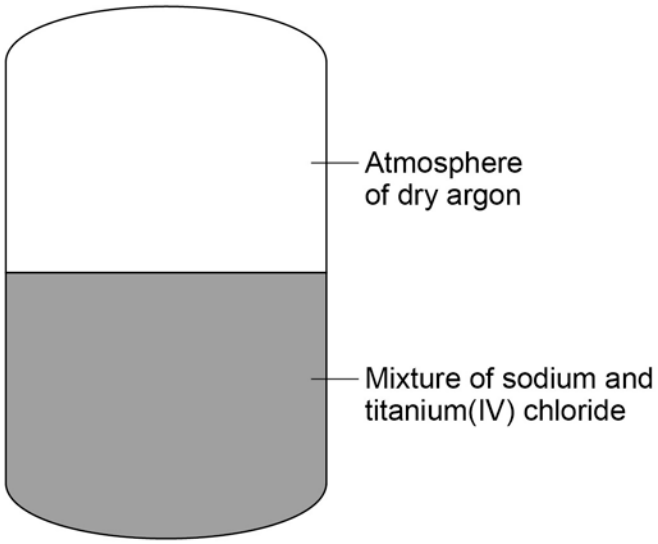
Describe how the calcium atom and the oxygen atom forms calcium oxide.

You should give the charge on each ion formed.

[4 marks]

0 2 **Figure 2** shows a reactor used to produce titanium from titanium(IV) chloride.

Figure 2



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

0 2 . 1 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]

Mass of titanium = _____ kg

0 2 . 2 **Table 1** shows the solubility of sodium chloride in 100 cm^3 of aqueous solution at different temperatures.

Table 1

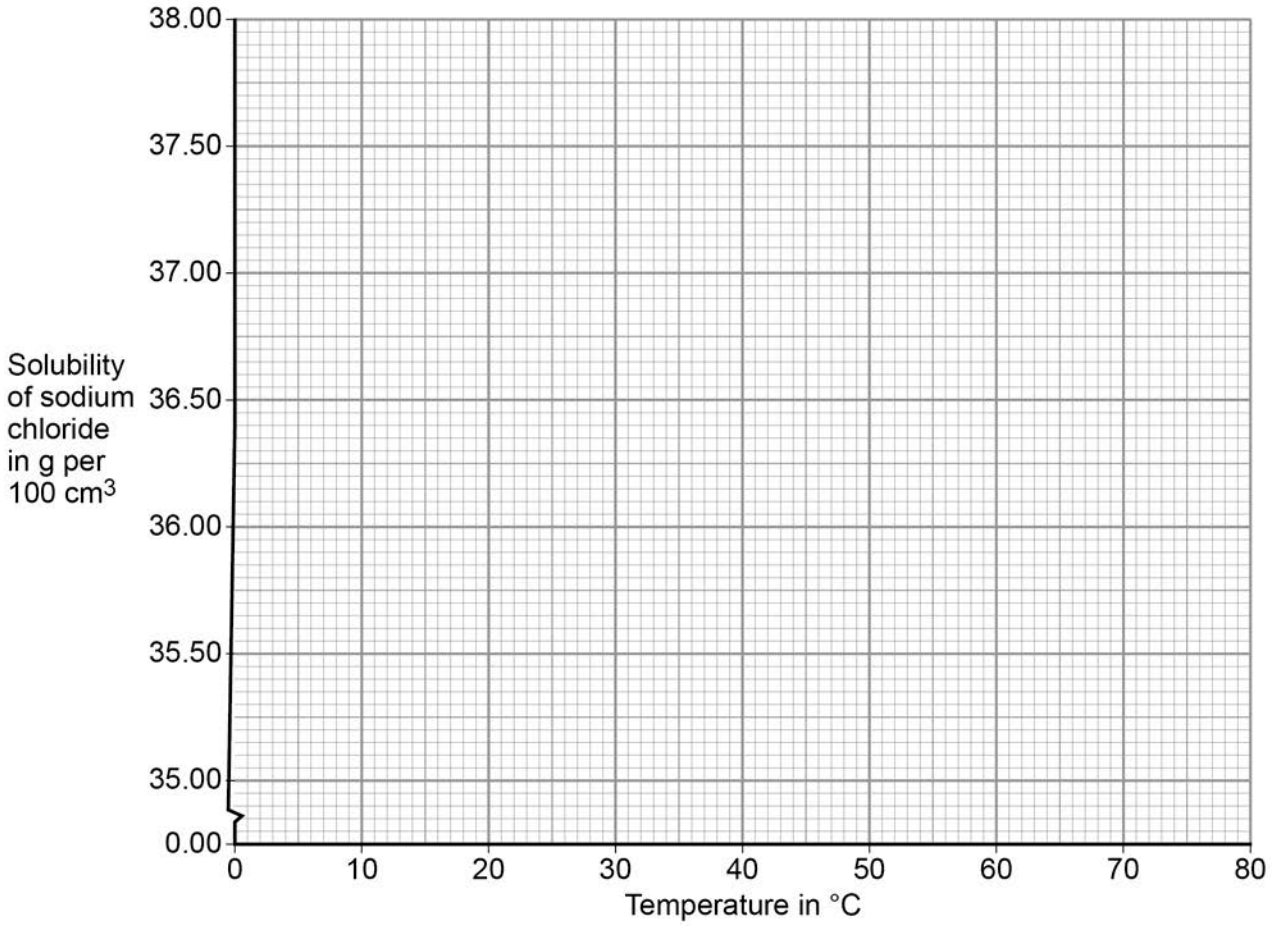
Solubility of sodium chloride in g per 100cm^3	**Temperature in °C**
35.72	10
35.89	20
36.09	30
37.37	40
36.69	50
37.04	60

On **Figure 3**:

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

[3 marks]

Figure 3



Question 2 continues on the next page

0 2 . 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]

Volume of water = _____ dm^3

0 2 . 4 Calculate the percentage by mass of titanium in titanium(IV) chloride ($TiCl_4$).

Give your answer to 3 significant figures.

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

[3 marks]

Percentage of titanium by mass = _____ %

0 2 . 5 Suggest why the reaction is done in an atmosphere of dry argon instead of air containing water vapour.

[3 marks]

0 2 . 6 Explain why titanium conducts electricity.

[3 marks]

Turn over for the next question

0 3 Elements are made up of atoms.

0 3 . 1 What is the approximate radius of an atom?

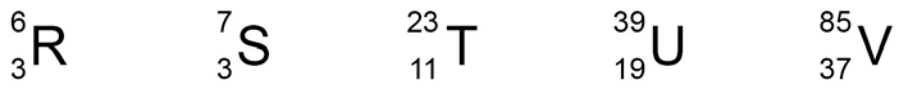
[1 mark]

Tick **one** box.

- 1×10 m ☐
- 1×10^{-1} m ☐
- 1×10^{-10} m ☐
- 1×10^{-100} m ☐

Figure 4 shows the atoms of five elements.

Figure 4



The letters are **not** the symbols of these elements.

0 3 . 2 Complete the sentence.

[1 mark]

All of the elements in **Figure 3** are in Group _____

of the periodic table.

0 3 . 3 Which **two** atoms in **Figure 4** are isotopes of the same element?

Explain your answer fully.

[3 marks]

0 3 . 4 The halogens are in Group 7 of the periodic table.

Explain the trend in reactivity of the halogens.

[6 marks]

Turn over for the next question

0 4 Copper can be produced from copper(II) sulfate solution by two different methods.

Method 1 – Electrolysis

0 4 . 1 To produce copper by electrolysis a student has inert electrodes, a d.c. power supply, a switch and electrical wires for the external circuit.

Draw and label the apparatus set up to produce copper from copper(II) sulfate solution by electrolysis.

[2 marks]

0 4 . 2 Suggest why the colour of the copper(II) sulfate solution fades during the electrolysis.

[3 marks]

0 4 . 3 Explain how copper is produced from copper(II) sulfate solution by electrolysis.

[4 marks]

Method 2 – Displacement

0 4 . 4 The chemical equation for the displacement of copper using iron is:

$$CuSO_4 + Fe \rightarrow Cu + FeSO_4$$

Calculate the minimum mass of iron needed to displace all of the copper from 50 cm^3 of copper(II) sulfate solution.

The concentration of the copper(II) sulfate solution is 80 g $CuSO_4$ per dm^3.

Relative atomic masses (A_r): O = 16; S = 32; Fe = 56; Cu = 63.5

Give your answer to 2 significant figures.

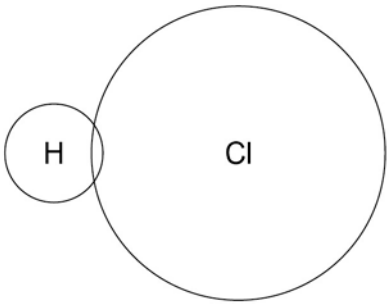
[4 marks]

Mass of iron = _____ g

0 5 Hydrogen chloride (HCl) is a gas.

0 5 . 1 Complete the diagram to show all of the arrangement of the outer shell electronsof the hydrogen and chlorine atoms in hydrogen chloride.

[1 mark]



0 5 . 2 Hydrochloric acid is a strong acid.
Ethanoic acid is a weak acid.

Describe a reaction that could be used to show the difference between a weak acid and a strong acid.

You should explain why the weak acid and the strong acid give different results.

[6 marks]

Turn over for the next question

0 6 Exothermic reactions transfer energy to the surroundings.

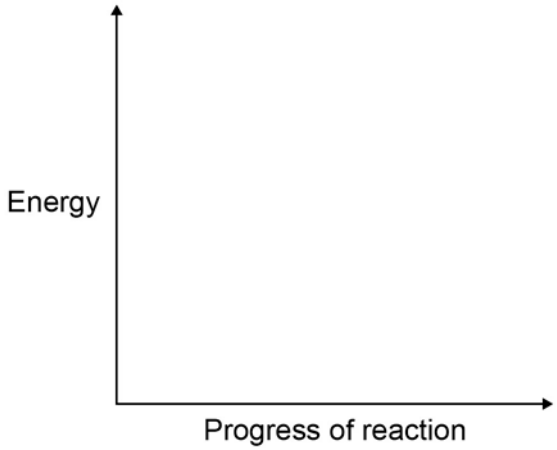
0 6 . 1 Draw a reaction profile for an exothermic reaction using the axes in **Figure 5**.

Show the:

- relative energies of the reactants and products
- activation energy and overall energy change.

[2 marks]

Figure 5

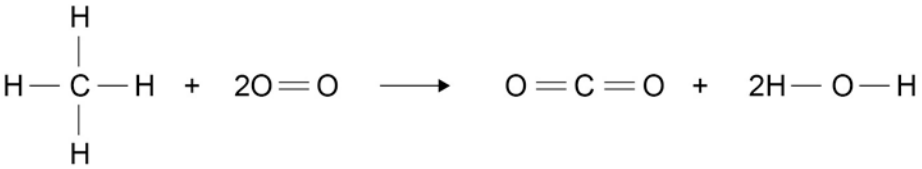


0 6 . 2 Combustion is an exothermic reaction.

Calculate the overall energy change for the complete combustion of one mole of methane in oxygen.

[3 marks]

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$



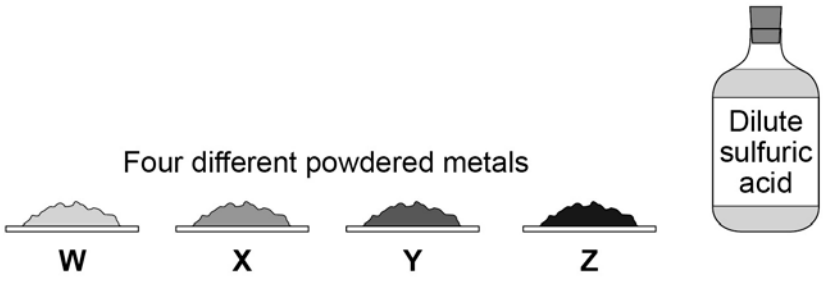
Bond	Bond energy in kJ/mol
C — H	413
O = O	498
C = O	805
O — H	464

Overall energy change = _____ kJ/mol

Question 6 continues on the next page

Figure 6 shows the chemicals given to a student.

Figure 6



0 6 . 3 The student wants to investigate the reactivity of the four metals.

Outline a plan the student could use to investigate the relative reactivity of the four metals, **W**, **X**, **Y** and **Z**.

The plan should use the fact that all four metals react exothermically with dilute sulfuric acid.

You should name the apparatus used and comment on the safe use of the chemicals.

[6 marks]

Question 6 continues on the next page

Another student used displacement reactions to investigate the relative reactivity of the four metals, **W**, **X**, **Y** and **Z**.

Table 2 shows the student's results.

Table 2

	Observations			
Solution	**Metal W**	**Metal X**	**Metal Y**	**Metal Z**
Copper nitrate	Brown layer formed on metal	Brown layer formed on metal	Brown layer formed on metal	No change
Magnesium sulfate	No change	No change	No change	No change
Sulfuric acid	Gas bubbles produced	Few gas bubbles produced	Gas bubbles produced	No change
Zinc chloride	Grey layer formed on metal	No change	No change	No change

0 6 . 4 Give the order of reactivity of metals, **W**, **X**, **Y** and **Z**.

Use the results in **Table 2** to justify your answer.

[3 marks]

_____ > _____ > _____ > _____

0 6 . 5 The student concluded that these results could also be used to justify the order of reactivity of copper, magnesium, hydrogen and zinc.

The student is **not completely** correct. Use the results in **Table 2** to explain why.

Suggest one further experiment that would provide evidence for the student's conclusion.

[4 marks]

END OF QUESTIONS

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