SPECIMEN MATERIAL

# GCSE CHEMISTRY

H

## Higher Tier Chemistry 1H

Specimen 2018

Time allowed: 1 hour 45 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 100 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 02.3, 05.2, 08.5 and 09.4 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

0 1 This question is about halogens and their compounds.

Table 1 shows the boiling points and properties of some of the elements in Group 7 of the periodic table.

Table 1

| Element | Boiling point in C ° | olour in aqueous solution |
|---|---|---|
| | Fluorine -188 | colourless |
| | Chlorine -35 | pale green |
| Bromine X | orange | |
| Iodine 184 | brown | |

0 1 . 1 Why does iodine have a higher boiling point than chlorine?

[1 mark]

Tick one box.

Iodine is ionic and chlorine is covalent ☐

Iodine is less reactive than chlorine ☐

The covalent bonds between iodine atoms are stronger ☐

The forces between iodine molecules are stronger ☐

0 1 . 2 Predict the boiling point of bromine.

[1 mark]

A redox reaction takes place when aqueous chlorine is added to potassium iodide solution.

The equation for this reaction is:

$$Cl_2(aq) + 2KI(aq) \rightarrow I_2(aq) + 2KCl(aq)$$

0 1 . 3 Look at Table 1.

What is the colour of the final solution in this reaction?

[1 mark]

Tick one box.

- Brown ☐
- Orange ☐
- Pale green ☐
- Colourless ☐

0 1 . 4 What is the ionic equation for the reaction of chlorine with potassium iodide?

[1 mark]

Tick one box.

- $Cl_2 + 2K \rightarrow 2KCl$ ☐
- $2I^- + Cl_2 \rightarrow I + 2Cl^{-2}$ ☐
- $I^- + Cl \rightarrow I + Cl^-$ ☐
- $I^- + K^+ \rightarrow KI$ ☐

Question 1 continues on the next page

0 1 . 5 Why does potassium iodide solution conduct electricity?

[1 mark]

Tick one box.

It contains a metal ☐

It contains electrons which can move ☐

It contains ions which can move ☐

It contains water ☐

0 1 . 6 What are the products of electrolysing potassium iodide solution?

[1 mark]

Tick box.

one

Product at cathode Product at anode

hydrogen iodine ☐

hydrogen oxygen ☐

potassium iodine ☐

potassium oxygen ☐

0 2 An atom of aluminium has the symbol $^{27}_{13}Al$

0 2 . 1 Give the number of protons, neutrons and electrons in this atom of aluminium.

[3 marks]

Number of protons _____

Number of neutrons _____

Number of electrons _____

0 2 . 2 Why is aluminium positioned in Group 3 of the periodic table?

[1 mark]

Question 2 continues on the next page

0 2 . 3 In the periodic table, the transition elements and Group 1 elements are metals.

Some of the properties of two transition elements and two Group 1 elements are shown in Table 2.

Table 2

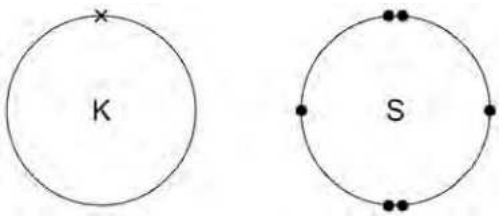
| | Transition elements | | Group 1 elements | |
|---|---|---|---|---|
| | Chromium | Iron | Sodium | Caesium |
| Melting point in °C | 1857 | 1535 | 98 | 29 |
| Formula of oxides | CrO<br>Cr2O3<br>CrO2<br>CrO3 | FeO<br>Fe2O3<br>Fe3O4 | Na2O | Cs2O |

Use your own knowledge and the data in Table 2 to compare the chemical and physical properties of transition elements and Group 1 elements.

[6 marks]

0 3 Figure 1 shows the outer electrons in an atom of the Group 1 element potassium and in an atom of the Group 6 element sulfur.

Figure 1




0 3 . 1 Potassium forms an ionic compound with sulfur.

Describe what happens when two atoms of potassium react with one atom of sulfur.

Give your answer in terms of electron transfer.

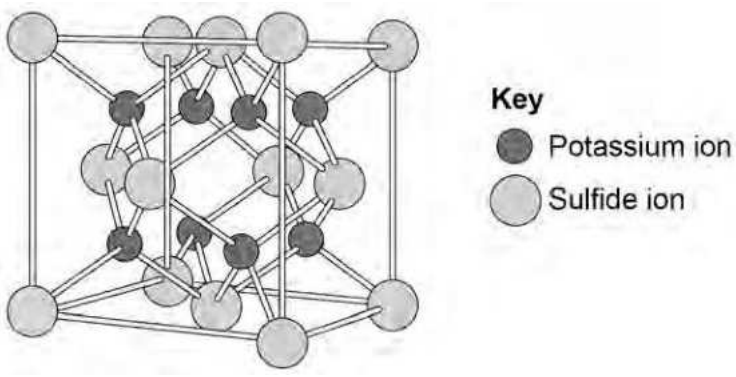
Give the formulae of the ions formed.

[5 marks]

Question 3 continues on the next page

0 3 . 2 The structure of potassium sulfide can be represented using the ball and stick model in Figure 2.

Figure 2




The ball and stick model is **not** a true representation of the structure of potassium sulfide.

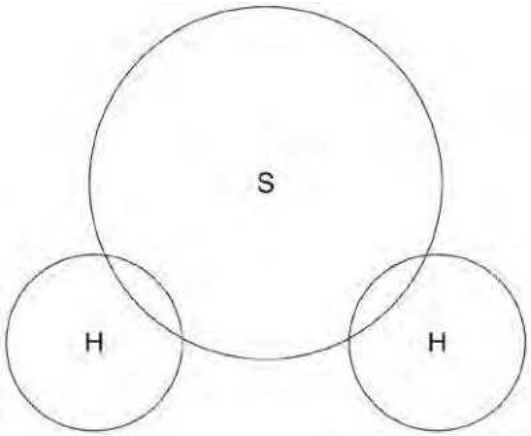
Give one reason why.

[1 mark]

0 3 . 3 Sulfur can also form covalent bonds.

Complete the dot and cross diagram to show the covalent bonding in a molecule of hydrogen sulfide.
Show the outer shell electrons only.

[2 marks]




0 3 . 4 Calculate the relative formula mass (*Mr*) of aluminium sulfate, Al2(SO4)3

Relative atomic masses (*A*r): oxygen = 16; aluminium = 27; sulfur = 32

[2 marks]

Relative formula mass =

Question 3 continues on the next page

0 3 . 5 Covalent compounds such as hydrogen sulfide have low melting points and do not conduct electricity when molten.
Draw one line from each property to the explanation of the property.

[2 marks]

| Property | Explanation of property |
| --- | --- |
| Low melting point | Electrons are free to move |
| Does not conduct electricity when molten | There are no charged particles free to move |
| | Ions are free to move |
| | Weak intermolecular forces of attraction |
| | Bonds are weak |
| | Bonds are strong |

0 3 . 6 Ionic compounds such as potassium sulfide have high boiling points and conduct electricity when dissolved in water.
Draw one line from each property to the explanation of the property.

[2 marks]

| Property | Explanation of property |
| --- | --- |
| High boiling point | Electrons are free to move |
| Conduct electricity when molten | There are no charged particles free to move |
| | Ions are free to move |
| | Weak intermolecular forces of attraction |
| | Bonds are weak |
| | Bonds are strong |

Turn over for the next question

0 4 Rock salt is a mixture of sand and salt.

Salt dissolves in water. Sand does not dissolve in water.

Some students separated rock salt.

This is the method used.

1. Place the rock salt in a beaker.
2. Add 100 cm3 of cold water.
3. Allow the sand to settle to the bottom of the beaker.
4. Carefully pour the salty water into an evaporating dish.
5. Heat the contents of the evaporating dish with a Bunsen burner until salt crystals start to form.

0 4 . 1 Suggest one improvement to step 2 to make sure all the salt is dissolved in the water.

[1 mark]

The salty water in step 4 still contained very small grains of sand.

0 4 . 2 Suggest one improvement to step 4 to remove all the sand.

[1 mark]

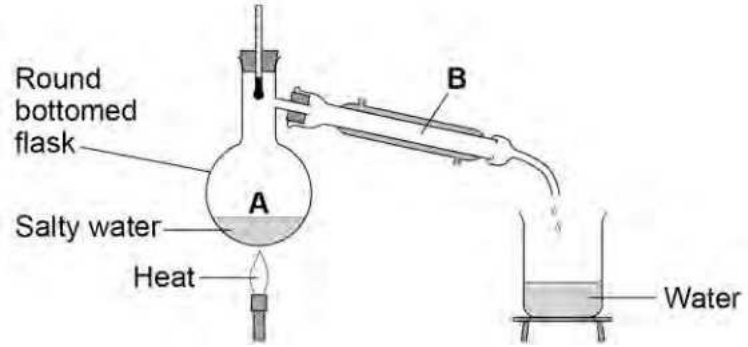
Suggest one safety precaution the students should take in step 5.

0 4 . 3

[1 mark]

Another student removed water from salty water using the apparatus in Figure 3.

Figure 3




0 4 . 4 Describe how this technique works by referring to the processes at A and B.

[2 marks]

0 4 . 5 What is the reading on the thermometer during this process?

[1 mark]

_____ °C

0 5 A student investigated the reactions of copper carbonate and copper oxide with dilute hydrochloric acid.
In both reactions one of the products is copper chloride.

0 5 . 1 Describe how a sample of copper chloride crystals could be made from copper carbonate and dilute hydrochloric acid.

[4 marks]

0 5 . 2 A student wanted to make 11.0 g of copper chloride.

The equation for the reaction is:

$$CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2$$

Relative atomic masses, *A*r: H = 1; C = 12; O = 16; Cl = 35.5; Cu = 63.5

Calculate the mass of copper carbonate the student should react with dilute hydrochloric acid to make 11.0 g of copper chloride.

[4 marks]

Mass of copper carbonate = _____ g

0 5 . 3 The percentage yield of copper chloride was 79.1 %.

Calculate the mass of copper chloride the student actually produced.

[2 marks]

Actual mass of copper chloride produced = _____ g

Question 5 continues on the next page

0 5 . 4 Look at the equations for the two reactions:

Reaction 1 $CuCO_3(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l) + CO_2(g)$

Reaction 2 $CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$

Reactive formula masses: CuO = 79.5; HCl = 36.5; $CuCl_2$ = 134.5; $H_2O$ = 18

The percentage atom economy for a reaction is calculated using:

$$\frac{\text{Relative formula mass of desired product from equation} \times 100}{\text{Sum of relative formula masses of all reactants from equation}}$$

Calculate the percentage atom economy for Reaction 2.

[3 marks]

Percentage atom economy = _____ %

0 5 . 5 The atom economy for Reaction 1 is 68.45 %.

Compare the atom economies of the two reactions for making copper chloride.

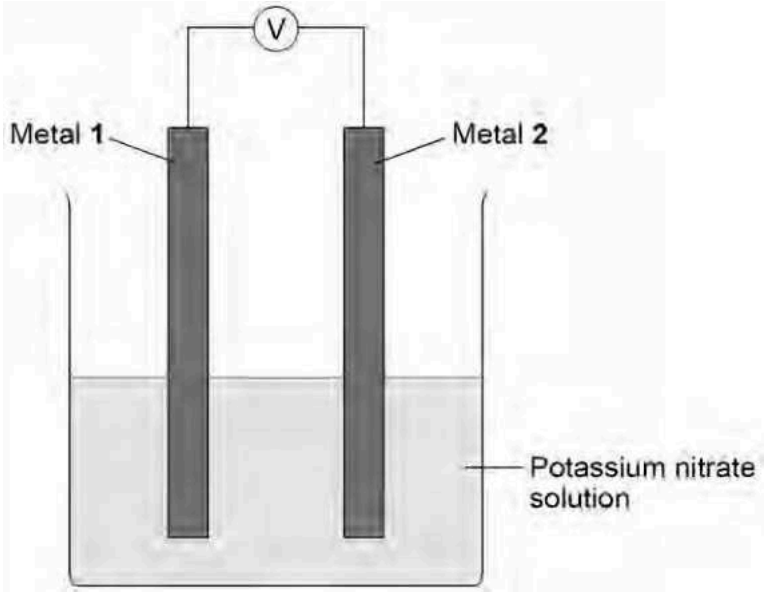
Give a reason for the difference.

[1 mark]

Turn over for the next question

0 6 A student investigated simple cells using the apparatus shown in Figure 4.

Figure 4




• If metal 2 is more reactive than metal 1 then the voltage measured is positive.

• If metal 1 is more reactive than metal 2 then the voltage measured is negative.

• The bigger the difference in reactivity of the two metals, the larger the voltage produced.

The student's results are shown in Table 3.

Table 3

| Metal 2 / Metal 1 | Chromium | Copper | Iron | Tin | Zinc |
|---|---|---|---|---|---|
| Chromium | 0.0 V | | | | |
| Copper | 1.2 V | 0.0 V | 0.0 V | | |
| Iron | 0.5 V | not measured | 0.3 V | 0.0 V | 0.0 V |
| Tin | 0.8 V | -0.4 V | -0.3 V | -0.6 V | |
| Zinc | 0.2 V | -1.0 V | | | |

0 6 . 1 The ionic equation for the reaction occuring at the zinc electrode in the simple cell made using copper and zinc electrodes is:

$Zn \rightarrow Zn^{2+} + 2e^-$

Zinc is oxidised in this reaction.

Give a reason why this is oxidation.

[1 mark]

0 6 . 2 Look at Table 3.

Which one of the metals used was the least reactive?

Give a reason for your answer.

[2 marks]

Metal

Reason

Question 6 continues on the next page

0 6 . 3 Predict the voltage that would be obtained for a simple cell that has iron as metal 1 and copper as metal 2.
Explain your answer.

[3 marks]

0 6 . 4 Hydrogen fuel cells have been developed for cars.

Write a word equation for the overall reaction that takes place in a hydrogen fuel cell.

[1 mark]

0 6 . 5 Write the two half equations for the reactions that occur at the electrodes in a hydrogen fuel cell.

[2 marks]

Turn over for the next question

0 7 Sodium carbonate reacts with dilute hydrochloric acid:

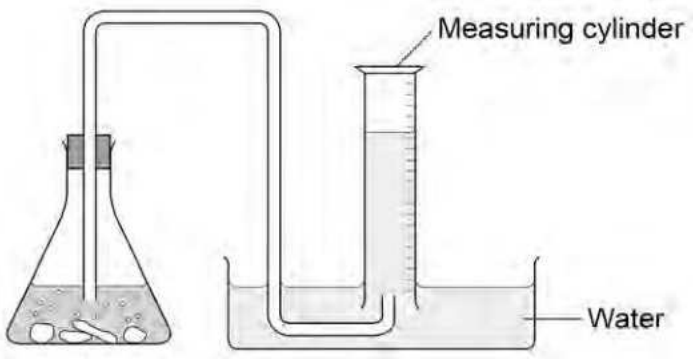
$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

A student investigated the volume of carbon dioxide produced when different masses of sodium carbonate were reacted with dilute hydrochloric acid.
This is the method used.

1. Place a known mass of sodium carbonate in a conical flask.
2. Measure 10 cm3 of dilute hydrochloric acid using a measuring cylinder.
3. Pour the acid into the conical flask.
4. Place a bung in the flask and collect the gas until the reaction is complete.

The student set up the apparatus as shown in Figure 5.

0 7 . 1 Figure 5




Identify the error in the way the student set up the apparatus.

Describe what would happen if the student used the apparatus shown.

[2 marks]

The student corrected the error.

The student's results are shown in Table 4.

Table 4

| Mass of sodium carbonate in g | Volume of carbon dioxide gas in cm3 |
|---|---|
| 0.07 | 16.0 |
| 0.12 | 27.5 |
| 0.23 | 52.0 |
| 0.29 | 12.5 |
| 0.34 | 77.0 |
| 0.54 | 95.0 |
| 0.59 | 95.0 |
| 0.65 | 95.0 |

The result for 0.29 g of sodium carbonate is anomalous.

0 7 . 2 Suggest what may have happened to cause this anomalous result.

[1 mark]

0 7 . 3 Why does the volume of carbon dioxide collected stop increasing at 95.0 cm3?

[1 mark]

Question 7 continues on the next page

0 7 . 4 What further work could the student do to be more certain about the minimum mass of sodium carbonate needed to produce 95.0 cm3 of carbon dioxide?

[1 mark]

0 7 . 5 The carbon dioxide was collected at room temperature and pressure.
The volume of one mole of any gas at room temperature and pressure is 24.0 dm3.

How many moles of carbon dioxide is 95.0 cm3?

Give your answer in three significant figures.

[2 marks]

mol

0 7 . 6 Suggest one improvement that could be made to the apparatus used that would give more accurate results.

Give a reason for your answer.

[2 marks]

0 7 . 7 One student said that the results of the experiment were wrong because the first few bubbles of gas collected were air.
A second student said this would make no difference to the results.

Explain why the second student was correct.

[2 marks]

Turn over for the next question

0 8 Sodium hydroxide neutralises sulfuric acid.

The equation for the reaction is:

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

0 8 . 1 Sulfuric acid is a strong acid.

What is meant by a strong acid?

[2 marks]

Write the ionic equation for this neutralisation reaction. Include state symbols.

0 8 . 2

[2 marks]

0 8 . 3

A student used a pipette to add 25.0 cm3 of sodium hydroxide of unknown concentration to a conical flask.
The student carried out a titration to find out the volume of 0.100 mol/dm3 sulfuric acid needed to neutralise the sodium hydroxide.
Describe how the student would complete the titration.

You should name a suitable indicator and give the colour change that would be seen.

[4 marks]

Question 8 continues on the next page

The student carried out five titrations. Her results are shown in Table 5.

Table 5

| Titration 1 | Titration 2 | Titration 3 | Titration 4 | Titration 5 | | | |
|---|---|---|---|---|---|---|---|
| Volume of 0.100 mol/dm3 sulfuric acid in cm3 | 27.40 | 28.15 | 27.05 | 27.15 | 27.15 | | |

0 8 . 4 Concordant results are within 0.10 cm3 of each other.

Use the student's concordant results to work out the mean volume of 0.100 mol/dm3 sulfuric acid added.

[2 marks]

Mean volume = cm3

0 8 . 5 The equation for the reaction is:

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

Calculate the concentration of the sodium hydroxide.

Give your answer to three significant figures.

[4 marks]

Concentration = mol/dm3

0 8 . 6 The student did another experiment using 20 cm3 of sodium hydroxide solution with a concentration of 0.18 mol/dm3.

Relative formula mass (*Mr*) of NaOH = 40

Calculate the mass of sodium hydroxide in 20 cm3 of this solution.

[2 marks]

Mass = g

Turn over for the next question

0 9 This question is about the reaction of ethene and bromine.

The equation for the reaction is:

C2H4 + Br2 → C2H4Br2

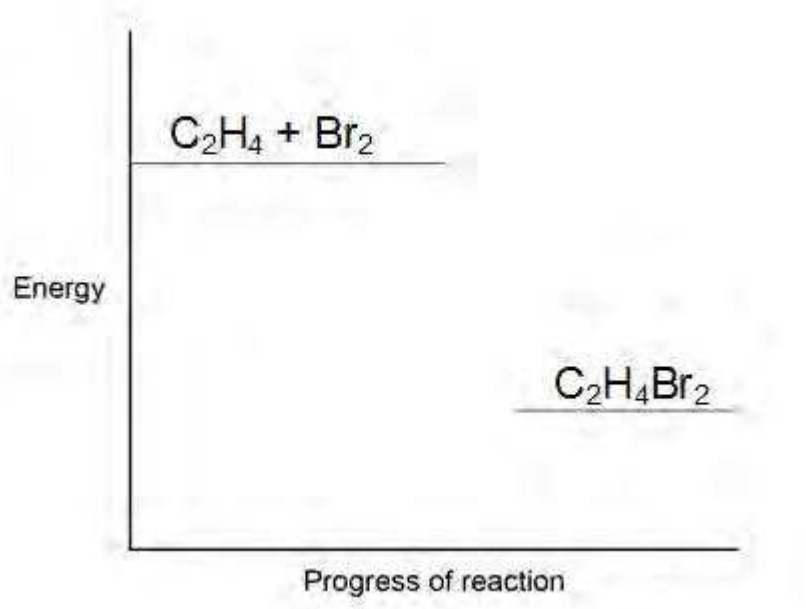
0 9 . 1 Complete the reaction profile in Figure 6 .

Draw labelled arrows to show:

- The energy given out ($\Delta H$)
- The activation energy.

[3 marks]

Figure 6



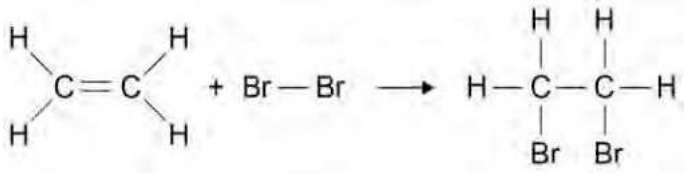
0 9 . 2 When ethene reacts with bromine, energy is required to break covalent bonds in the molecules.

Explain how a covalent bond holds two atoms together.

[2 marks]

Figure 7 shows the displayed formulae for the reaction of ethene with bromine.

Figure 7



The bond enthalpies and the overall energy change are shown in Table 6.

Table 6

| | C=C | C−H | C−C | C−Br | Overall energy change |
|---|---|---|---|---|---|
| Energy in kJ/mole | | 612 412 | 348 | 276 | -95 |

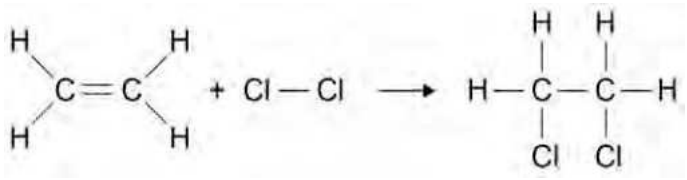
0 9 . 3 Use the information in Table 6 and Figure 7 to calculate the bond energy for the Br−Br bond.

[3 marks]

Bond energy _____ kJ/mole

0 9 . 4 Figure 8 shows the reaction between ethene and chlorine and is similar to the reaction between ethene and bromine.

Figure 8




"The more energy levels (shells) of electrons an atom has, the weaker the covalent bonds that it forms."

Use the above statement to predict and explain how the overall energy change for the reaction of ethene with chlorine will differ from the overall energy change for the reaction of ethene with bromine.

[6 marks]

END OF QUESTIONS

There are no questions printed on this page

There are no questions printed on this page