

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

INTERNATIONAL GCSE COMBINED SCIENCE

Paper 2 Chemistry Extension

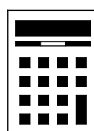
E

Friday 3 November 2023 07:00 GMT Time allowed: 1 hour 45 minutes

Materials

For this paper you must have:

- a pencil and a ruler
- a scientific calculator
- the periodic table (enclosed).



Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- All working must be shown.
- Do all rough work in this book. Cross through any work you do not want to be marked.

For Examiner's Use	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
9	
TOTAL	

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 100.
- You are expected to use a scientific calculator where appropriate.
- The periodic table is provided as a loose insert.



N 0 V 2 3 9 2 0 4 C E 0 1

IB/G/Nov23/E7

9204/CE

Answer **all** questions in the spaces provided.

0 1

This question is about lithium compounds.

0 1 . 1

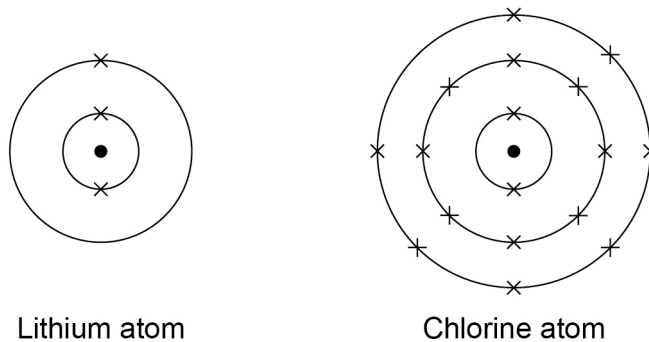
What colour flame would lithium chloride give in a flame test?

[1 mark]

0 1 . 2

Figure 1 shows the electronic structures of a lithium atom and of a chlorine atom.

Figure 1



Describe what happens when a lithium atom reacts with a chlorine atom to produce lithium chloride.

You should refer to electrons in your answer.

[4 marks]



0 1 . 3 Barium chloride solution and hydrochloric acid were added to lithium sulfate solution.

What colour precipitate was observed?

[1 mark]

Tick (✓) **one** box.

Blue

☐

Cream

☐

White

☐

Yellow

☐

0 1 . 4 The formula of lithium sulfate is Li_2SO_4

Calculate the percentage by mass of lithium in lithium sulfate.

Give your answer to 3 significant figures.

Relative atomic mass (A_r): Li = 7

Relative formula mass (M_r): Li_2SO_4 = 110

[3 marks]

Percentage by mass (3 significant figures) = _____ %

9

Turn over ►



0 2

This question is about the reaction of calcium carbonate with hydrochloric acid.

Calcium carbonate reacts with hydrochloric acid to produce calcium chloride, water and a gas.

0 2**. 1**

Which gas is produced when calcium carbonate reacts with hydrochloric acid?

[1 mark]

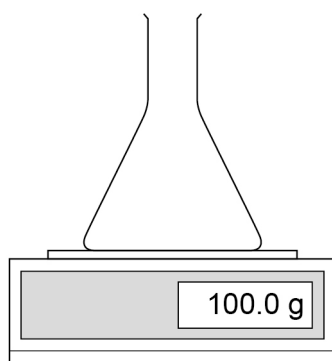
A student investigated the effect of changing the surface area of calcium carbonate pieces on the rate of reaction with hydrochloric acid.

Different-sized calcium carbonate pieces have different surface areas.

The mass of the reaction mixture decreases during the reaction because a gas is produced.

Figure 2 shows the apparatus.

Figure 2



Plan a method to investigate the effect of changing the surface area of calcium carbonate pieces on the rate of reaction with hydrochloric acid.

[6 marks]

This image shows a blank sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Explain the effect of increasing the surface area of calcium carbonate pieces on the rate of reaction with hydrochloric acid.

[2 marks]

Question 2 continues on the next page

Turn over ►

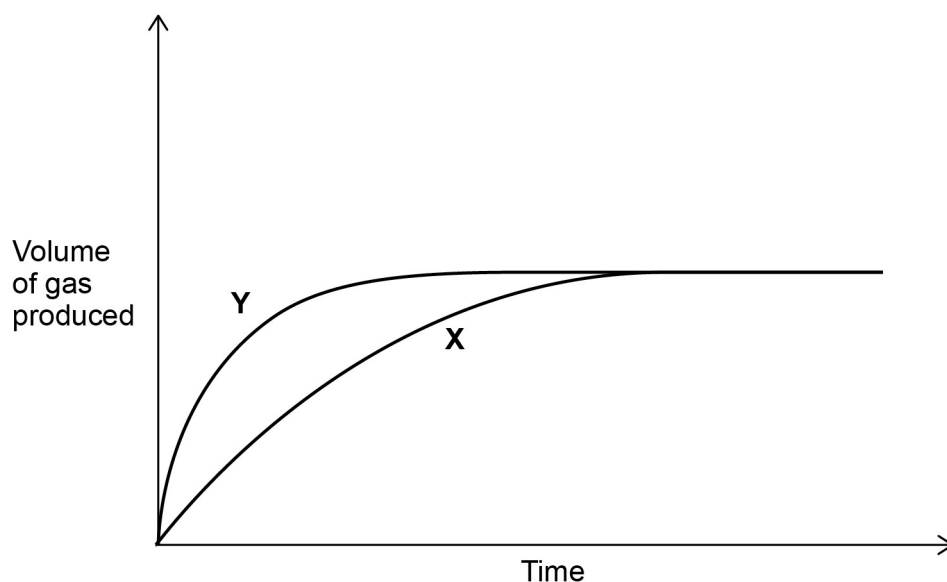


0	2	4
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A different student investigated the effect of changing temperature on the rate of reaction between calcium carbonate and hydrochloric acid.

Figure 3 shows the results.

Figure 3



Curve **X** shows the results at 25 °C.

Curve **Y** shows the results at a higher temperature.

Explain how curve **Y** shows the rate of reaction is different at a higher temperature.

[2 marks]

0 3

This question is about the elements in Group 7 of the periodic table.

0 3 . 1

Which Group 7 element has the lowest melting point?

Use the periodic table.

[1 mark]

0 3 . 2

Table 1 shows the melting point and the boiling point of bromine.

Table 1

Melting point in °C	−7
Boiling point in °C	59

What is the change of state when bromine is cooled from 100 °C to 50 °C?

[1 mark]

From _____ to _____

Question 3 continues on the next page

Turn over ►



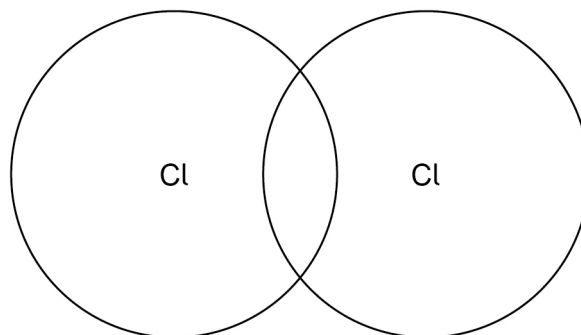
0 3 . 3

Chlorine exists as molecules of Cl_2

A chlorine atom has the electron arrangement 2,8,7

Complete **Figure 4** to show the arrangement of the outer shell electrons in chlorine (Cl_2).

Use dots (•) or crosses (×) to represent the electrons.

[2 marks]**Figure 4**

0 3 . 4

Bromine reacts with metals to form bromide ions.

What is the charge on a bromide ion?

[1 mark]Tick (✓) **one** box.

-2

☐

-1

☐

+1

☐

+2

☐

The reactivity of halogens decreases down the group.

0 3 . 5 A teacher demonstrated the reactivity of the halogens.

The teacher added halogen solutions to potassium halide solutions **X**, **Y** and **Z**.

The potassium halide solutions were:

- potassium bromide solution
- potassium chloride solution
- potassium iodide solution

Table 2 shows the observations made.

Table 2

Halogen solution	Potassium halide solution		
	X	Y	Z
Chlorine	Changes to brown solution	No change	Changes to orange solution
Bromine	Changes to brown solution	No change	No change
Iodine	No change	No change	No change

Draw **one** line from each potassium halide solution to the correct name of the solution.
[2 marks]

Solution	Name of solution
X	Potassium bromide
Y	Potassium chloride
Z	Potassium iodide

Question 3 continues on the next page

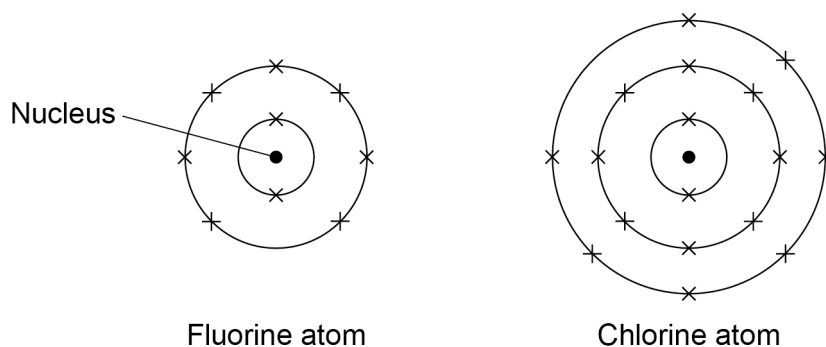
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0 3 . 6

Figure 5 shows the electronic structure of a fluorine atom and of a chlorine atom.

Figure 5



Explain why fluorine is more reactive than chlorine.

Refer to the electrostatic force of attraction between the nucleus and the outer energy level in your answer.

[3 marks]

10



0 4

This question is about elements and metal extraction.

Germanium and zinc are elements.

Both germanium and zinc have isotopes with a mass number of 70

The isotopes are represented as ${}_{32}^{70}\text{Ge}$ and ${}_{30}^{70}\text{Zn}$

0 4 . 1

Explain why germanium and zinc are different elements but have isotopes with the same mass number.

Refer to protons and neutrons in your answer.

[2 marks]

0 4 . 2

Why do germanium and zinc have different chemical properties?

Use the periodic table.

[1 mark]

Question 4 continues on the next page

Turn over ►

A rock sample contains both lead and zinc compounds.

The metals are both extracted from the sample by heating with carbon in a furnace.

0 4 . 3 The rock sample contains lead oxide.

Complete the word equation for the reaction between lead oxide and carbon.

[1 mark]

lead oxide + carbon $\rightarrow$ _____ + _____

0 4 . 4 The furnace operates at a temperature of 1200 °C.

The lead forms as a liquid in the furnace.

The zinc is separated from the lead in the furnace.

Table 3 shows the melting point and the boiling point of zinc.

Table 3

	Zinc
Melting point in °C	420
Boiling point in °C	907

Explain how zinc is separated from the lead in the furnace and then collected as a liquid.

[2 marks]



A different rock sample contained aluminium oxide.

Aluminium is **not** extracted from aluminium oxide by heating with carbon.

Aluminium is extracted from aluminium oxide by electrolysis.

0 4 . 5

Why is aluminium **not** extracted from aluminium oxide by heating with carbon?

[1 mark]

0 4 . 6

In electrolysis, aluminium ions (Al^{3+}) are attracted to the negative electrode.

Describe how aluminium atoms are formed at the negative electrode.

[2 marks]

0 4 . 7

The positive electrode needs to be replaced at regular intervals.

Explain why.

[3 marks]



0	5
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This question is about fuels and pollution.

Some fuels contain alkanes.

Alkanes are saturated hydrocarbons.

0	5	.	1
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What is a hydrocarbon?

[1 mark]

0	5	.	2
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What does 'saturated' mean in the term 'saturated hydrocarbon'?

[1 mark]

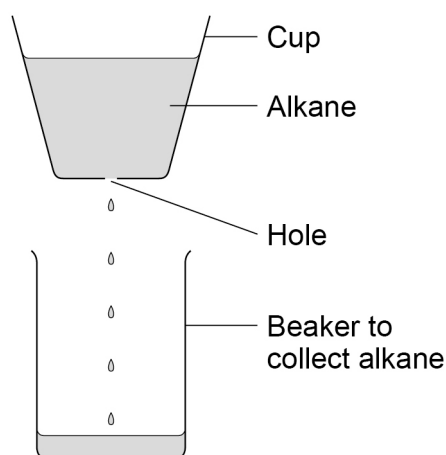


A student investigated the effect of temperature on the viscosity of a liquid alkane.

The student measured the rate of flow of the alkane through a hole in a cup.

Figure 6 shows the apparatus.

Figure 6



This is the method used.

1. Measure 50 cm^3 of the alkane.
2. Measure the temperature of the alkane.
3. Pour the alkane into the cup.
4. Record the time taken for all of the alkane to flow through the hole.
5. Repeat steps 1 to 4 with the alkane at different temperatures.

0 5 3

The student should **not** use a Bunsen burner to change the temperature of the alkane.

Give **one** reason why.

[1 mark]

Question 5 continues on the next page

Turn over ►



0 5 . 4 Table 4 shows the results.

Table 4

Temperature in °C	Time taken for alkane to flow through the hole in seconds
25	76
30	66
35	58
40	51
45	47
50	45

Describe the relationship between the temperature of the alkane and the **viscosity** of the alkane.

[3 marks]



0 5 . 5

A compound in a fuel contains carbon, hydrogen and oxygen.

13.8 g of the compound contains 7.2 g of carbon and 4.8 g of oxygen.

Calculate the empirical formula of the compound.

Relative atomic masses (A_r): C = 12 H = 1 O = 16

[5 marks]

Empirical formula _____

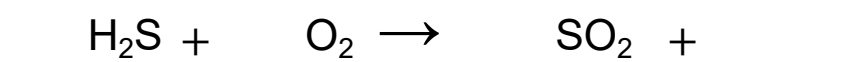
0 5 . 6

Fuels sometimes contain the impurity hydrogen sulfide.

Complete the equation for the combustion of hydrogen sulfide to produce sulfur dioxide and one other substance.

You should balance the equation.

[2 marks]



0 5 . 7

What environmental problem is caused by sulfur dioxide?

[1 mark]

Question 5 continues on the next page

Turn over ►



0	5	.	8
---	---	---	---

Explain how global dimming is caused by burning fuels.

[3 marks]

0	5	.	9
---	---	---	---

Describe how oxides of nitrogen are formed from nitrogen during the combustion of fuels in car engines.

[2 marks]



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0 6

This question is about obtaining useful substances from crude oil.

Hydrocarbons from crude oil can be cracked to produce more useful hydrocarbons.

Table 5 shows the hydrocarbons present in a sample of oil before and after the sample was cracked.

Table 5

Hydrocarbons present before the sample was cracked	Hydrocarbons present after the sample was cracked
$C_{13}H_{28}$ $C_{14}H_{30}$	C_2H_4 C_3H_6 C_6H_{14} C_7H_{16}

0 6 . 1

One mole of tetradecane ($C_{14}H_{30}$) is cracked.

The products are:

- 2 moles of ethene (C_2H_4)
- 1 mole of propene (C_3H_6)
- 1 mole of another hydrocarbon.

Write a balanced equation for the reaction.

[2 marks]

_____ $\rightarrow$ _____ + _____ + _____

0 6 . 2

Describe the conditions used in cracking.

[2 marks]



0 6 . 3

The hydrocarbons present after the sample was cracked have a lower viscosity than the hydrocarbons present before the sample was cracked.

Describe **two** other properties that will be different for the hydrocarbons present after the sample was cracked.

Use **Table 5**.

[2 marks]

1 _____

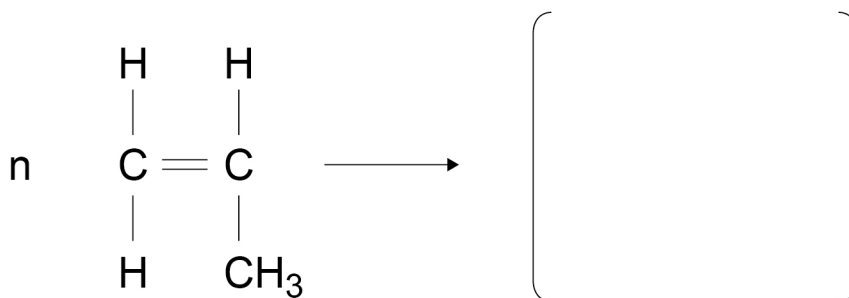
2 _____

0 6 . 4

Propene (C_3H_6) can be used to produce poly(propene).

Complete the equation to show the formation of poly(propene) from propene.

[3 marks]



9

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Turn over ►



0 7

A student did a titration to neutralise potassium hydroxide with sulfuric acid.

This is the method used.

1. Measure 25.0 cm^3 of the potassium hydroxide solution using a measuring cylinder.
2. Add the potassium hydroxide solution to a conical flask on a white tile.
3. Add a few drops of an indicator to the potassium hydroxide solution.
4. Add sulfuric acid from a burette 1.0 cm^3 at a time.
5. Mix the contents of the flask.
6. Stop adding sulfuric acid when the indicator changes colour.

0 7 . 1

In **step 1** the student used a measuring cylinder.

How could **step 1** be improved to get more accurate results?

[1 mark]

0 7 . 2

In **step 4** the student added sulfuric acid 1.0 cm^3 at a time.

How could **step 4** be improved to measure a more accurate volume of sulfuric acid needed to neutralise 25.0 cm^3 of potassium hydroxide?

[1 mark]

0 7 . 3

The method is **not** complete.

What instruction should be added after **step 6** to complete the method to get more accurate results?

[1 mark]



0 7 . 4

Give the ionic equation for a neutralisation reaction.

[1 mark]

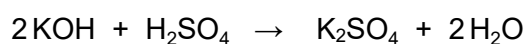
_____ + _____ → _____

0 7 . 5

A different student did a titration using a more accurate method.

The student found that 20.0 cm³ of sulfuric acid completely reacted with 25.0 cm³ of potassium hydroxide solution of concentration 0.220 mol/dm³.

The equation for the reaction is:



Calculate the concentration of the sulfuric acid in mol/dm³.

[4 marks]

Concentration = _____ mol/dm³

8

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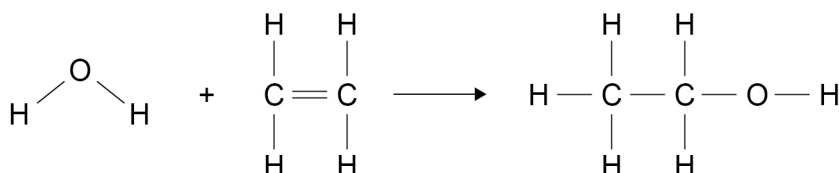
0 8

This question is about ethanol.

Ethene reacts with steam to produce ethanol.

0 8

1

Figure 7 shows the displayed structures of the reactants and the product.**Figure 7****Table 6** shows the bond energies.**Table 6**

Bond	Bond energy in kJ/mol
C=C	612
C-C	347
C-H	413
C-O	358
O-H	464

Calculate the overall energy change for the reaction.

[3 marks]

Overall energy change = _____ kJ/mol

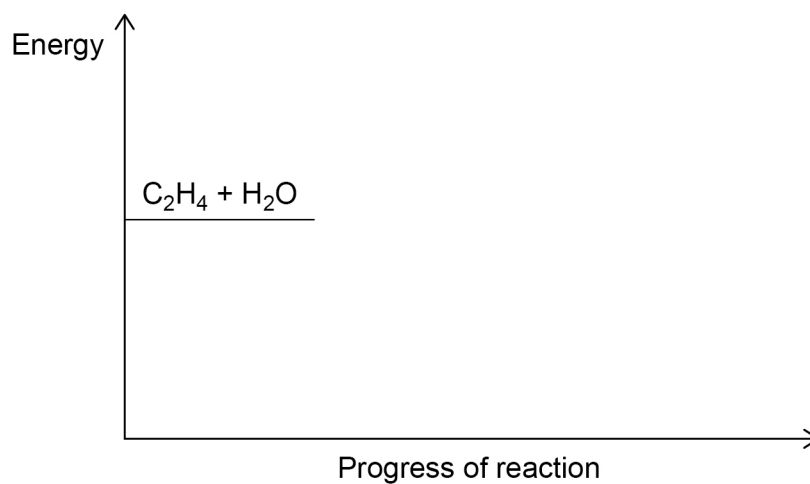


0 8 . 2

Figure 8 shows part of an energy level diagram for the reaction between ethene and steam.

The reaction is exothermic

Figure 8



Complete **Figure 8**.

You should:

- label the activation energy
- label the overall energy change
- include the formula of the product.

[4 marks]

Question 8 continues on the next page

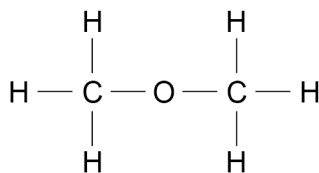
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0 8 . 3

Figure 9 shows the displayed structure of compound X.

Figure 9

Compound X is **not** an alcohol.

Compound X has the following properties:

- burns in air
- dissolves in water
- does not react with sodium.

Compare the properties of compound X with the properties of ethanol.

[3 marks]

0 8 . 4

Ethanol can be oxidised to compound Y using a chemical oxidising agent.

What is the name of compound Y?

[1 mark]



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0	9
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Chlorine reacts with two different elements, **X** and **Z**.

X and **Z** are **not** the chemical symbols of the elements.

One of these elements is a metal and the other element is a non-metal.

The formulae of the compounds produced are **XCl** and **ZCl**

0	9	.	1
---	---	---	---

Both **XCl** and **ZCl** dissolve in water to form solutions.

The solutions react with silver nitrate to produce silver chloride.

What is observed when silver chloride is produced?

[1 mark]



0 9 . 2 Table 7 shows the melting points of compounds **XCl** and **ZCl**

Table 7

	Melting point in °C
XCl	770
ZCl	−115

Explain why compounds **XCl** and **ZCl** have different melting points.

You should refer to the structure and bonding in **XCl** and **ZCl**

[5 marks]

Question 9 continues on the next page

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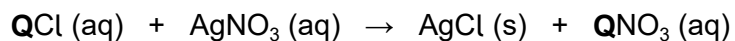
0 9 . 3

5.85 g of a different chloride **QCl** was dissolved in water.

The solution of **QCl** reacted with excess silver nitrate solution.

14.35 g of silver chloride was produced.

The equation for the reaction is:



Determine the name of element **Q**.

You should calculate the relative formula mass (M_r) of **QCl**

Relative atomic mass (A_r) Cl = 35.5

Relative formula mass (M_r) of AgCl = 143.5

[5 marks]

Relative formula mass (M_r) of **QCl** = _____

Name of element **Q** _____

11

END OF QUESTIONS



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