



*Rewarding Learning*

General Certificate of Secondary Education  
2023

Centre Number

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Candidate Number

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# Double Award Science: Chemistry

Unit C2



Foundation Tier

**[GDW51]**

\*GDW51\*

**TUESDAY 13 JUNE, MORNING**

## TIME

1 hour 15 minutes.

## INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

**You must answer the questions in the spaces provided.**

**Do not write outside the boxed area on each page or on blank pages.**

Complete in black ink only. **Do not write with a gel pen.**

Answer **all seven** questions.

## INFORMATION FOR CANDIDATES

The total mark for this paper is 70.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

Quality of written communication will be assessed in Question 2.

A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.



1 Metals vary in their reactivity with oxygen, water and steam.

(a) Complete the reactivity series below by placing the metals **iron**, **potassium**, and **aluminium** in their correct positions.

	Most reactive
sodium	
calcium	
magnesium	
zinc	
copper	Least reactive

[1]



(b) Calcium reacts readily with water.

- (i) Name the compound formed when calcium reacts with water.  
Circle the correct answer.

calcium  
chloride

calcium  
oxide

calcium  
hydroxide

calcium  
carbonate

[1]

- (ii) A student made four predictions about the reaction of calcium with water. Using your own knowledge, complete the following table to show if each prediction is correct or incorrect by placing a tick (✓) in the appropriate column.

Prediction for reaction of calcium with water	Correct	Incorrect
The metal will burn with a lilac flame		
The metal will sink and then rise		
The solution formed will be blue		
Bubbles of gas will be given off		

[4]

[Turn over



**(c)** A reaction occurs when tin is added to a solution of copper(II) sulfate. The solution changes from blue to colourless and a solid forms.

**(i)** Name the type of reaction happening when tin reacts with copper(II) sulfate solution.

\_\_\_\_\_ [1]

**(ii)** Complete the word equation for the reaction.

tin + copper(II) sulfate → \_\_\_\_\_ + \_\_\_\_\_ [1]

**(iii)** State the colour of the solid formed in this reaction.

\_\_\_\_\_ [1]

**(iv)** What does this reaction tell you about the reactivity of tin compared to copper?

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [1]





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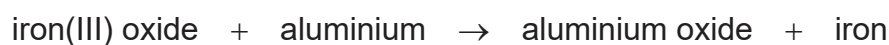
**[Turn over**



**\*24GDW5105\***

- 2 The reaction between iron(III) oxide and aluminium is an exothermic reaction and also a redox reaction.

The word equation for the reaction is:



- Write the chemical formula of aluminium oxide
- State what is meant by an exothermic reaction
- Explain, in terms of oxygen content, why this reaction is described as a redox reaction.

**In this question you will be assessed on your written communication skills including the use of specialist scientific terms.**

Write the chemical formula of aluminium oxide:

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State what is meant by an exothermic reaction:

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[6]

**[Turn over**



\*24GDW5107\*

- 3 (a) Substances conduct electricity when charged particles can move and carry the charge.

Aluminium conducts electricity.

Lead(II) bromide does not conduct electricity when solid but does conduct electricity when molten.

Molten lead(II) bromide is an electrolyte.

- (i) Complete the table below to show how molten lead(II) bromide conducts electricity.

Place a tick (✓) in the correct column.

Substance	Particle which can move and carry the charge		
	Proton	Electron	Ion
solid aluminium		✓	
molten lead(II) bromide			

[1]

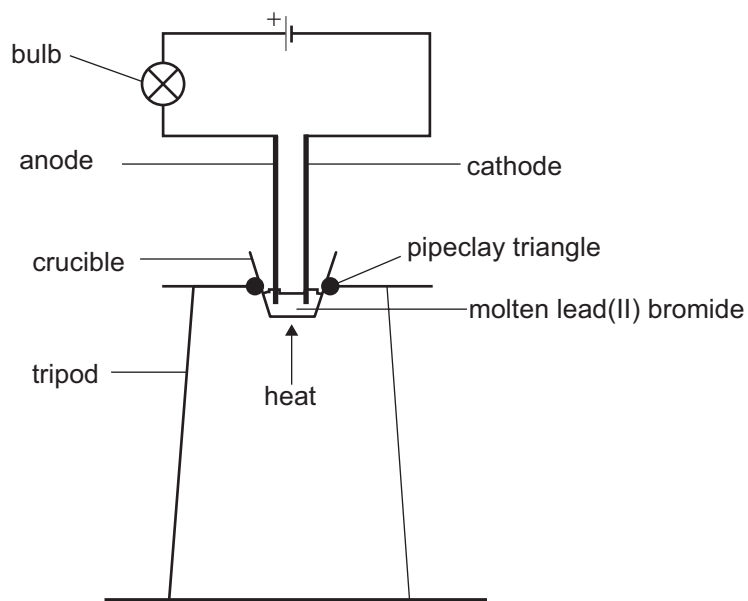
- (ii) What happens to electrolytes, such as molten lead(II) bromide, when they conduct electricity?

[1]





- (b) The labelled diagram below shows the apparatus used for the electrolysis of molten lead(II) bromide.



- (i) What is meant by the term **anode**?

\_\_\_\_\_ [1]

- (ii) The anode and cathode are both made from graphite.

State two reasons, apart from cost, why graphite is a suitable material to use for the anode and the cathode.

1. \_\_\_\_\_
2. \_\_\_\_\_ [2]

[Turn over



(iii) Complete the table below by predicting the observations and names of the products formed at the anode and cathode for the electrolysis of molten lead(II) bromide.

Anode		Cathode	
Observations	Name of product formed	Observations	Name of product formed
		Grey liquid formed	

[4]

(iv) Explain why this electrolysis should be carried out in a fume cupboard.

[1]





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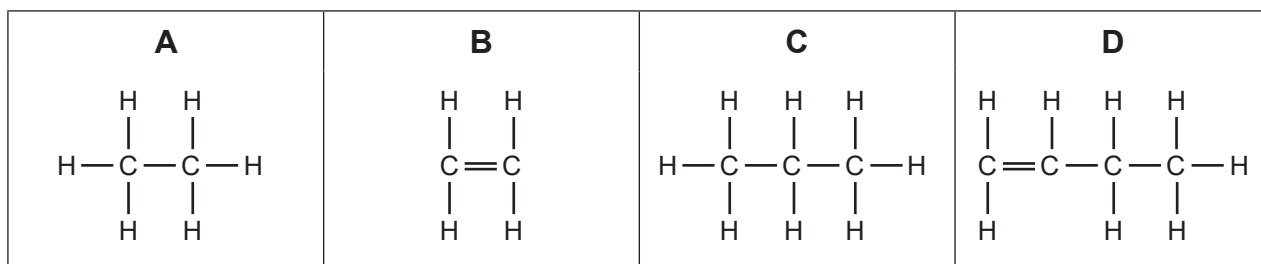
13893

**[Turn over**



**\*24GDW5111\***

4 (a) The structural formulae of four hydrocarbons labelled **A** to **D** are given below.



(i) Complete the definition of the term **hydrocarbon**.

A hydrocarbon is a compound consisting of only \_\_\_\_\_  
 \_\_\_\_\_ [1]

(ii) Which compound (**A**, **B**, **C** or **D**) is ethane?

\_\_\_\_\_ [1]

(iii) Write the molecular formula of compound **B**.

\_\_\_\_\_ [1]

(iv) How many of the compounds (**A**, **B**, **C** or **D**) are gases at room temperature? Circle the correct answer.

none                  one                  two                  three                  four  
 \_\_\_\_\_ [1]

(v) Name the homologous series to which compound **C** belongs.

\_\_\_\_\_ [1]

(vi) What is the name of compound **D**? Circle the correct answer.

but-1-ene                  but-2-ene                  propane                  propene  
 \_\_\_\_\_ [1]



**(b)** Propene is a gaseous hydrocarbon that contains a  $C=C$  bond.

- (i)** Write the general formula of the homologous series which contains a  $C=C$  bond.

\_\_\_\_\_ [1]

- (ii)** Name the reagent that can be used to prove that propene contains a  $C=C$  bond.

\_\_\_\_\_ [1]

- (iii)** State the colour change observed when propene is bubbled through the reagent named in **(b)(ii)**.

Colour change from: \_\_\_\_\_ to \_\_\_\_\_ [1]

**(c)** The hydrocarbon butane is widely used as a fuel.

- (i)** Draw the structural formula of butane.

[1]

- (ii)** Write a word equation for the complete combustion of butane.

\_\_\_\_\_ [2]

- (iii)** Name the toxic gas that is produced by the incomplete combustion of butane.

\_\_\_\_\_ [1]

**[Turn over]**



**5** Hydrated sodium carbonate,  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ , contains water of crystallisation.

A solid sample of hydrated sodium carbonate may be heated to remove the water of crystallisation and form anhydrous sodium carbonate. The equation for this reaction is:



**(a)** What is meant by the term **water of crystallisation**?

\_\_\_\_\_  
\_\_\_\_\_ [1]

**(b)** Calculate the relative formula masses ( $M_r$ ) of the following compounds.  
(Relative atomic masses:  $\text{H} = 1$ ;  $\text{C} = 12$ ;  $\text{O} = 16$ ;  $\text{Na} = 23$ )

**(i)** anhydrous sodium carbonate,  $\text{Na}_2\text{CO}_3$

relative formula mass ( $M_r$ ) \_\_\_\_\_ [1]

**(ii)** hydrated sodium carbonate,  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$

relative formula mass ( $M_r$ ) \_\_\_\_\_ [1]



- (c) Many calcium containing compounds such as gypsum (hydrated calcium sulfate) occur naturally. Hydrated calcium sulfate,  $\text{CaSO}_4 \cdot x\text{H}_2\text{O}$ , has a relative formula mass ( $M_r$ ) of 172.

Calculate the value of  $x$  in  $\text{CaSO}_4 \cdot x\text{H}_2\text{O}$ . **Show your working out.**  
(Relative atomic masses:  $\text{H} = 1$ ;  $\text{O} = 16$ ;  $\text{S} = 32$ ;  $\text{Ca} = 40$ )

$x$  \_\_\_\_\_ [3]

[Turn over]

13893



\*24GDW5115\*

- (d) Epsom salts are used in bath water to relax muscles and relieve pain. The main ingredient in Epsom salts is hydrated magnesium sulfate.

A sample of hydrated magnesium sulfate was heated in an evaporating basin and the following mass measurements were recorded.

Mass measurement	Mass /g
Mass of evaporating basin	80.8
Mass of evaporating basin and hydrated magnesium sulfate	142.3
Mass of evaporating basin and contents after heating for 1 minute	127.3
Mass of evaporating basin and contents after heating for 2 minutes	122.3
Mass of evaporating basin and contents after heating for 3 minutes	110.8
Mass of evaporating basin and contents after heating for 4 minutes	110.8

Use the mass measurements above to answer the following questions.

- (i) Calculate the mass of hydrated magnesium sulfate.

mass of hydrated magnesium sulfate \_\_\_\_\_ g [1]





(ii) Calculate the mass of anhydrous magnesium sulfate.

mass of anhydrous magnesium sulfate \_\_\_\_\_ g [1]

(iii) Calculate the mass of water of crystallisation.

mass of water of crystallisation \_\_\_\_\_ g [1]

(iv) As shown in the table, the sample was repeatedly heated and weighed until two consecutive mass measurements were the same. Why was this done?

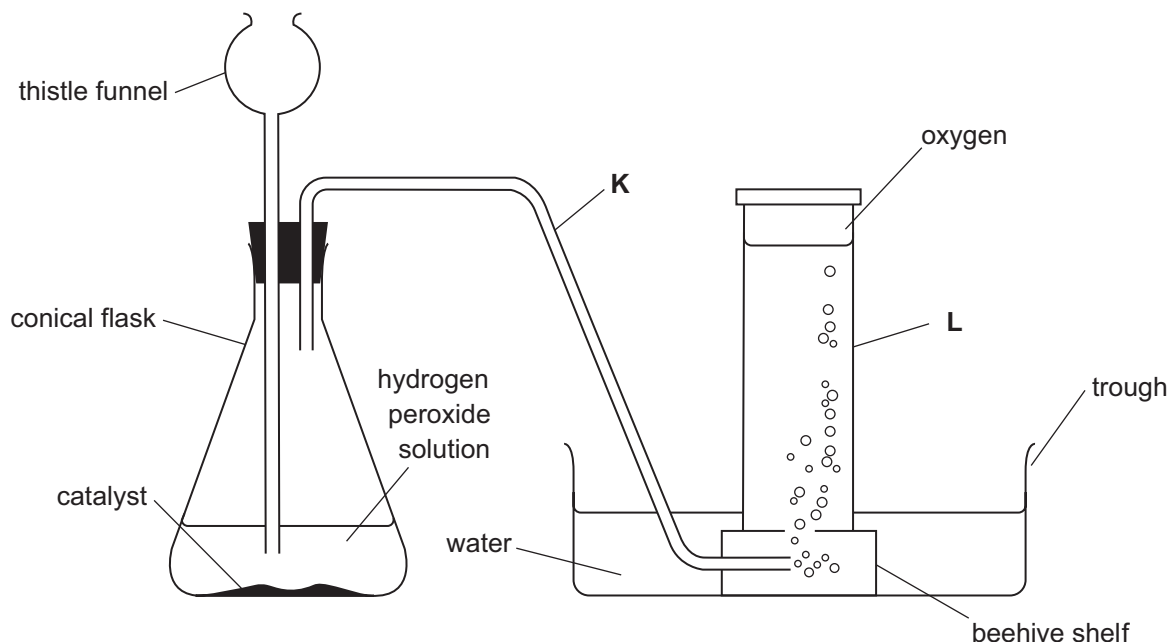
\_\_\_\_\_  
\_\_\_\_\_ [1]

[Turn over



- 6 Hydrogen peroxide decomposes rapidly into water and oxygen in the presence of a catalyst.

(a) The diagram below shows the apparatus used to prepare and collect oxygen gas from hydrogen peroxide solution using a catalyst.



(i) What labels should be placed at **K** and **L**?

**K** \_\_\_\_\_  
**L** \_\_\_\_\_ [2]

(ii) The balanced symbol equation for the decomposition of hydrogen peroxide in solution to form water and oxygen gas is shown below. Insert state symbols.



(iii) Name the catalyst used for this preparation.

\_\_\_\_\_ [1]

(iv) Oxygen is used in medicine for patients with breathing difficulties. State one other use for oxygen.

\_\_\_\_\_ [1]

(v) Describe the test for oxygen gas.

\_\_\_\_\_  
\_\_\_\_\_ [1]

(b) A student heated some magnesium and some copper in air using a Bunsen burner.

Complete the table below giving the observations which occur during heating and a description of the appearance of the products.

Metal	Observations during heating	Appearance of product
Magnesium		
Copper		

[4]

[Turn over



- 7 Carbon dioxide gas is formed when magnesium carbonate reacts with dilute hydrochloric acid. The equation for the reaction is:

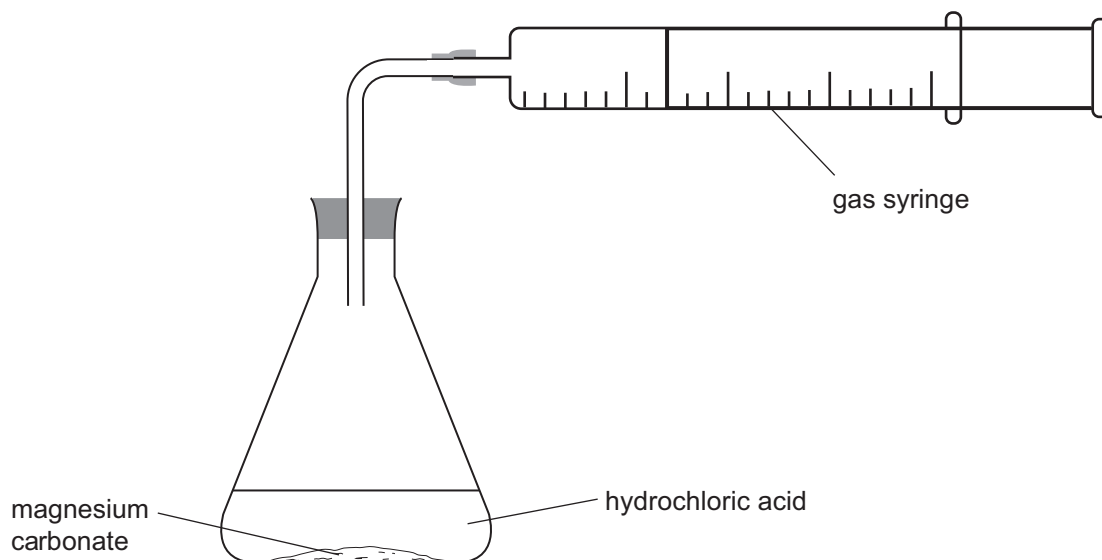


Some experiments were carried out to investigate the effect of changing the concentration of hydrochloric acid on the rate of this reaction.

Solid magnesium carbonate was added to 50 cm<sup>3</sup> of hydrochloric acid in a conical flask.

A gas syringe was attached to the conical flask and it was used to measure the volume of carbon dioxide produced. A diagram of the apparatus used is shown below.

This was repeated with different concentrations of hydrochloric acid.



- (a) Apart from safety glasses, name one other piece of apparatus that would be essential to carry out these experiments.

\_\_\_\_\_ [1]



- (b) In each experiment the time taken to produce 25 cm<sup>3</sup> of carbon dioxide was recorded. The results are shown in the table below.

Experiment	Concentration of hydrochloric acid /mol/dm <sup>3</sup>	Time taken to produce 25 cm <sup>3</sup> of carbon dioxide /s
1	0.1	75
2	0.2	59
3	0.3	45
4	0.4	31
5	0.5	16

- (i) In each experiment the same volume of hydrochloric acid was used.

State one other variable the student must keep the same to make the investigation a fair test.

\_\_\_\_\_ [1]

- (ii) Which experiment (1, 2, 3, 4, 5) was the fastest?

\_\_\_\_\_ [1]

- (iii) Which one of the equations below can be used to calculate rate?  
Circle the correct answer.

$$\text{rate} = \frac{\text{time}}{1}$$

$$\text{rate} = \frac{1}{\text{concentration}}$$

$$\text{rate} = \frac{1}{\text{time}}$$

[1]

[Turn over]



(c) Calcium hydroxide solution may be used to test for carbon dioxide gas.

(i) What is the common name of calcium hydroxide solution?

\_\_\_\_\_ [1]

(ii) What is observed when carbon dioxide gas is bubbled through calcium hydroxide solution?

\_\_\_\_\_  
\_\_\_\_\_ [2]

(iii) From the following list, circle **two** words which describe carbon dioxide.

acidic

basic

colourless

neutral

red

white

[2]



(d) Carbon dioxide is also formed in the reversible reaction between methane and steam.

(i) In the equation below insert the correct symbol in the box to show that this is a reversible reaction.



(ii) State one condition which could be changed to alter the direction of this reversible reaction.

\_\_\_\_\_ [1]

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**THIS IS THE END OF THE QUESTION PAPER**

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For Examiner's use only	
Question Number	Marks
1	
2	
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Total Marks	
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Examiner Number

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## SYMBOLS OF SELECTED IONS

### Positive ions

Name	Symbol
Ammonium	$\text{NH}_4^+$
Chromium(III)	$\text{Cr}^{3+}$
Copper(II)	$\text{Cu}^{2+}$
Iron(II)	$\text{Fe}^{2+}$
Iron(III)	$\text{Fe}^{3+}$
Lead(II)	$\text{Pb}^{2+}$
Silver	$\text{Ag}^+$
Zinc	$\text{Zn}^{2+}$

### Negative ions

Name	Symbol
Butanoate	$\text{C}_3\text{H}_7\text{COO}^-$
Carbonate	$\text{CO}_3^{2-}$
Dichromate	$\text{Cr}_2\text{O}_7^{2-}$
Ethanoate	$\text{CH}_3\text{COO}^-$
Hydrogencarbonate	$\text{HCO}_3^-$
Hydroxide	$\text{OH}^-$
Methanoate	$\text{HCOO}^-$
Nitrate	$\text{NO}_3^-$
Propanoate	$\text{C}_2\text{H}_5\text{COO}^-$
Sulfate	$\text{SO}_4^{2-}$
Sulfite	$\text{SO}_3^{2-}$

## Data Leaflet

### Including the Periodic Table of the Elements

For the use of candidates taking  
Science: Chemistry,  
Science: Double Award  
or Science: Single Award

Copies must be free from notes or additions of any  
kind. No other type of data booklet or information  
sheet is authorised for use in the examinations

### SOLUBILITY IN COLD WATER OF COMMON SALTS, HYDROXIDES AND OXIDES

Soluble
All sodium, potassium and ammonium salts
All nitrates
Most chlorides, bromides and iodides EXCEPT silver and lead chlorides, bromides and iodides
Most sulfates EXCEPT lead and barium sulfates Calcium sulfate is slightly soluble
Insoluble
Most carbonates EXCEPT sodium, potassium and ammonium carbonates
Most hydroxides EXCEPT sodium, potassium and ammonium hydroxides
Most oxides EXCEPT sodium, potassium and calcium oxides which react with water

# gcse examinations chemistry

THE PERIODIC TABLE OF ELEMENTS

Group

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\* 58 – 71 Lanthanum series  
† 90 – 103 Actinium series

aXb

a = relative atomic mass (approx)  
x = atomic symbol  
b = atomic number

140	<b>Ce</b> Cerium 58	141	<b>Pr</b> Praseodymium 59	144	<b>Nd</b> Neodymium 60	145	<b>Pm</b> Promethium 61	150	<b>Sm</b> Samarium 62	152	<b>Eu</b> Europium 63	157	<b>Gd</b> Gadolinium 64	159	<b>Tb</b> Terbium 65	162	<b>Dy</b> Dysprosium 66	165	<b>Ho</b> Holmium 67	167	<b>Er</b> Erbium 68	169	<b>Tm</b> Thulium 69	173	<b>Yb</b> Ytterbium 70	175	<b>Lu</b> Lutetium 71
232	<b>Th</b> Thorium 90	231	<b>Pa</b> Protactinium 91	238	<b>U</b> Uranium 92	237	<b>Np</b> Neptunium 93	242	<b>Pu</b> Plutonium 94	243	<b>Am</b> Americium 95	247	<b>Cm</b> Curium 96	245	<b>Bk</b> Berkelium 97	251	<b>Cf</b> Californium 98	254	<b>Es</b> Einsteinium 99	253	<b>Fm</b> Fermium 100	256	<b>Md</b> Mendelevium 101	254	<b>No</b> Nobelium 102	257	<b>Lr</b> Lawrencium 103