



Rewarding Learning

General Certificate of Secondary Education
2023

Centre Number

--	--	--	--	--

Candidate Number

--	--	--	--	--

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]





BLANK PAGE

DO NOT WRITE ON THIS PAGE

(Questions continue overleaf)

13893

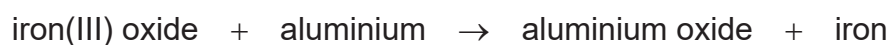
[Turn over



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:

State what is meant by an exothermic reaction:



Explain, in terms of oxygen content, why this reaction is described as a redox reaction:

[6]

[Turn over



- 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			

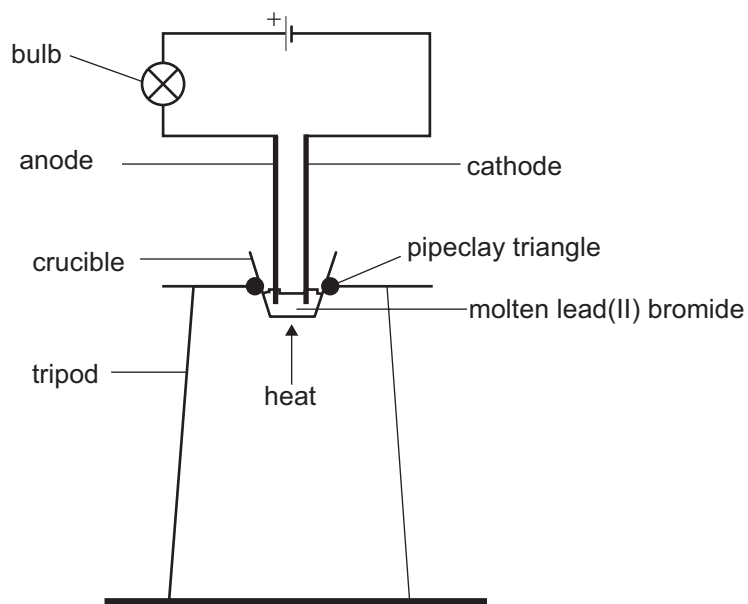
[1]

- (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]





BLANK PAGE

DO NOT WRITE ON THIS PAGE

(Questions continue overleaf)

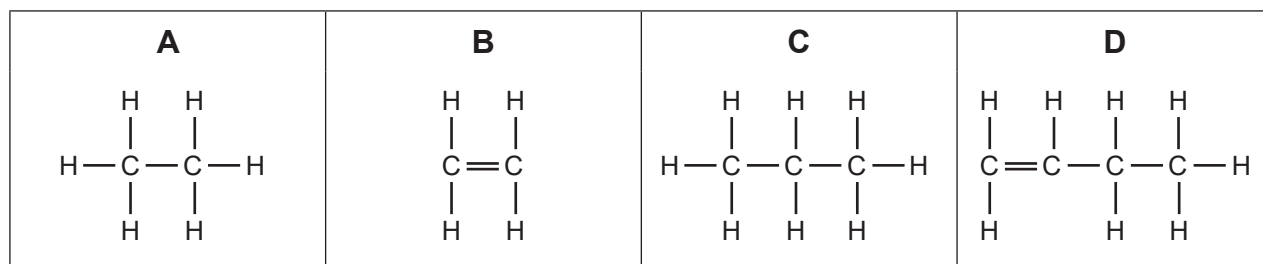
13893

[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, Na_2CO_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?

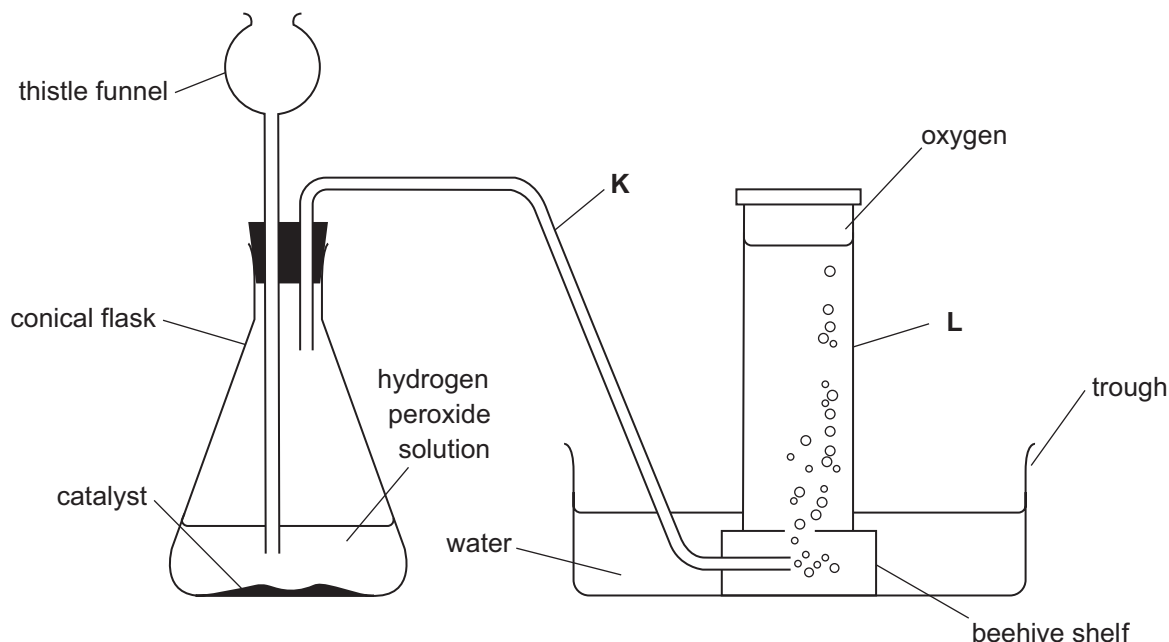
_____ [1]

[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:

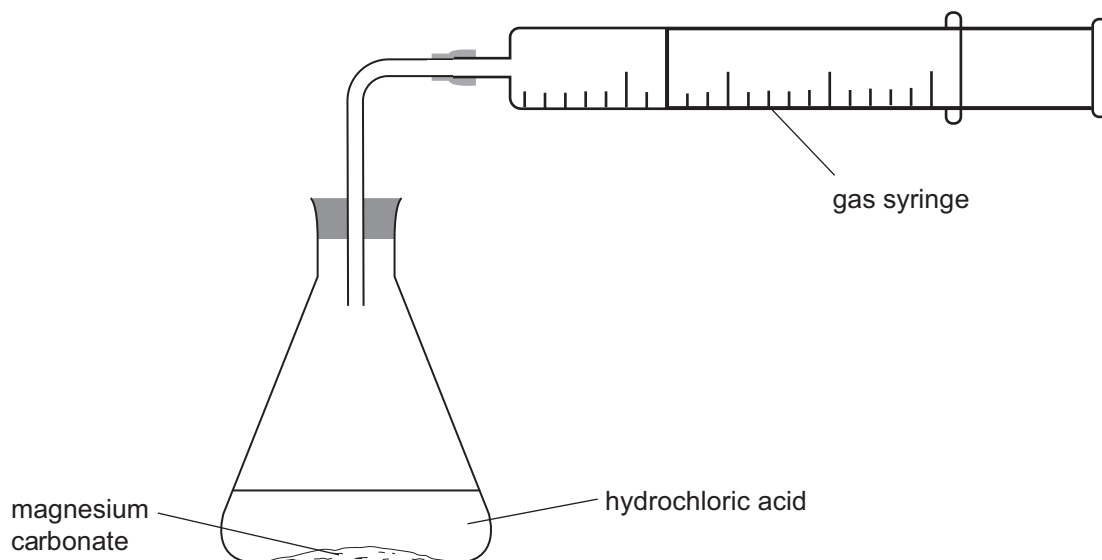


Some experiments were carried out to investigate the effect of changing the concentration of hydrochloric acid on the rate of this reaction.

Solid magnesium carbonate was added to 50 cm³ 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 cm³ of carbon dioxide was recorded. The results are shown in the table below.

Experiment	Concentration of hydrochloric acid /mol/dm ³	Time taken to produce 25 cm ³ 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]

THIS IS THE END OF THE QUESTION PAPER



DO NOT WRITE ON THIS PAGE

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	

Total Marks	
-------------	--

Examiner Number

Permission to reproduce all copyright material has been applied for.
In some cases, efforts to contact copyright holders may have been unsuccessful and CCEA
will be happy to rectify any omissions of acknowledgement in future if notified.

GDW51/7
284210



SYMBOLS OF SELECTED IONS

Positive ions

Name	Symbol
Ammonium	NH_4^+
Chromium(III)	Cr^{3+}
Copper(II)	Cu^{2+}
Iron(II)	Fe^{2+}
Iron(III)	Fe^{3+}
Lead(II)	Pb^{2+}
Silver	Ag^+
Zinc	Zn^{2+}

Negative ions

Name	Symbol
Butanoate	$\text{C}_3\text{H}_7\text{COO}^-$
Carbonate	CO_3^{2-}
Dichromate	$\text{Cr}_2\text{O}_7^{2-}$
Ethanoate	CH_3COO^-
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-
Methanoate	HCOO^-
Nitrate	NO_3^-
Propanoate	$\text{C}_2\text{H}_5\text{COO}^-$
Sulfate	SO_4^{2-}
Sulfite	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

Group

1		2		Hydrogen 1																3		4		5		6		7		2	
7 Li Lithium 3	9 Be Beryllium 4																	11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10								
23 Na Sodium 11	24 Mg Magnesium 12																	27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18								
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36														
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	98 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54														
133 Cs Caesium 55	137 Ba Barium 56	139 La [*] Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86														
223 Fr Francium 87	226 Ra Radium 88	227 Ac [†] Actinium 89	261 Rf Rutherfordium 104	262 Db Dubnium 105	266 Sg Seaborgium 106	264 Bh Bohrium 107	277 Hs Hassium 108	268 Mt Meitnerium 109	271 Ds Darmstadtium 110	272 Rg Roentgenium 111	285 Cn Copernicium 112																				

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

$\boxed{\begin{smallmatrix} \text{a} & & \\ & \text{X} & \\ \text{b} & & \end{smallmatrix}}$

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

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