



Rewarding Learning

General Certificate of Secondary Education
2023

Centre Number

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Candidate Number

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GCSE Chemistry

Unit 2

Foundation Tier



[GCM21]

GCM21

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 six** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 80.

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 **6(a)**.

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

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20GCM2101

1 Some metals react with oxygen in the air and with cold water.

(a) Complete the following table giving information about the reactions of the metals potassium and copper with oxygen in the air and with cold water.

	Potassium	Copper
Three observations when the metal is heated in air	grey solid metal burns with a lilac flame white solid forms	
Balanced symbol equation for the reaction of the metal with oxygen		$2\text{Cu} + \text{O}_2 \rightarrow 2\text{CuO}$
Three observations during the reaction of the metal with cold water		no reaction
Balanced symbol equation for the reaction of the metal with cold water		

[12]



(b) Displacement reactions may be used to establish a reactivity series of metals.

Several experiments were carried out using the metals lead, magnesium, zinc and silver. A sample of each metal was added to solutions of the metal nitrates. The results obtained are shown in the table below. A tick (✓) indicates that a reaction occurs.

Solution	Metal			
	Lead	Magnesium	Zinc	Silver
Lead(II) nitrate		✓	✓	✗
Magnesium nitrate	✗		✗	✗
Zinc nitrate	✗	✓		✗
Silver nitrate	✓	✓	✓	

Use the results to put the metals in order of reactivity with the most reactive metal first.

most reactive: _____

least reactive: _____

[1]

[Turn over



(c) Iron is extracted from its ore in the Blast Furnace. The ore contains iron(III) oxide. The word equation for the reaction in which iron is formed is shown below.



(i) Name the ore from which iron is extracted.

_____ [1]

(ii) Write the formula of iron(III) oxide.

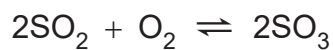
_____ [1]

(iii) Explain, in terms of oxygen content, why the reaction is described as a redox reaction.

_____ [5]



2 The balanced symbol equation below shows a reversible reaction which reaches a dynamic equilibrium at 450 °C.



(a) What do you understand by the term reversible?

[1]

(b) How does the equation show that the reaction is reversible?

[1]

(c) State two features of a dynamic equilibrium.

1.

2.

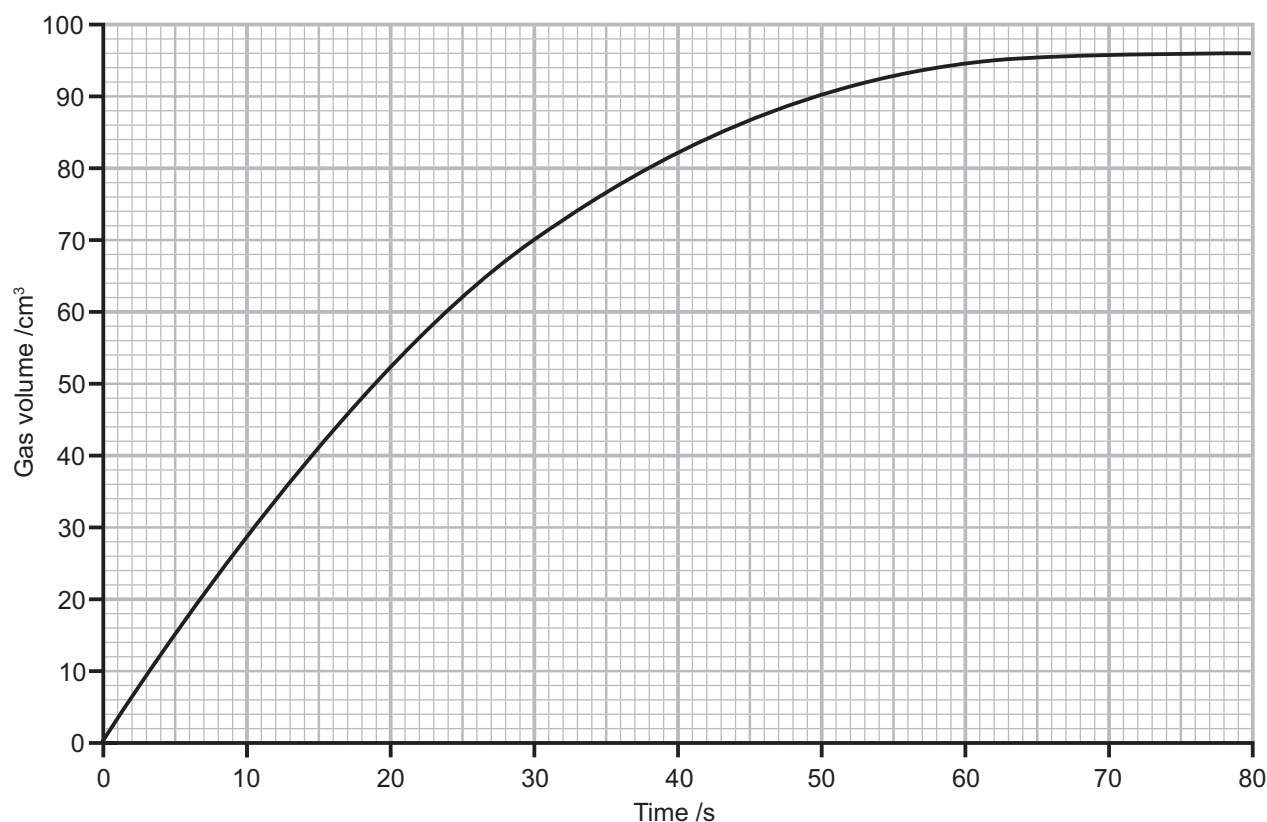
[2]

[Turn over



3 Zinc metal reacts with dilute sulfuric acid to produce hydrogen gas.

0.26 g of zinc granules were added to 25.0 cm³ of 0.50 mol/dm³ sulfuric acid at room temperature (20 °C). The volume of gas produced was recorded every 10 seconds. The acid was in excess. The results are plotted on the graph below.



(a) Write a balanced symbol equation for the reaction between zinc and sulfuric acid.

_____ [2]

(b) What was the volume of gas produced at 30 s?

_____ [2]

(c) At what time did the reaction finish?

_____ [1]

(d) Copper(II) sulfate may be used as a catalyst for this reaction.

(i) Explain how a catalyst increases the rate of a chemical reaction.

_____ [2]

(ii) Sketch on the axes opposite, the graph obtained when the experiment is repeated with 1.0 g of copper(II) sulfate added. All other factors remain the same. Label this graph A. [1]

[Turn over



4 Crude oil is a mixture of hydrocarbons and is the main source of organic chemicals.

(a) (i) Name the process used to separate crude oil into its components.

_____ [2]

(ii) State the meaning of the term hydrocarbon.

_____ [1]

(iii) The table below shows some of the components obtained when crude oil is separated and the uses of these components. Complete the table.

Component	Uses
Kerosene	
	Fuel for cars
Bitumen	

[3]

(b) Most of the hydrocarbons obtained from crude oil belong to a homologous series named the alkanes.

(i) What is meant by the term homologous series?

_____ [3]

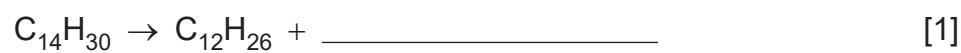


(ii) Write the general formula of the alkanes.

_____ [1]

(iii) Some of the large alkane molecules obtained from crude oil undergo the process of cracking. Cracking produces smaller, more useful hydrocarbons.

Complete the balanced symbol equation below to show the cracking of the alkane, $C_{14}H_{30}$.



[Turn over

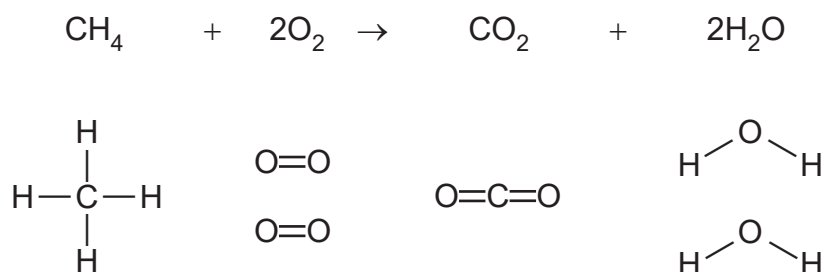
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(c) Alkanes are mainly used as fuels. Methane, CH₄, is the main constituent of natural gas and is used to generate electricity and heat our homes.

(i) The covalent bonds which are present in the reactants and products are shown below the balanced symbol equation for the combustion of methane.



Use the bonds shown above and the bond energy values in the table below to calculate the energy change for the reaction.

Bond	Bond energy /kJ
C—H	412
O=O	496
C=O	803
O—H	463

energy change = _____ kJ [4]



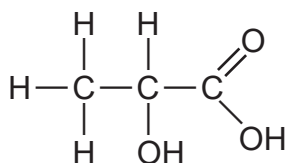
- (ii) Many compounds formed from the combustion of fuels have an effect on the environment.

In the diagram below, draw a line from each compound to its main effect.

Compound	Effect
carbon dioxide	acid rain
sulfur dioxide	no effect
	greenhouse effect

[2]

- (d) Lactic acid is a carboxylic acid that can build up in muscles during strenuous exercise causing cramps and fatigue. The structural formula of lactic acid is shown below.



- (i) The molecular formula of lactic acid may be written as $\text{C}_x\text{H}_y\text{O}_z$. What are the values of x, y and z in this molecular formula?

x = _____ y = _____ z = _____ [2]

- (ii) A sample of solid copper(II) carbonate was added to a solution of lactic acid. State three observations you would make during this reaction.

[3]

[Turn over

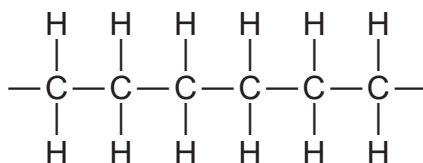


(e) Polymers such as polythene are non-biodegradable.

(i) What is meant by the term polymer?

_____ [1]

(ii) Part of the structure of polythene is shown below.



Name the monomer from which polythene is formed.

_____ [1]

(iii) What is meant by the term non-biodegradable?

_____ [1]

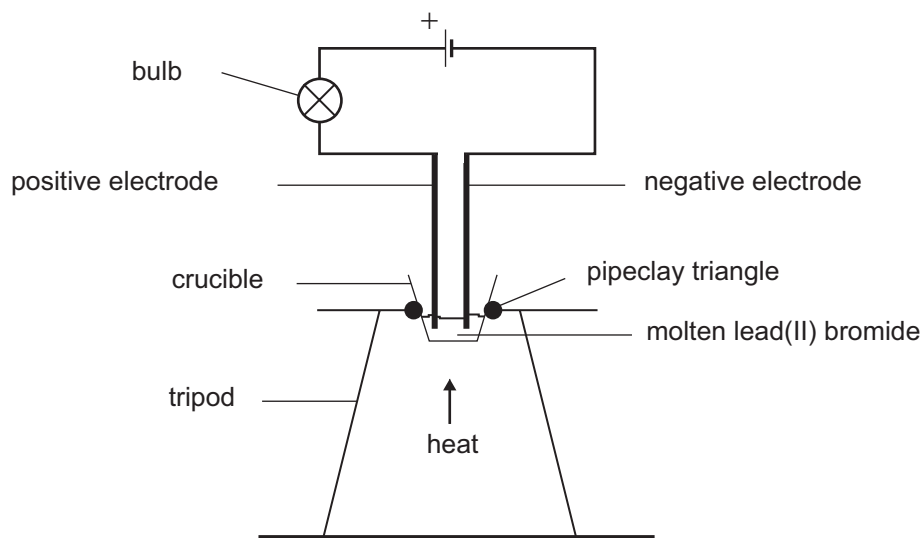
(iv) State two methods used to dispose of polymers.

1. _____ [2]

2. _____



- 5 The diagram below shows the apparatus used to carry out the electrolysis of molten lead(II) bromide.



- (a) (i) What name is used for a liquid that conducts electricity and is decomposed by it?

_____ [1]

- (ii) How would you know the molten lead(II) bromide was conducting electricity?

_____ [1]



(b) (i) Name the product formed at the negative electrode during the electrolysis of molten lead(II) bromide.

_____ [1]

(ii) What is observed at the positive electrode during the electrolysis of molten lead(II) bromide?

_____ [2]



(c) Molten lithium chloride also undergoes electrolysis.

(i) Write a word equation for the overall reaction which occurs during the electrolysis of molten lithium chloride.

_____ [1]

(ii) The electrodes used in the electrolysis of molten lithium chloride do not take part in the reaction. What term is used to describe electrodes that do not take part in an electrolysis reaction?

_____ [1]

(iii) Name a substance which could be used to make the electrodes in this electrolysis.

_____ [1]

(iv) Explain how molten lithium chloride conducts electricity.

_____ [1]

[Turn over



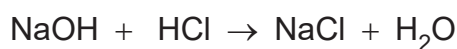
- (b) Name a suitable indicator for this titration and state the colour change observed at the end point.

Name of indicator:

Colour change at end point:

From _____ to _____ [3]

- (c) The titration in (a) produces sodium chloride and water. The balanced symbol equation for the reaction is:



Calculate the atom economy of this reaction to produce sodium chloride.

atom economy = _____ % [3]

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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	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

THE PERIODIC TABLE OF ELEMENTS

Group

												1							0
												1 H Hydrogen 1							4 He Helium 2
1	2											3	4	5	6	7			
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

$\begin{matrix} a \\ \boxed{X} \\ b \end{matrix}$ 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