



Rewarding Learning

General Certificate of Secondary Education
2024

Centre Number

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Candidate Number

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GCSE Chemistry

Unit 2

Foundation Tier



[GCM21]

GCM21

FRIDAY 14 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 five** 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 **2(a)(iii)**.

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

13960



20GCM2101

1 The reactions of metals with oxygen in air, with water and with steam differ based on the reactivity of the metal.

(a) Information on the reactions of three metals when heated in air is given below.

Metal 1: Grey solid burns with orange sparks forming a black solid

Metal 2: Red-brown solid glows red when heated and changes to a black solid

Metal 3: Grey solid burns with a brick red flame forming a white solid

(i) Identify the metals.

Metal 1: _____

Metal 2: _____

Metal 3: _____ [3]

(ii) Based on your answer to (a)(i), write a balanced symbol equation for the reaction of Metal 3 when heated in air.

_____ [3]

(b) Aluminium metal reacts with steam when heated. Hydrogen gas is formed.

The word equation for the reaction is:

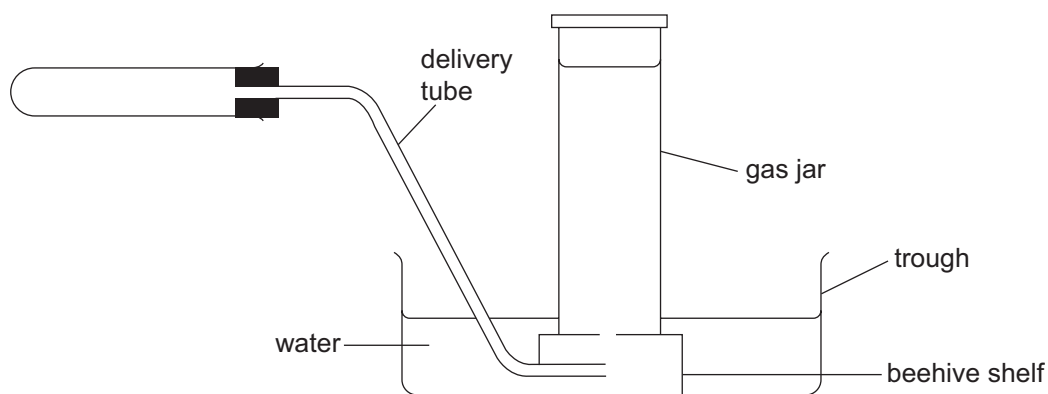
aluminium + steam → aluminium oxide + hydrogen

(i) Insert the missing balancing number and state symbol in the equation below.

$2\text{Al}(\text{s}) + 3\text{H}_2\text{O}(\quad) \rightarrow \text{Al}_2\text{O}_3(\text{s}) + \quad\quad\quad \text{H}_2(\text{g})$ [2]



- (ii) The apparatus below was used to react aluminium with steam. A small amount of hydrogen was produced.



Show the position of the following on the diagram using the letter indicated in the table below.

Letter label	Apparatus/chemicals
A	damp mineral wool
B	aluminium
C	hydrogen

[3]

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

[5]

[Turn over



(c) Based on your knowledge of the reactivity of metals, predict which of the following reactions would occur. Place a tick (✓) in the right-hand box for any reactions which would occur.

copper + steam

zinc + sodium chloride solution

magnesium + steam

[1]





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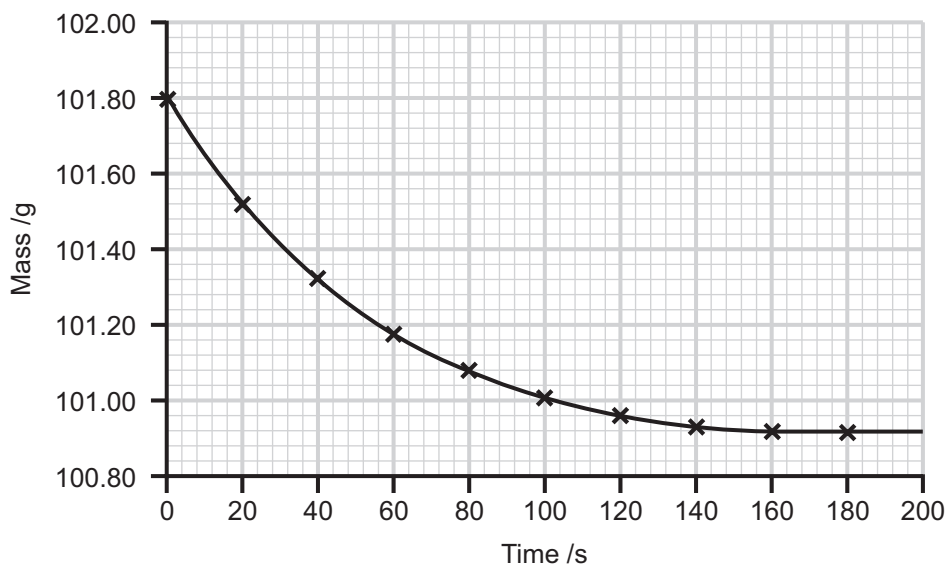
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20GCM2105

2 Carbon dioxide is produced in many chemical reactions including the reaction of marble chips with hydrochloric acid.

(a) In an experiment, 2.0 g of marble chips (calcium carbonate) and 25 cm³ of 2.0 mol/dm³ hydrochloric acid (an excess) were reacted in a conical flask at room temperature. The mass of the reaction mixture was recorded and a graph of mass against time was drawn. The graph is shown below.



(i) Calculate the total loss in mass.
Show your working out.

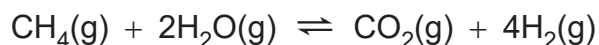
total loss in mass = _____ g [3]

(ii) At what time did the reaction finish?

_____ s [1]



- (b) The reaction between methane and water vapour is a reversible reaction producing hydrogen. Carbon dioxide is a waste product. The reaction is a dynamic equilibrium.



- (i) State one factor which could be changed to alter the position of equilibrium.

_____ [1]

- (ii) Place ticks (✓) in the right-hand boxes to indicate which statements are true about a dynamic equilibrium.

The rate of the forward reaction is greater than the rate of the reverse reaction.

The amounts of reactants and products present at equilibrium are equal.

The rate of the forward reaction is equal to the rate of the reverse reaction.

The amounts of the reactants and products present at equilibrium are constant.

[2]



(iii) Calculate the percentage atom economy of hydrogen in this reaction.
Give your answer to 1 decimal place.

percentage atom economy = _____ % [3]



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20GCM2110



3 Organic compounds are classified into different families called homologous series. All the compounds in a homologous series have the same general formula. Some homologous series are hydrocarbons.

(a) (i) State one feature which is **similar** for all compounds of a homologous series.

_____ [1]

(ii) State one way in which successive members of a homologous series differ from each other.

_____ [1]

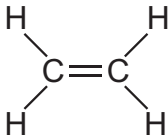
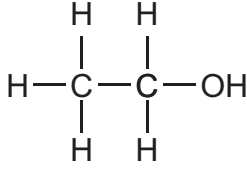
(iii) What is meant by the term hydrocarbon?

_____ [1]

[Turn over



(b) The table below shows some details of four organic compounds, **A**, **B**, **C** and **D**.

	Homologous series	Number of carbon atoms	Name	Structural formula	Molecular formula
A	Alkane		methane		CH ₄
B		2	ethene		
C	Alkane		butane		C ₄ H ₁₀
D	Alcohol	2			

(i) Complete the table. [8]

(ii) Which of the substances (**A**, **B**, **C**, **D**) are gases at room temperature?

_____ [1]



(iii) Write a balanced symbol equation for the complete combustion of **A**.

_____ [3]

(iv) **B** can undergo polymerisation. State the type of polymerisation.

_____ [1]

(v) Name the process by which **D** is produced from sugar using yeast.

_____ [1]

(c) Butane can undergo cracking to form two products, one of which is unsaturated. The balanced symbol equation for the reaction given below is incomplete.



(i) Complete the equation by giving the formula of the second product. [1]

(ii) What is meant by the term unsaturated?

_____ [1]

(iii) Describe how you would test for the presence of the unsaturated product.

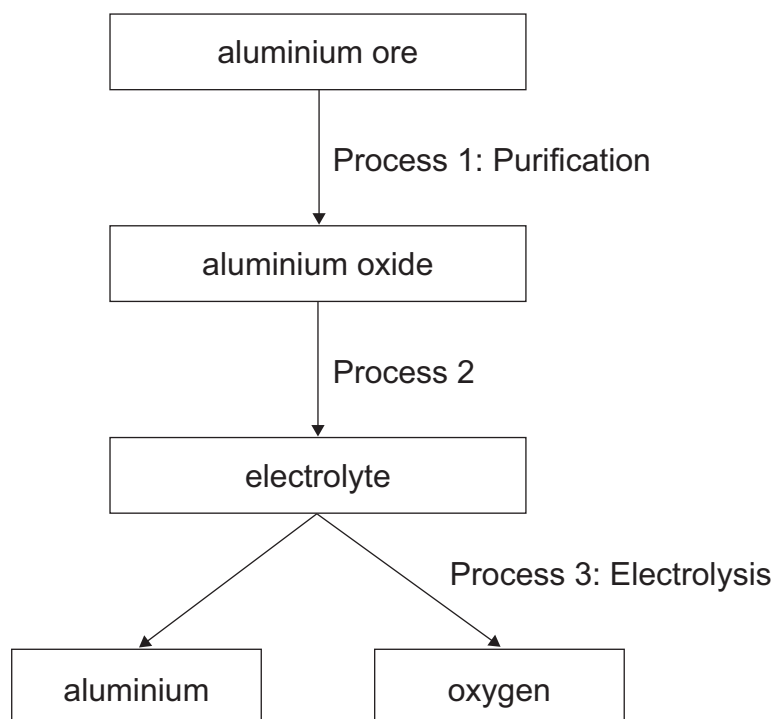
_____ [2]

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4 Many useful materials, such as aluminium, iron and plastics, are produced from the Earth's natural resources.

(a) The flow scheme below shows the main processes involved in the production of aluminium from its ore.



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

_____ [1]

(ii) What name is used for the purified aluminium oxide formed in Process 1?

_____ [1]

(iii) How is the electrolyte made in Process 2?

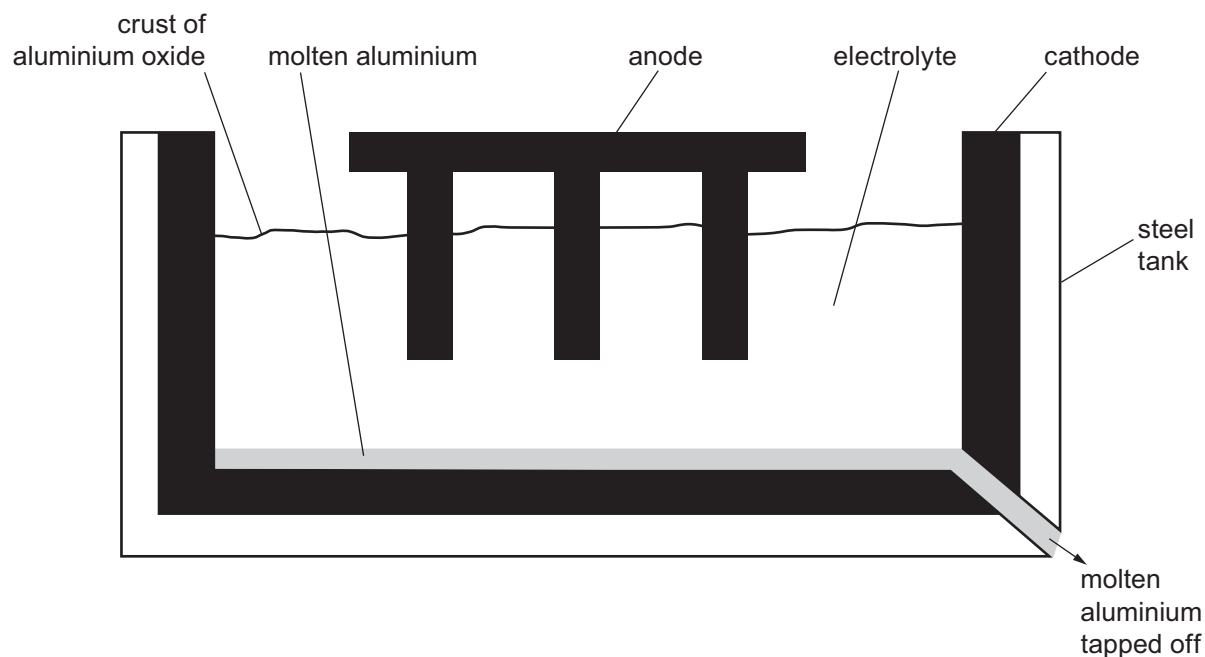
_____ [1]



(iv) What is meant by the term electrolyte?

[1]

(b) The diagram below shows the industrial apparatus used to extract aluminium from the electrolyte. Aluminium is produced at the cathode and oxygen gas is produced at the anode. The anode and cathode are made of graphite.



(i) State one function of the crust of aluminium oxide.

[1]

(ii) What is the operating temperature of this process?

[1]

[Turn over



(iii) State two reasons why the electrodes are made of graphite.

1. _____

2. _____

[2]

(iv) Describe one problem which occurs due to the use of graphite for the electrodes.

[1]





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20GCM2117

5 Many chemical reactions, including combustion, produce gases. Some gases cause pollution.

(a) Hydrogen gas is produced when zinc reacts with sulfuric acid. In an experiment, a sample of zinc metal was reacted with 25.0 cm^3 of sulfuric acid in a conical flask. The volume of hydrogen gas produced was measured using a gas syringe.

(i) Draw a labelled diagram of the assembled apparatus used to carry out the experiment.

[4]

(ii) State one use of hydrogen gas.

[1]

(iii) Write a balanced symbol equation for the reaction of zinc with sulfuric acid.

[2]

(b) Ammonia gas is formed when nitrogen from the air reacts with hydrogen. The reaction requires a high temperature and pressure as nitrogen is very unreactive.

(i) Explain why nitrogen is very unreactive.

[2]



(ii) Write the formula of ammonia.

_____ [1]

(iii) Complete the table below which gives details of the main gases present in air.

Gas present in air	Percentage composition /%
nitrogen	
	21
argon	1
carbon dioxide	

[3]

(iv) Name one other gas found in air.

_____ [1]

(c) Sulfur burns in air, when heated, producing a gas. A flame is observed. The gas produced causes pollution.

(i) Name the gas produced when sulfur burns in air.

_____ [1]

(ii) What colour is the flame observed when sulfur burns in air?

_____ [1]

(iii) What type of pollution is caused by the gas produced when sulfur burns in air?

_____ [1]

THIS IS THE END OF THE QUESTION PAPER



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Question Number	Marks
1	
2	
3	
4	
5	

Total Marks	
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Examiner Number

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20GCM2120

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

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

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

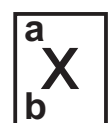
gcse examinations chemistry

THE PERIODIC TABLE OF ELEMENTS

Group

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



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