



Rewarding Learning

General Certificate of Secondary Education
2022

Centre Number

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Candidate Number

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GCSE Chemistry

Unit 2

Higher Tier



[GCM22]

GCM22

MONDAY 20 JUNE, MORNING

TIME

1 hour 30 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 100.

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 **3(d)(iii)**.

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

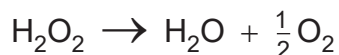
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20GCM2201

- 1 Dilute hydrogen peroxide solution is a mild antiseptic which can be used on the skin to prevent infection of minor cuts. Hydrogen peroxide decomposes at room temperature and releases oxygen. The release of oxygen causes foaming which helps to remove dead skin and clean the cut.

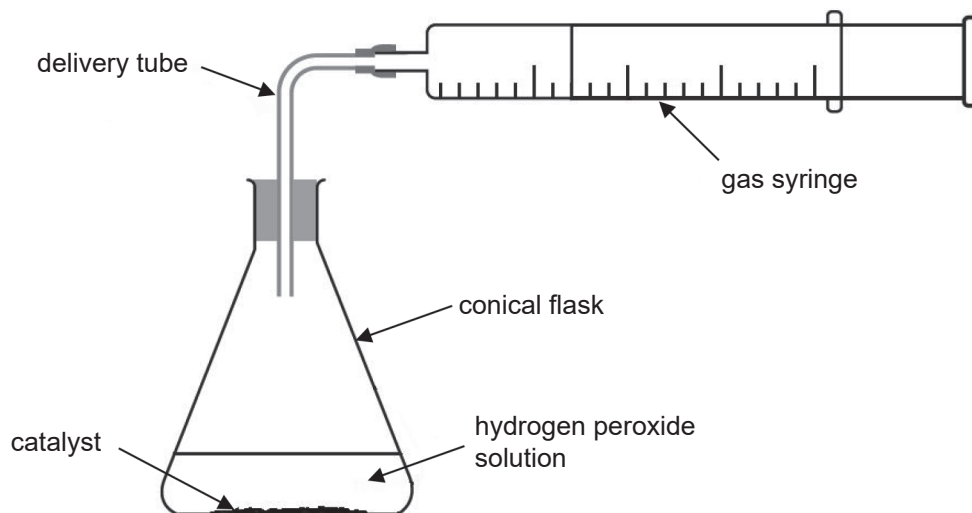
(a) The equation for the decomposition of hydrogen peroxide may be written as:



Calculate the volume of oxygen gas which is produced when 17 g of hydrogen peroxide completely decompose at 20 °C and 1 atm pressure. State the units.

volume = _____ [4]

(b) The diagram below shows some of the apparatus used in the laboratory to investigate the rate of reaction for the decomposition of hydrogen peroxide.



(i) Name one other piece of apparatus which the student must use in order to investigate the rate of reaction for the decomposition of hydrogen peroxide.

_____ [1]

(ii) Name a catalyst which can be used to increase the rate of decomposition of hydrogen peroxide.

_____ [1]

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

_____ [2]

(iv) Explain why increasing the concentration of hydrogen peroxide solution will increase the rate of the reaction.

_____ [3]

[Turn over



(c) The results obtained from the experiment in (b) are shown in the table below.

Time /s	0	10	20	30	40	50	60	70	80	90
Volume of oxygen /cm ³	0	60	90	105	112	116	118	120	120	120

(i) Calculate the number of moles of oxygen collected in the first 20 seconds.

moles of oxygen = _____ [2]

(ii) Explain why the volume of gas did not increase beyond 120 cm³.

_____ [1]



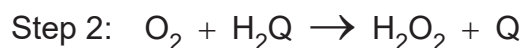
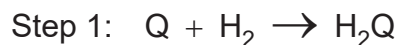
- (d) Hydrogen peroxide may be manufactured by reacting barium peroxide, BaO_2 , with cold dilute sulfuric acid. The equation for the reaction is:



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

percentage atom economy = _____ % [2]

- (e) Hydrogen peroxide may also be manufactured using hydrogen gas, oxygen from the air and a substance called anthraquinone (represented by the letter Q). It is a two-step reaction.



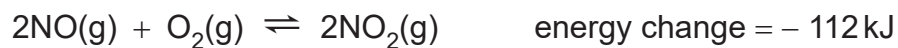
Suggest one advantage of manufacturing hydrogen peroxide using this method.

_____ [1]

[Turn over



- 2 Nitrogen monoxide reacts with oxygen to form nitrogen dioxide as shown in the equation below. A dynamic equilibrium is established.



- (a) State two features of a dynamic equilibrium.

[2]

- (b) State and explain the effect of increasing pressure on the equilibrium yield of nitrogen dioxide.

[3]

- (c) The table below shows the percentage yield of nitrogen dioxide at different temperatures.

Temperature /°C	100	200	300	400
Percentage yield of NO ₂ at equilibrium /%	98	92	85	76



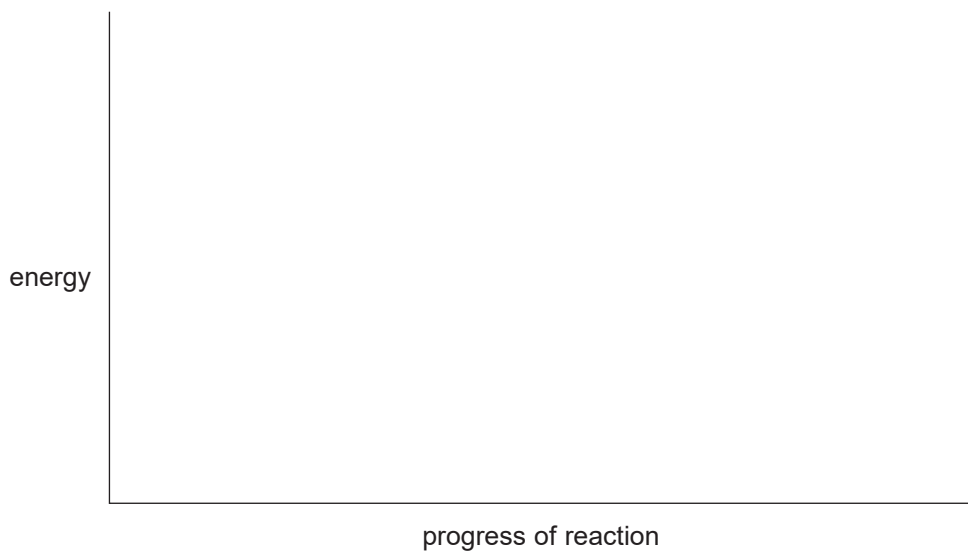
- (i) Use the data in the table to state the effect of an increase in temperature on the percentage yield of NO_2 .

[1]

- (ii) Explain the effect of an increase in temperature on the equilibrium yield of NO_2 .

[2]

- (d) On the axes below, draw a **labelled** reaction profile diagram for the reaction between nitrogen monoxide and oxygen forming nitrogen dioxide. The diagram should include the energy levels of the reactants and products, the energy change, a reaction pathway and the activation energy.



[4]

[Turn over



3 Organic compounds may be grouped into different homologous series.

(a) State two features of a homologous series of organic compounds.

[2]

(b) Complete the table below to give the functional group of some homologous series.

Homologous series	Functional group
alkenes	
alcohols	
carboxylic acids	

[3]

(c) Suggest why alkanes are less reactive than alkenes.

[1]



(d) Alcohols such as ethanol and propan-1-ol are colourless liquids.

(i) Draw the structural formulae of ethanol and propan-1-ol.

ethanol

propan-1-ol

[2]

(ii) Name another alcohol which has the same molecular formula as propan-1-ol.

[1]

[Turn over



(e) Propan-1-ol may be converted to propanoic acid. Propanoic acid reacts with metals such as magnesium.

(i) Name the reagent used to convert propan-1-ol to propanoic acid.

_____ [2]

(ii) What colour change is observed during the reaction of propan-1-ol with the reagent identified in (e)(i)?

_____ [1]

(iii) State the type of reaction occurring when propan-1-ol is converted to propanoic acid.

_____ [1]

(iv) Write a balanced symbol equation for the reaction of propanoic acid with magnesium.

_____ [3]

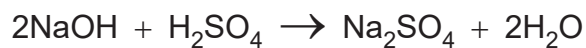
(v) What is observed when excess propanoic acid reacts with magnesium?

_____ [3]

[Turn over



- 4 A titration was carried out to find the concentration of a solution of sulfuric acid. 25.0 cm³ of 0.088 mol/dm³ aqueous sodium hydroxide were neutralised by 17.6 cm³ of dilute sulfuric acid.



- (a) In addition to a retort stand and clamp, name four essential pieces of equipment needed to carry out a titration.

[2]

- (b) Calculate the concentration of the sulfuric acid in mol/dm³.

concentration of sulfuric acid = _____ mol/dm³ [3]



(c) Calculate the concentration of the sulfuric acid in g/dm^3 . Give your answer to 1 decimal place.

concentration of sulfuric acid = _____ g/dm^3 [2]

(d) Hydrated sodium sulfate, $\text{Na}_2\text{SO}_4 \cdot x\text{H}_2\text{O}$, has a relative formula mass (M_r) of 322.

Calculate the value of x in $\text{Na}_2\text{SO}_4 \cdot x\text{H}_2\text{O}$

$x =$ _____ [2]

[Turn over



5 Nearly 75% of the elements in the Periodic Table are classified as metals. These metals show different reactivities.

(a) In an experiment, a small piece of metal was added to a fixed volume of water and the time taken for the reaction to finish was recorded. The results are shown in the table below.

Metal	Time taken for reaction to finish /s
calcium	42
lithium	35
magnesium	Not finished after 300 s
potassium	5
sodium	11

(i) Write a balanced symbol equation for the reaction of potassium with water.

_____ [3]

(ii) A few drops of phenolphthalein were added to the solution produced when potassium reacted with water. State the colour observed.

_____ [1]

(iii) Describe, in terms of electrons, what happens to the potassium atoms when they react with water.

_____ [2]



(iv) Compare the reactivity of Group 1 and Group 2 metals. Give evidence from the table to support your answer.

[2]

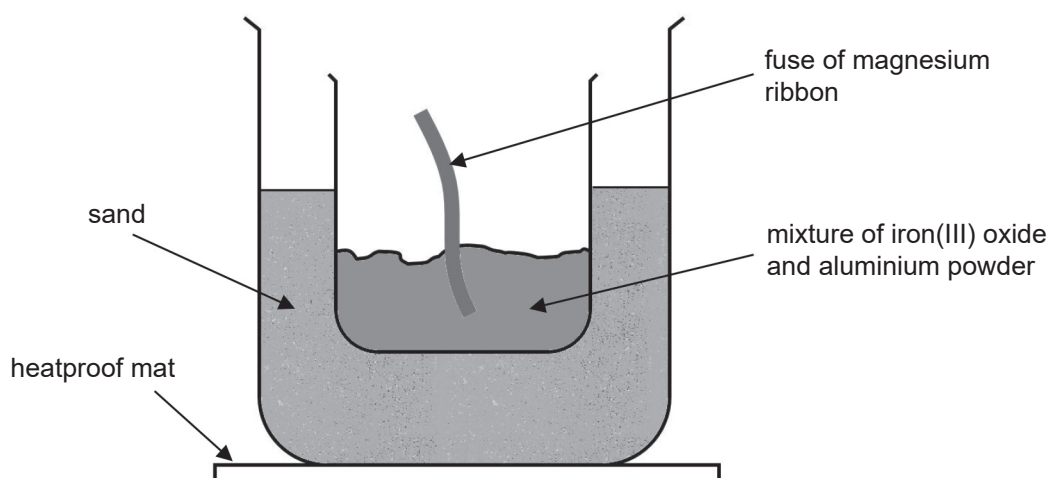
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- (b) When a mixture of iron(III) oxide and aluminium powder is reacted in the apparatus shown below, a bright flame and sparks are observed. Molten iron is formed.



- (i) Write a balanced symbol equation for the reaction of iron(III) oxide with aluminium.

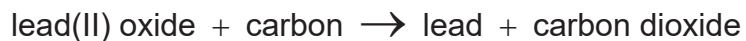
_____ [3]

- (ii) Explain, in terms of reactivity, why the reaction of iron(III) oxide with aluminium occurs.

_____ [1]



(c) Lead can be extracted from lead(II) oxide using carbon in a furnace. The word equation for the reaction is:



Explain fully, in terms of change in oxygen content, why this reaction is described as a redox reaction.

[5]

[Turn over



6 (a) Electrolysis occurs when molten sodium chloride conducts electricity.

(i) What is meant by the term electrolysis?

_____ [1]

(ii) Explain why molten sodium chloride conducts electricity.

_____ [1]

(iii) What is observed at the anode?

_____ [2]

(iv) Name a suitable material used for the electrodes.

_____ [1]

(v) Write a half-equation for the reaction which occurs at the anode.

_____ [3]

(b) Dilute sulfuric acid also undergoes electrolysis.

(i) Name the electrolysis product at the cathode.

_____ [1]

(ii) Write a half-equation for the reaction which occurs at the anode.

_____ [3]



(c) Aluminium may be extracted from its ore by electrolysis. The ore of aluminium is purified in a series of reactions which produces solid aluminium hydroxide. The solid aluminium hydroxide is then heated to form aluminium oxide and water vapour is released. Aluminium oxide is dissolved in molten cryolite and the electrolysis is carried out.

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

_____ [1]

(ii) Write a balanced symbol equation for the reaction which occurs when solid aluminium hydroxide is heated. Include state symbols.

_____ [4]

(iii) State one reason why aluminium oxide is dissolved in molten cryolite.

_____ [1]

(iv) The half-equation for the reaction which occurs at the cathode is:



Explain why this reaction is a reduction reaction.

_____ [2]

THIS IS THE END OF THE QUESTION PAPER



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Question Number	Marks
1	
2	
3	
4	
5	
6	
Total Marks	

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 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

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