Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2017

GCSE Chemistry

Unit 2

Higher Tier

[GCH22]

GCH22

WEDNESDAY 21 JUNE, MORNING

TIME

1 hour 45 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 115.
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 **4(d)** and **6(b)(iv)**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

10556

24GCH2201

1 Aluminium metal is obtained from its ore by electrolysis. Aluminium is used to manufacture drinks cans.

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(a) **(i)** Name the ore from which aluminium is obtained.

_____ [1]

(ii) State two reasons why the purified ore is dissolved in molten cryolite.

1. _____

_____

2. _____

_____ [2]

(iii) Write a half equation for the production of aluminium at the cathode.

_____ [3]

(iv) Name the electrolysis product obtained at the anode and write a half equation for the reaction which occurs at the anode.

Product: _____ [1]

Half equation: _____ [3]

(b) An aluminium manufacturing company is exploring the possibility of setting up an aluminium extraction plant.

State two factors that need to be considered by the company when choosing a site for the aluminium extraction plant.

1. _____

_____

2. _____

_____ [2]

2 Organic compounds are grouped into homologous series. Alkenes are a homologous series of hydrocarbons.

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

_____

_____

_____

_____

_____ [3]

(ii) Complete the table below.

Name	Molecular formula	Physical state at room temperature
ethene		gas
	C_3H_6	

[3]

(iii) What is the functional group of the alkenes?

_____ [1]

(b) Vinegar contains the weak acid, ethanoic acid.

(i) Draw the structural formula of ethanoic acid.

[1]

(ii) What is meant by the term weak acid?

_____

_____

_____ [1]

(c) Ethanoic acid undergoes typical reactions of acids.

(i) Write a balanced symbol equation for the reaction of ethanoic acid with magnesium.

_____ [3]

(ii) What is observed when magnesium reacts with ethanoic acid?

_____

_____

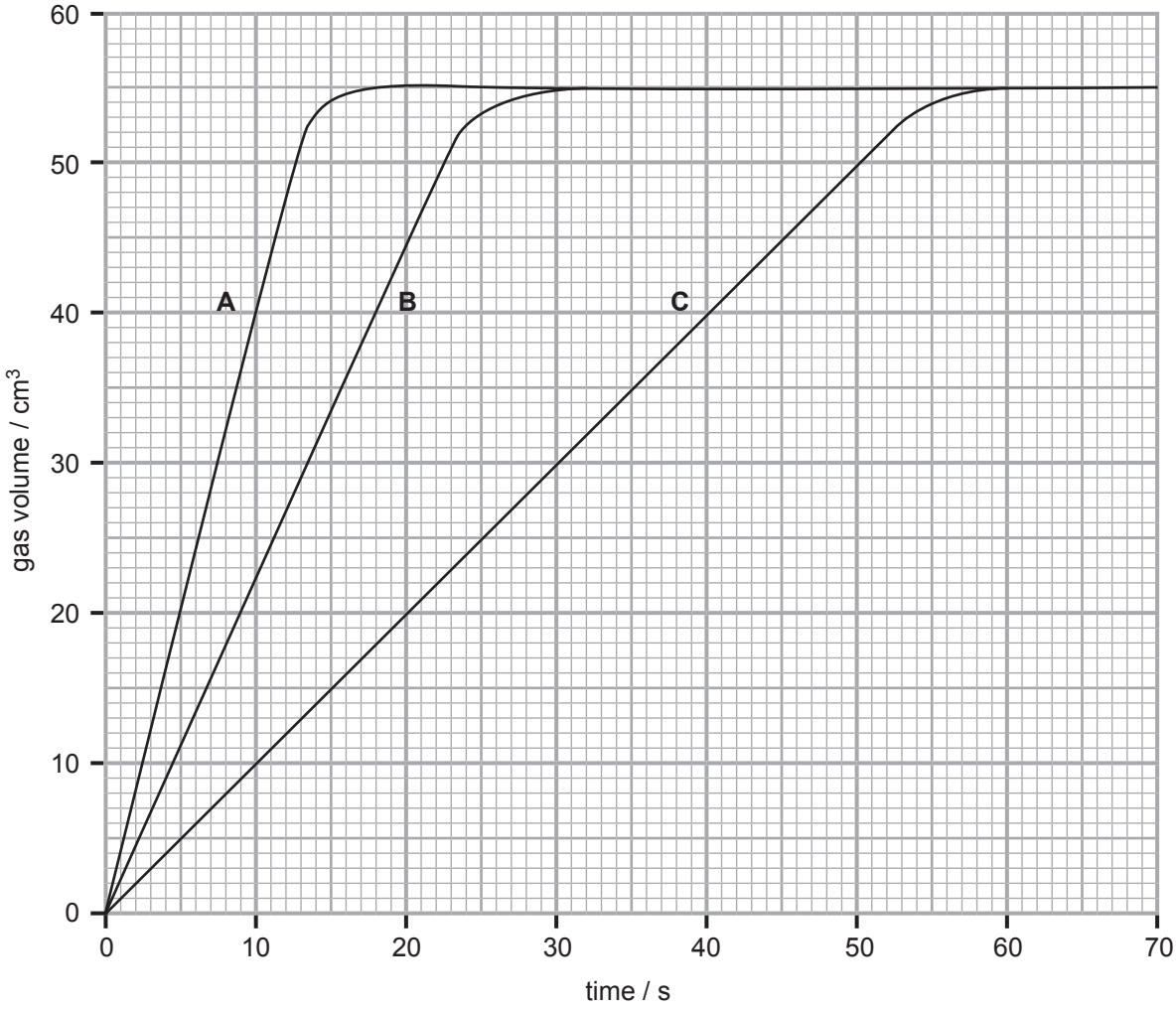
_____

_____ [3]

[Turn over

3 The rate of a chemical reaction is affected by several factors including the concentration of the reactants, temperature and presence of a catalyst.

(a) To investigate the effect of concentration of acid on the rate of reaction, a student reacted a 0.055 g strip of magnesium ribbon with solutions of hydrochloric acid of three different concentrations (0.5, 1.0 and 1.5 mol/dm^3). All reactions were carried out at room temperature. The results obtained are shown on the graph below.



10556

(i) State and explain which line (A, B or C) was obtained using 1.5 mol/dm^3 hydrochloric acid.

Line _____

_____

_____

_____

_____ [3]

(ii) The student repeated the experiment using hydrochloric acid of concentration 2.0 mol/dm^3. **Sketch** a line on the same axes to represent the results obtained and label this curve D. [3]

(b) Explain in terms of particles why the rate of reaction increases as temperature increases.

_____

_____

_____

_____

_____

_____ [3]

(c) The activation energy required for a reaction is affected by the presence of a catalyst. What is meant by the term activation energy?

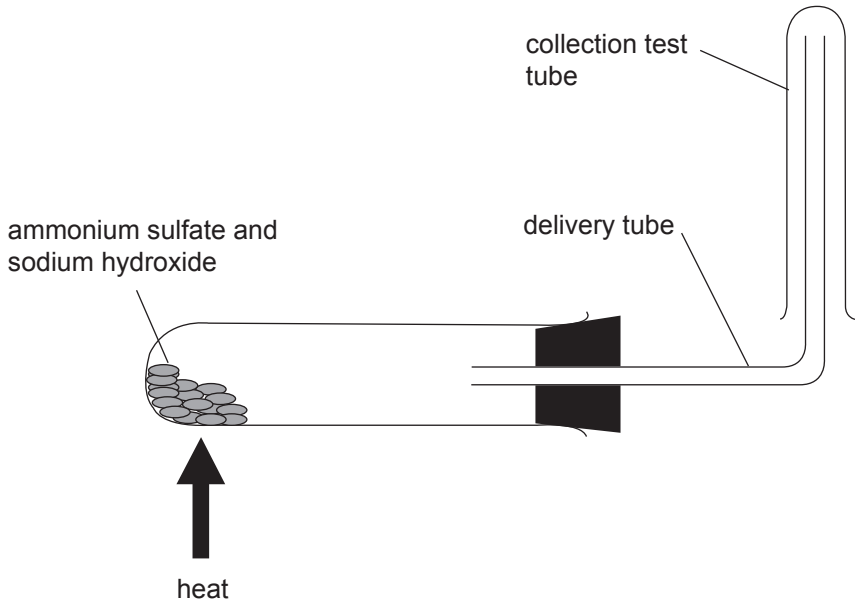
_____

_____ [1]

[Turn over

4 Ammonia is an important chemical in the production of explosives and fertilisers. The Haber process is used to produce ammonia industrially.

(a) Ammonia can be prepared in the laboratory by the reaction of an ammonium compound with an alkali using the apparatus shown below.



(i) State two physical properties of ammonia gas.

1. _____

2. _____ [2]

(ii) Write a balanced symbol equation for the preparation of ammonia from ammonium sulfate and sodium hydroxide.

_____ [3]

(b) Nitrogen reacts with hydrogen in the Haber process according to the equation:

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(i) Explain why nitrogen is described as being reduced in this reaction.

_____

_____

_____ [2]

(ii) What is meant by $\rightleftharpoons$ in the equation above?

_____

_____ [1]

(iii) Describe the test used to identify ammonia gas.

_____

_____

_____

_____

_____

_____ [3]

[Turn over

(c) Ammonia reacts with oxygen producing nitrogen and water.

(i) Write a balanced symbol equation for this reaction.

_____ [3]

(ii) Explain why nitrogen gas is unreactive.

_____

_____

_____ [2]

(d) A solution of ammonia is added slowly, until it is in excess, to separate solutions of copper(II) sulfate and magnesium sulfate. Describe the observations and write equations for the reactions.

Your answer should include:

- observations for both reactions
- ionic equations for the precipitation reactions.

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

[6]

[Turn over

5 Copper is a transition metal and it forms many coloured compounds.

(a) Copper reacts when heated in air.

Write a balanced symbol equation for the reaction which occurs when copper is heated in air.

_____ [3]

(b) Copper(II) carbonate decomposes when heated.

(i) What colour change is observed in this reaction?

From _____ to _____ [2]

(ii) Write a balanced symbol equation for the decomposition of copper(II) carbonate on heating.

_____ [2]

(c) Copper(II) oxide may be reduced in the laboratory by heating in a stream of hydrogen.

(i) Write the balanced symbol equation for the reaction.

_____ [2]

(ii) Draw a labelled diagram of the assembled apparatus used to safely heat a sample of copper(II) oxide in a stream of hydrogen in the laboratory.

[4]

(d) The reduction of copper(II) oxide may be carried out in the laboratory using methane instead of hydrogen. The reaction produces copper, carbon dioxide and water.

(i) Write a balanced symbol equation for the reduction of copper(II) oxide using methane.

_____ [3]

(ii) Anhydrous copper(II) sulfate is used to test for water. What is meant by the term anhydrous?

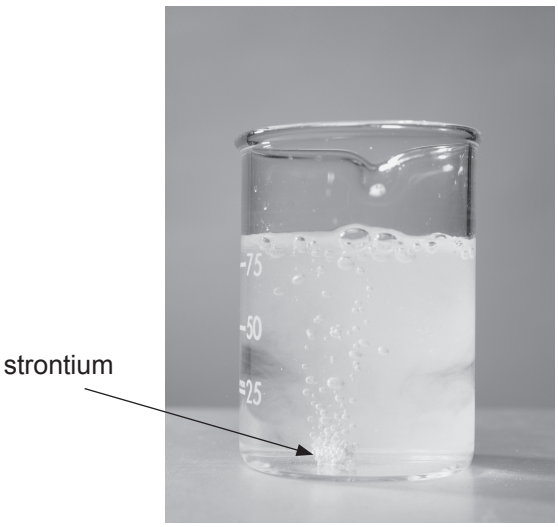
_____

_____ [1]

[Turn over

6 Strontium is a typical Group 2 metal. It is toxic to humans in low doses.

(a) The photograph below shows the vigorous reaction of strontium with water.



© Andrew Lambert Photography / Science Photo Library

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

_____ [3]

(ii) **Compare** the observations made when strontium reacts with water with the observations made when potassium reacts with water.

_____

_____

_____

_____

_____

_____ [3]

(b) The table below shows if a displacement occurs (✓) when a metal is added to a solution of a metal ion.

metal ion solution / metal	Strontium nitrate	Calcium nitrate	Cadmium(II) nitrate	Copper(II) nitrate	Iron(II) nitrate	Silver nitrate
Strontium		✓	✓	✓	✓	✓
Calcium	×		✓	✓	✓	✓
Cadmium	×	×		✓	×	✓
Copper	×	×	×		×	✓
Iron	×	×	✓	✓		✓
Silver	×	×	×	×	×	

(i) Write a balanced symbol equation for the reaction between strontium and silver nitrate.

_____ [3]

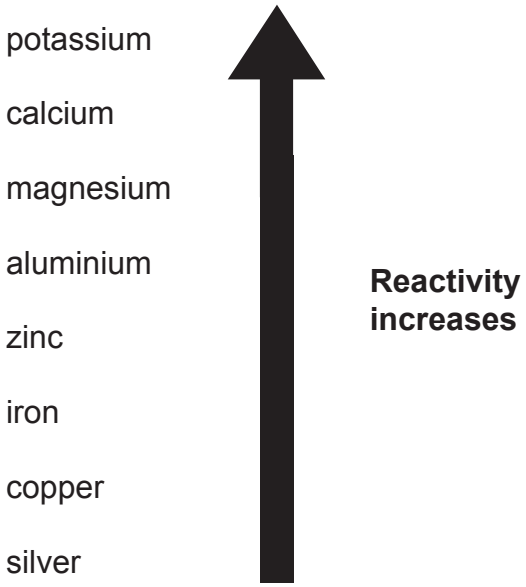
(ii) Name the products when calcium reacts with cadmium(II) nitrate solution.

_____

_____ [2]

[Turn over

(iii) On the reactivity series below indicate the position of strontium and cadmium clearly using the information from the reactions in **(a)** and **(b)**.



[3]

(iv) Explain, in terms of electrons, why the reaction between iron and cadmium(II) nitrate is a redox reaction.

$$Fe + Cd(NO_3)_2 \rightarrow Fe(NO_3)_2 + Cd$$

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

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [6]

(c) A barium meal medical test uses a compound of another Group 2 metal, barium. This compound allows soft tissues like the stomach and upper intestine to be X-rayed.

(i) Name the barium compound used.

_____ [1]

(ii) State why this compound is used despite the toxicity of barium compounds.

_____

_____ [1]

7 Barium hydroxide forms crystals with the formula $Ba(OH)_2.8H_2O$.

(a) Calculate the mass of barium hydroxide crystals, $Ba(OH)_2.8H_2O$, required to make 1000 cm^3 of a 0.25 mol/dm^3 solution of barium hydroxide.
(Relative atomic masses: H = 1; O = 16; Ba = 137)

Mass = _____ g [2]

(b) A different solution of a metal hydroxide, $M(OH)_2$, was made by dissolving 15.25 g of solid $M(OH)_2$ in 250 cm^3 of water.

Calculate the concentration of the solution in g/dm^3.

Concentration = _____ g/dm^3 [1]

(c) To determine the identity of $M(OH)_2$, a titration was carried out. 25.0 cm^3 of the $M(OH)_2$ solution from **(b)** were placed in a conical flask with a few drops of bromothymol blue indicator. The conical flask was placed on a white tile and titrated with 1.25 mol/dm^3 hydrochloric acid until the end-point.

Indicator	Colour in acid solution	Colour in neutral solution	Colour in alkaline solution
bromothymol blue	yellow	green	blue

(i) Why is a white tile used in this practical technique?

_____

_____ [1]

(ii) Use the table above to determine the colour change of the indicator at the end-point.

From _____ to _____ [1]

(iii) State two ways in which the end-point may be determined accurately.

1. _____

_____

2. _____

_____ [2]

[Turn over

(d) The results obtained in the titration are shown in the table below.

	Rough titration	**Accurate titration 1**	**Accurate titration 2**
Final burette reading (cm^3)	20.9	40.8	20.1
Initial burette reading (cm^3)	0.0	20.9	0.0
Titre (cm^3)	20.9	19.9	20.1

(i) Calculate the average titre.

Average titre = _____ cm^3 [2]

The equation for the reaction is represented by:

$$M(OH)_2 + 2HCl \rightarrow MCl_2 + 2H_2O$$

(ii) Calculate the concentration of $M(OH)_2$ in mol/dm^3.

Concentration = _____ mol/dm^3 [5]

(iii) Use your answers from **(b)** and **(d)(ii)** to calculate the relative formula mass of $M(OH)_2$ and state the identity of element M. Show your working out clearly.

Identity of M = _____

[3]

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For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
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
Carbonate	CO_3^{2-}
Dichromate	$Cr_2O_7^{2-}$
Ethanoate	CH_3COO^-
Hydrogen carbonate	HCO_3^-
Hydroxide	OH^-
Methanoate	$HCOO^-$
Nitrate	NO_3^-
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}

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

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DATA LEAFLET

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.

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Solubility of Common Salts 4

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THE PERIODIC TABLE OF ELEMENTS

Group

1	2											3	4	5	6	7	0
							1 H Hydrogen 1										4 He Helium 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	99 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	263 Sg Seaborgium 106	262 Bh Bohrium 107	265 Hs Hassium 108	266 Mt Meitnerium 109	269 Ds Darmstadtium 110	272 Rg Roentgenium 111	285 Cn Copernicium 112						

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	147 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

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

a	
b	x

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