Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2024

GCSE Chemistry

Unit 1

Higher Tier

[GCM12]

GCM12

WEDNESDAY 22 MAY, 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 **4(c)**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

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20GCM1201

1 The positions of some elements in the Periodic Table are shown below.

							H										
Li															O		
	Mg																
K							Fe							As			
																I	

(a) Select the correct **symbol** from the Periodic Table above to answer the following questions.

(i) Which element has five electrons in the outer shell of its atom?

_____ [1]

(ii) Which element has three shells containing electrons in its atom?

_____ [1]

(iii) Which element forms an ion with a charge of 2–?

_____ [1]

(iv) Which element is a transition metal?

_____ [1]

(v) Which element forms an ion with the same electronic configuration as argon?

_____ [1]

(b) Group 1 of the Periodic Table contains reactive elements. They show similar chemical properties and there is a trend in reactivity down the group.

(i) How are the Group 1 elements stored in the laboratory?

_____ [1]

(ii) State the name by which the Group 1 elements are known.

_____ [1]

(iii) Explain why the Group 1 elements show similar chemical properties.

_____

_____ [1]

(iv) State and explain the trend in reactivity down Group 1.

Trend: _____

Explanation: _____

_____

_____

_____

_____ [3]

(c) Group 1 elements react vigorously with cold water.

(i) State two observations which are made when a piece of potassium reacts with cold water but are not made when a piece of lithium reacts with cold water.

1. _____

2. _____ [2]

(ii) Write a half equation for the formation of a potassium ion from a potassium atom.

_____ [2]

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(Questions continue overleaf)

2 Magnesium chloride and hydrogen chloride are compounds of chlorine.

(a) **(i)** Draw a dot and cross diagram to show how magnesium chloride forms from atoms of magnesium and chlorine.

[6]

(ii) State two physical properties of magnesium chloride.

1. _____

2. _____ [2]

(b) **(i)** Draw a dot and cross diagram to show the bonding in a molecule of hydrogen chloride. Label a lone pair of electrons in the diagram.

[2]

(ii) Write a balanced symbol equation for the formation of hydrogen chloride from hydrogen and chlorine.

_____ [3]

(c) Complete the table below to give the name of bonding and type of structure which are found in magnesium chloride and in hydrogen chloride.

Compound	**Bonding**	**Structure**
magnesium chloride		
hydrogen chloride		

[4]

[Turn over

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3 Acidic, neutral and alkaline solutions may be classified using indicators.

(a) Complete the table below.

Solution	pH	Indicator	Colour of indicator
sodium hydroxide	12	phenolphthalein	
hydrochloric acid		universal indicator	

[3]

(b) Sulfuric acid is a strong acid that ionises completely in water.

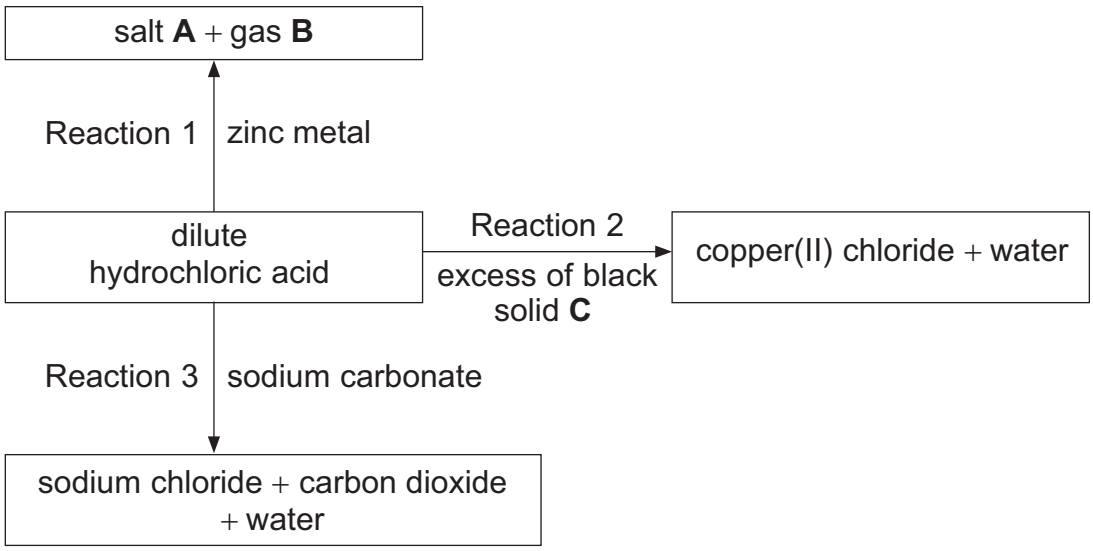
(i) Write an ionic equation to show the complete ionisation of sulfuric acid.

_____ [3]

(ii) State how the pH of a sulfuric acid solution changes as the concentration of hydrogen ions increases.

_____ [1]

(c) The diagram below shows three reactions used to prepare soluble salts.



(i) What is meant by the term salt?

_____

_____

_____ [2]

(ii) Write the formula of salt **A** produced in Reaction 1.

_____ [1]

(iii) Identify gas **B** produced in Reaction 1 and describe a test used to confirm the identity of this gas.

Gas **B**: _____

Test: _____

_____ [2]

(iv) Write the formula of the black solid **C** used in Reaction 2.

_____ [1]

(v) Explain why an excess of black solid **C** is used in Reaction 2.

_____

_____ [1]

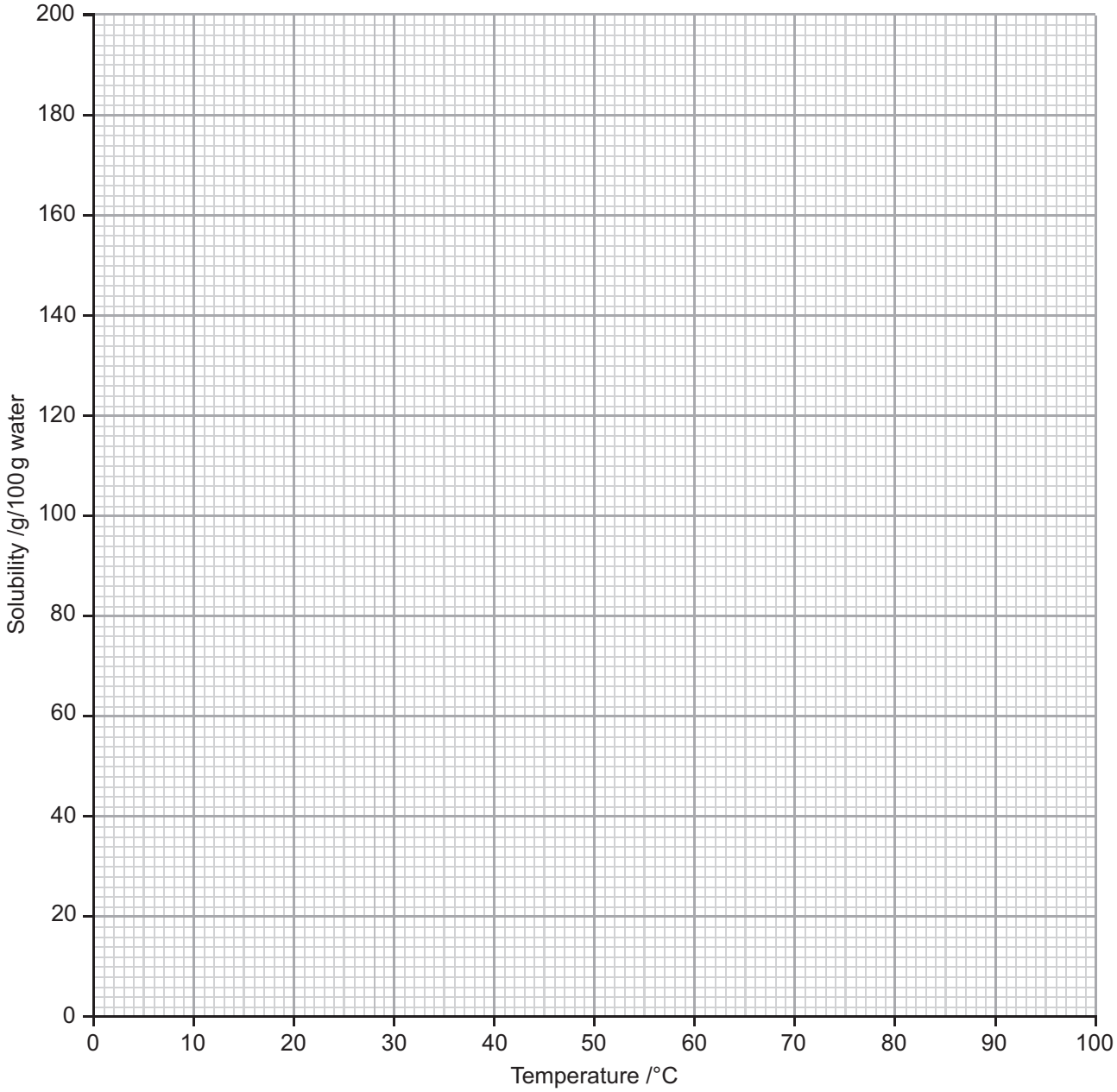
(vi) Write a balanced symbol equation for Reaction 3.

_____ [3]

4 The oceans and seas are valuable sources of many chemical compounds which are dissolved in the water. The table below gives solubility values of a solid obtained from sea water.

Temperature /°C	0	20	40	60	80	100
Solubility of solid /g/100 g water	80	87	100	120	145	178

(a) Plot a solubility curve for the solid on the axes below using the data in the table.



[3]

13959

(b) Use the solubility data and the graph you have drawn in **(a)** to answer the following questions.

(i) What is the solubility of the solid at 90 °C?

_____ g/100 g water [1]

(ii) 28 g of the solid are mixed with 25 g of water at 60 °C. Explain whether the solution formed is saturated or unsaturated.

_____

_____

_____ [2]

(iii) Calculate the mass of solid that will crystallise when a saturated solution containing 40 g of water at 70 °C is cooled to 20 °C.

mass of solid = _____ g [4]

[Turn over

(c) Sea water contains dissolved magnesium ions and chloride ions.

Describe chemical tests that could be carried out on a sample of sea water to confirm the presence of magnesium ions and of chloride ions.

Your answer should include:

- the reagents used in each test
- the results for a positive test
- ionic equations for any reactions which occur.

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

[6]

5 Silica gel is a desiccant which is often found in small packets in boxes of shoes and optical equipment.

A small quantity of anhydrous cobalt(II) chloride, $CoCl_2$, may be added to the silica gel. A colour change from blue to pink is observed as the silica gel absorbs water. The pink colour indicates that the silica gel is no longer effective.

(a) **(i)** Suggest what is meant by the term desiccant.

_____

_____ [1]

(ii) Name another compound which could be used in place of anhydrous cobalt(II) chloride.

_____ [1]

[Turn over

(b) A solution containing 0.15 moles of cobalt(II) chloride is mixed with another solution containing 0.26 moles of potassium hydroxide. A precipitate of cobalt(II) hydroxide forms. The equation for the reaction is:

$$CoCl_2(aq) + 2KOH(aq) \rightarrow Co(OH)_2(s) + 2KCl(aq)$$

(i) How many moles of potassium hydroxide are required to react with 0.15 moles of cobalt(II) chloride?

_____ [1]

(ii) Which reactant is the limiting reactant?

_____ [1]

(iii) How many moles of cobalt(II) hydroxide are formed?

_____ [1]

(iv) Calculate the mass of cobalt(II) hydroxide formed. Give your answer to 1 decimal place.

mass of cobalt(II) hydroxide = _____ g [2]

(c) A 3.57 g sample of hydrated cobalt(II) chloride crystals, $CoCl_2.xH_2O$, was heated to constant mass. 1.95 g of solid remained after heating.

(i) Calculate the number of moles of water lost.

moles of water = _____ [2]

(ii) Calculate the number of moles of anhydrous cobalt(II) chloride remaining after heating to constant mass.

moles of anhydrous cobalt(II) chloride = _____ [1]

(iii) Calculate the value of x in $CoCl_2.xH_2O$.

x = _____ [1]

[Turn over

(d) Cobalt(II) oxide reacts with oxygen at 700 °C to form Co_3O_4 as shown in the equation below.

$$6CoO + O_2 \rightarrow 2Co_3O_4$$

Calculate the mass of Co_3O_4, in kg, formed from the reaction of 945 g of cobalt(II) oxide with excess oxygen. Give your answer to 2 decimal places.

mass of Co_3O_4 = _____ kg [4]

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Question Number	**Marks**
1	
2	
3	
4	
5	
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	$C_3H_7COO^-$
Carbonate	CO_3^{2-}
Dichromate	$Cr_2O_7^{2-}$
Ethanoate	CH_3COO^-
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-
Methanoate	$HCOO^-$
Nitrate	NO_3^-
Propanoate	$C_2H_5COO^-$
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

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

gcse examinations

chemistry

11984.02

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	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						

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

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

a X b

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

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