Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2023

GCSE Chemistry

Unit 1

Higher Tier

[GCM12]

GCM12

MONDAY 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 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 **3(d)**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

13538

20GCM1201

1 A large underground salt mine in Carrickfergus supplies 750,000 tonnes of rock salt annually which is mainly used for de-icing roads in winter. Rock salt contains about 90% sodium chloride and some other minerals.

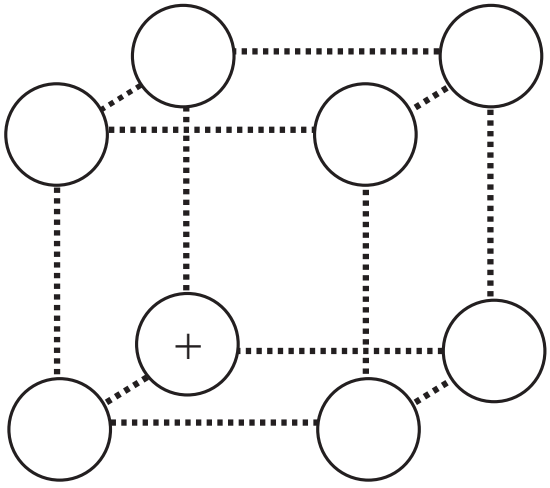
(a) (i) Explain what is meant by a pure substance **and** why rock salt is not classified as a pure substance.

_____

_____

_____ [2]

(ii) A diagram of part of the structure of solid sodium chloride is shown below. Complete the diagram by adding the appropriate charges.



[1]

(iii) What is the name for the type of structure shown for sodium chloride?

_____ [1]

(b) To extract the salt, a drill with a tungsten carbide tip bores into the rock. Tungsten carbide, for use in drills, is made by the reaction of tungsten metal with carbon at a high temperature.

(i) Describe the bonding in a metal such as tungsten.

_____

_____

_____ [2]

(ii) Tungsten (atomic number = 74, symbol: W) has four stable isotopes (^{182}W, ^{183}W, ^{184}W, and ^{186}W). Explain, with reference to numbers of subatomic particles, why these four atoms are described as isotopes.

_____

_____ [2]

(iii) Tungsten carbide has a high melting point of 2870 °C. Explain why it has a high melting point.

_____

_____ [2]

(iv) Graphite and diamond are two allotropes of carbon. Describe **one** similarity and **one** difference between the bonding and structure of graphite and the bonding and structure of diamond.

Similarity: _____

_____

Difference: _____

_____

_____ [2]

[Turn over

(c) In the salt mine there are several safety chambers, one of which is shown in the photograph below. These provide protection for up to 20 people for several days in the event of an accident and have supplies of oxygen gas and water.

Source: Principal Examiner

(i) Draw dot and cross diagrams to show the bonding in an oxygen molecule and the bonding in a water molecule.

oxygen	water

[2]

(ii) Explain why oxygen is a gas at room temperature.

_____

_____

_____ [2]

(iii) Name the type of structure in water.

_____ [1]

[Turn over

2 Mixtures can be separated using different separating techniques.

(a) Complete the table by giving the most appropriate separating technique.

Separation	Separating Technique
Pure water from sea water	
Silver chloride from a mixture of silver chloride and water	
Potassium chloride from aqueous potassium chloride	
Ethanol from a mixture of ethanol and water	

[4]

(b) When a mixture of ethanol and water is separated, two colourless liquids A and B are obtained. Liquid A is ethanol containing a small amount of water. Liquid B is pure water.

(i) Describe a chemical test to show that liquid A contains water.

_____

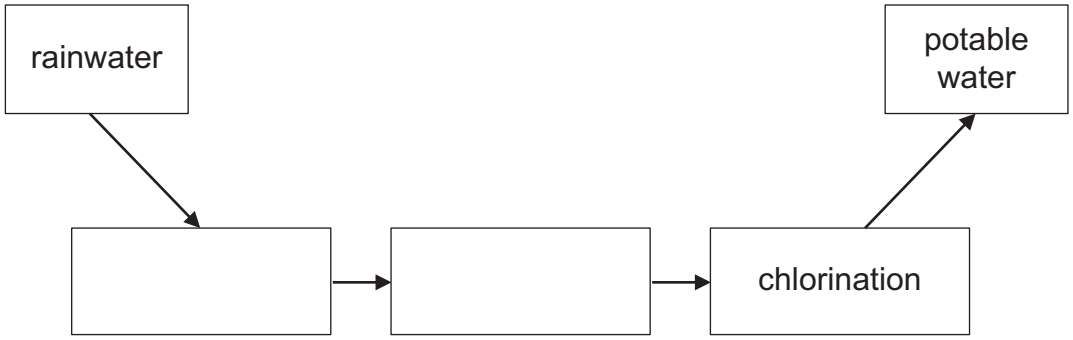
_____ [2]

(ii) Describe how you would show that liquid B is **pure** water.

_____

_____ [1]

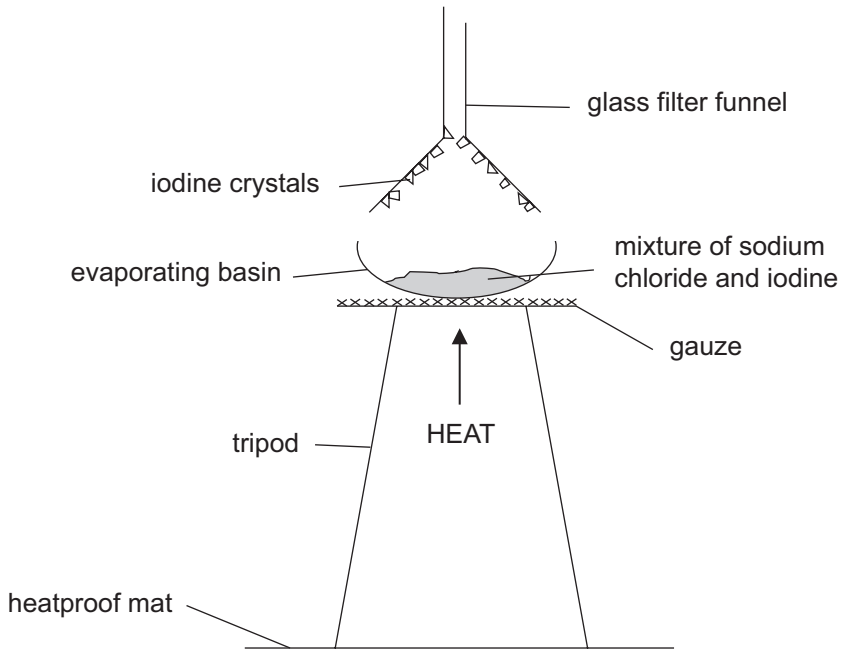
(iii) Complete the diagram to give the processes which convert rainwater into potable water.



[2]

[Turn over

(c) To separate a mixture of sodium chloride and iodine, the apparatus shown in the diagram below was set up. The mixture was heated for a few minutes.



Describe what is observed in this experiment and explain why this method can be used to separate sodium chloride and iodine.

observations _____

_____

explanation _____

_____

_____ [3]

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(Questions continue overleaf)

3 Crystals of hydrated sodium sulfate, $Na_2SO_4.10H_2O$, may be prepared using the following chemicals:

- sodium hydroxide solution
- sulfuric acid
- phenolphthalein indicator

In the laboratory 25.0 cm^3 of sodium hydroxide solution were pipetted into a conical flask. A few drops of phenolphthalein were added. Sulfuric acid was added until the indicator changed colour. The volume of acid needed to neutralise the alkali was 20.1 cm^3.

(a) State the colour change observed in this experiment.

From _____ to _____ [2]

(b) Name the piece of apparatus used to add the sulfuric acid.

_____ [1]

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

_____ [3]

(d) Describe how you would continue the experiment to obtain pure, dry crystals of hydrated sodium sulfate.

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

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____ [6]

(e) Calculate the percentage of water of crystallisation by mass in hydrated sodium sulfate, $Na_2SO_4.10H_2O$.

% of water of crystallisation = _____ % [2]

[Turn over

4 Elephant calves are dependent on their mothers' milk for two years. At an elephant orphanage in Kenya, baby elephants are fed bottles of milk made from a specialist formula milk powder which contains a large proportion of sugars, fats and amino acids.

Source: Principal Examiner

(a) A sample of a compound found in the formula milk powder contains 40.0% carbon, 6.7 % hydrogen and 53.3 % oxygen by mass. Determine the empirical formula of this compound.

Show your working out.

empirical formula = _____ [3]

(b) A sample of the elephant formula milk was analysed using paper chromatography to determine which amino acids were present.

(i) Name the stationary phase in this chromatography.

_____ [1]

(ii) Write an equation to define the term R_f.

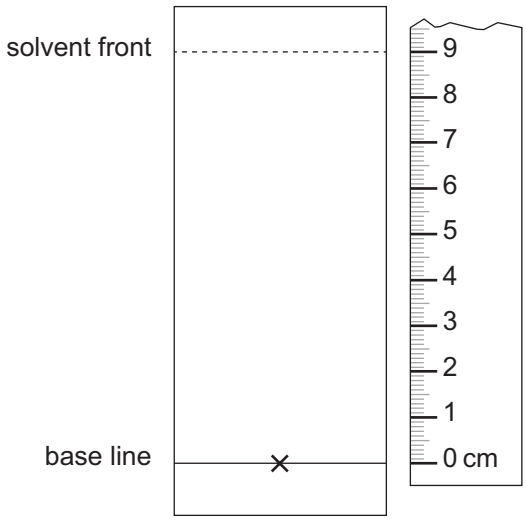
_____ [1]

(iii) Explain why different amino acids may have different R_f values.

_____

_____ [1]

(iv) One of the amino acids present had an R_f value of 0.6. Use the diagram below to calculate the distance travelled from the base line by this amino acid on the chromatogram.



distance travelled = _____ cm [1]

[Turn over

(c) During the day, elephants flick soil onto their backs as protection from the sun. Humans use sun cream as protection from the sun. The sun creams may contain nanoparticles.

(i) What size is a nanoparticle? Give your answer in **metres**.

_____ [1]

(ii) State one benefit of using nanoparticles in sun creams.

_____

_____ [1]

(d) Hipposudoric acid is a red pigment found in the sweat of a hippopotamus which acts as natural protection from the sun.

(i) Suggest why a solution of hipposudoric acid has a higher pH than a solution of sulfuric acid of the same concentration.

_____

_____ [1]

(ii) Other than using a pH meter, describe how you would find the pH of a solution of hipposudoric acid.

_____

_____ [2]

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(Questions continue overleaf)

5 The halogens are elements found in Group 7 of the Periodic Table. They are often used in disinfectants and can be obtained from different minerals or salts.

(a) Three statements about the halogens are shown below. Each statement contains **one incorrect word**.

Statement 1: The colour of the elements becomes lighter down the group.

Statement 2: The elements form ions with a single positive charge.

Statement 3: Bromine is a red-brown gas at room temperature.

Complete the table, giving the incorrect word in each statement and the correct word to replace it.

Statement	Incorrect word	Correct word
1		
2		
3		

[3]

(b) Explain why the halogens become less reactive down the group.

_____

_____

_____

_____ [3]

(c) Seawater contains bromide ions. Bromine can be extracted from seawater by bubbling chlorine gas into the water.

(i) Write a balanced ionic equation for the reaction of bromide ions with chlorine.

_____ [3]

(ii) State the colour change in this reaction.

From _____ to _____ [1]

(iii) Describe the test for chlorine gas.

_____

_____ [2]

(d) Compounds containing iodide ions are present in seaweed. When seaweed is heated it forms an ash which contains iodide ions. The iodide ions can be oxidised to iodine.

Write a half equation for the conversion of iodide ions into an iodine molecule.

_____ [3]

(e) Sodium chloride from seawater reacts with calcium carbonate to produce sodium carbonate as shown in the equation below.

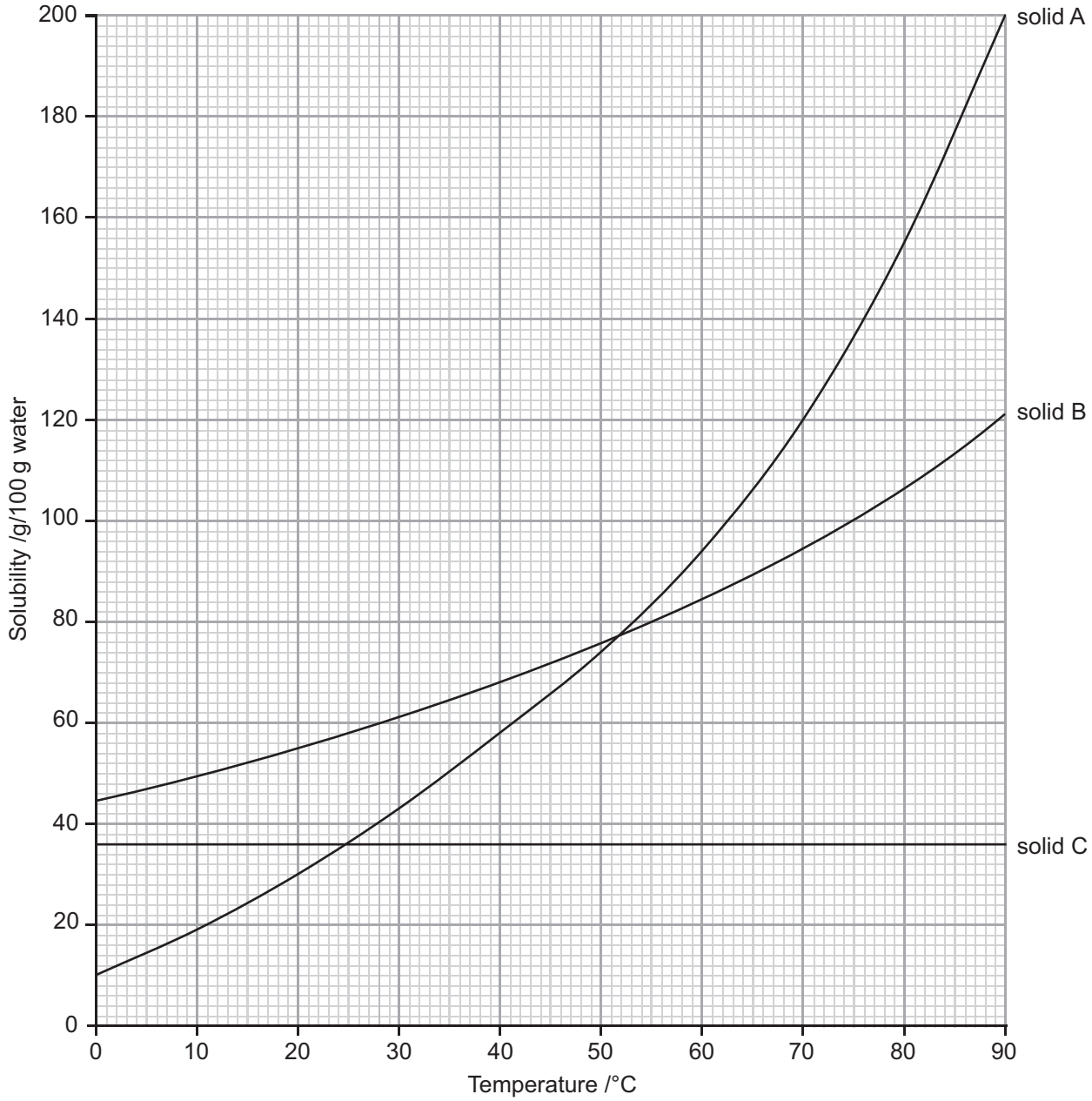
$$2NaCl + CaCO_3 \rightarrow Na_2CO_3 + CaCl_2$$

Calculate the maximum mass of sodium carbonate that could be formed by reacting 175.5 g of sodium chloride with excess calcium carbonate.

mass of sodium carbonate = _____ g [3]

[Turn over

6 The graph shows the solubility curves for three different solids, A, B and C.



13538

(a) Compare the effect of increasing temperature on the solubility of solid A and solid C.

_____

_____

_____ [1]

(b) A solution of solid B is prepared by adding 18 g of B to 25 g of water at 55 °C. Explain if the solution formed is saturated or unsaturated.

Show your working out.

_____

_____

_____ [2]

(c) Calculate the mass of solid A which would crystallise when a saturated solution containing 50 g of water at 70 °C is cooled to 20 °C.

mass of solid A = _____ g [4]

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	$C_3H_7COO^-$
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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