

New  
Specification



Centre Number

71	
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Candidate Number

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General Certificate of Secondary Education  
2012

## Science: Chemistry

Unit C1

Higher Tier

[GCH12]



TUESDAY 12 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.  
Write your answers in the spaces provided in this question paper.  
Answer **all seven** 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 questions **3(c)** and **5(a)(i)**.  
A Data Leaflet which includes a Periodic Table of the Elements is provided.



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use only

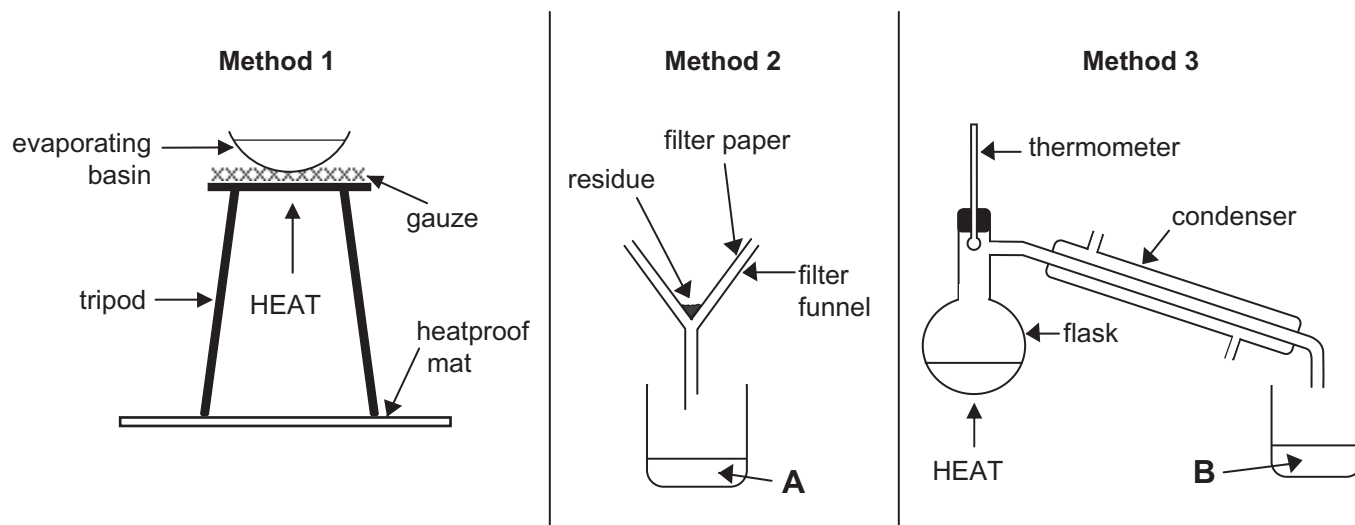
Question Number	Marks
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1 Mixtures may be separated in the laboratory in many different ways.

(a) Three different methods of separating mixtures are shown below.



(i) Which method (1, 2 or 3) would be most suitable for obtaining water from salt solution?

\_\_\_\_\_ [1]

(ii) Which method would be most suitable for removing sand from a mixture of sand and water?

\_\_\_\_\_ [1]

(iii) Explain fully why Method 2 would **not** be suitable to separate copper(II) sulfate from copper(II) sulfate solution.

\_\_\_\_\_  
 \_\_\_\_\_ [1]

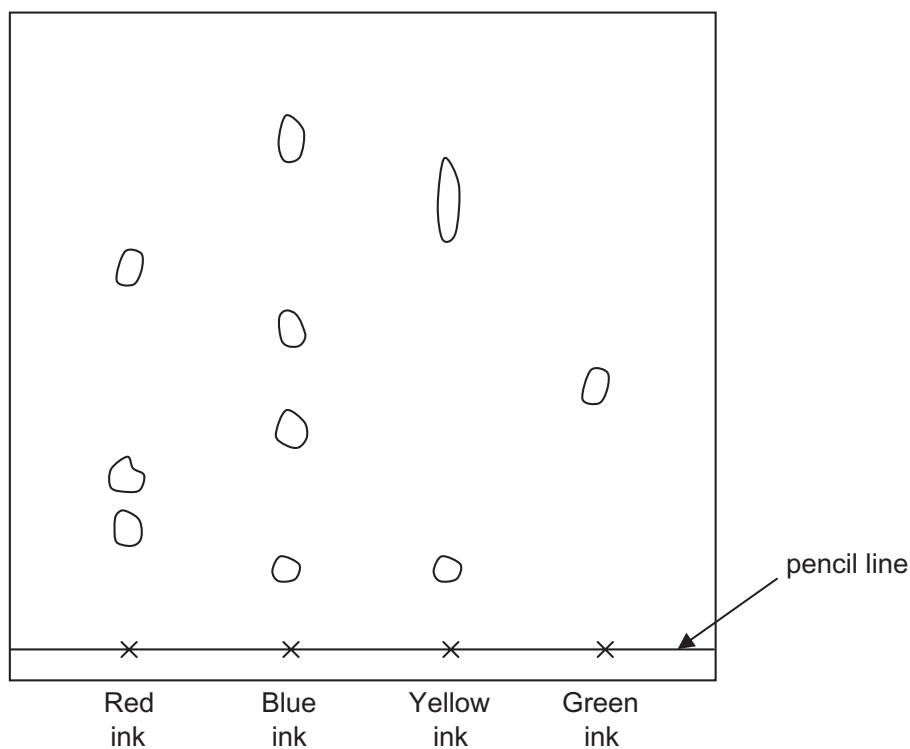
(iv) What general term is used for liquid **A** collected in Method 2 and liquid **B** collected in Method 3?

**A** \_\_\_\_\_

**B** \_\_\_\_\_ [2]

Examiner Only	
Marks	Remark

(b) A student analyses four different inks using paper chromatography. The inks are spotted along a pencil line. The chromatography paper is placed in a solvent and the coloured components in the inks separate out. The resulting chromatogram is shown below.



(i) Which ink contains four different components?

\_\_\_\_\_ [1]

(ii) Which ink contains the most soluble component?

\_\_\_\_\_ [1]

(iii) Which **two** inks contain one common component?

\_\_\_\_\_ [1]

(iv) What do you understand by the term solvent?

\_\_\_\_\_  
 \_\_\_\_\_ [1]

(v) Which ink is a pure substance?

\_\_\_\_\_ [1]

Examiner Only	
Marks	Remark

2 (a) Non-metallic elements form compounds with each other by bonding covalently.

(i) Explain what you understand by a single covalent bond.

\_\_\_\_\_  
\_\_\_\_\_ [2]

(ii) Draw a **dot and cross diagram** to show the covalent bonding in hydrogen chloride, HCl.

[3]

(iii) Name the weak forces of attraction that exist between simple covalent molecules like hydrogen chloride.

\_\_\_\_\_ [1]

Examiner Only

Marks Remark

(b) The table below gives some of the properties of the Period 3 element magnesium and one of its compounds, magnesium chloride.

Property	Magnesium (Mg)	Magnesium chloride (MgCl <sub>2</sub> )
melting point	649 °C	714 °C
solubility in water		soluble
electrical conductivity when solid	conducts	does not conduct
electrical conductivity when molten	conducts	conducts
electrical conductivity when dissolved in water		conducts

(i) Explain why magnesium has a high melting point.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ [2]

(ii) What type of structure does magnesium chloride have? Use evidence from the table to explain your answer.

Structure: \_\_\_\_\_

Explanation: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ [3]

(iii) Explain why magnesium chloride conducts electricity when molten.

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_ [2]

Examiner Only	
Marks	Remark

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- 3 In the Periodic Table, elements with similar properties appear in the same group. Some of the groups in the Periodic Table have names.

H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn						

- (a) Complete the table below by inserting the correct name for each group and state the number of electrons in the outer shell of atoms of elements in this group.

Group number	Name of group	Number of electrons in outer shell of atom
1		
2		

[4]

- (b) When Group 1 elements react, the atom forms an ion. For example when potassium reacts with chlorine, potassium ions are formed from potassium atoms.

- (i) Using electronic configurations, compare the stability of a potassium atom with that of a potassium ion.

electronic configuration of potassium atom \_\_\_\_\_

electronic configuration of potassium ion \_\_\_\_\_

\_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_  
 \_\_\_\_\_ [3]

- (ii) Write a balanced symbol equation for the reaction of potassium with chlorine.

\_\_\_\_\_ [3]

Examiner Only	
Marks	Remark

(c) The table below shows information about the reactions of Group 2 elements with water.

Element	Reactivity with water	Name of products on reaction with water
Beryllium	No reaction	No products
Magnesium	Reacts very slowly with cold water	Magnesium hydroxide and hydrogen
Calcium	Reacts moderately with cold water	Calcium hydroxide and hydrogen
Strontium	Reacts rapidly with cold water	Strontium hydroxide and hydrogen
Barium	Reacts very rapidly with cold water	Barium hydroxide and hydrogen

Use the information in the table and your own knowledge of Group 1 elements to compare and contrast the reactions of Group 1 and Group 2 elements with water.

In your answer compare:

- the products formed;
- the reactivity of the Group 1 elements compared to the Group 2 elements; and
- the trend in reactivity down both groups.

**In this question, you will be assessed on using your written communication skills including the use of specialist science terms.**

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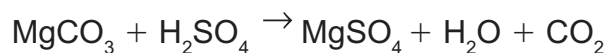
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Examiner Only	
Marks	Remark

- 4 Bath crystals are a mixture of water soluble solids which are added to bathwater for health benefits. Bath crystals contain Epsom salts (hydrated magnesium sulfate) which relax muscles, reduce inflammation and help muscle function.

'An image of a packet of Epsom Salts has been removed'

- (a) Magnesium sulfate crystals are prepared in the laboratory by reacting magnesium carbonate with sulfuric acid, as shown in the equation below.



(Relative atomic masses: C = 12; O = 16; Mg = 24; S = 32)

- (i) What is the maximum mass of magnesium sulfate which could be formed when 2.1 g of magnesium carbonate are reacted with sulfuric acid?

Mass of magnesium sulfate: \_\_\_\_\_ g [5]

- (ii) A student carried out this experiment and only obtained 1.8 g of magnesium sulfate. Calculate the percentage yield.

Percentage yield: \_\_\_\_\_ % [2]

Examiner Only

Marks Remark

(iii) Suggest why the percentage yield is not 100% in this reaction.

\_\_\_\_\_  
\_\_\_\_\_ [1]

(b) To find out the number of moles of water of crystallisation, a student heated some hydrated magnesium sulfate in a crucible and recorded the results in the table below.

(Relative atomic masses: H = 1; O = 16; Mg = 24; S = 32)

mass of empty crucible	12.73 g
mass of crucible + hydrated magnesium sulfate	13.96 g
mass of crucible after heating for 5 minutes	13.56 g
mass of crucible after heating for 10 minutes	13.33 g
mass of crucible after heating for 15 minutes	13.33 g

(i) Explain why the student weighed the crucible and its contents several times during the heating process.

\_\_\_\_\_  
\_\_\_\_\_ [1]

(ii) Calculate the mass of water of crystallisation lost.

\_\_\_\_\_ g [1]

(iii) Calculate the number of moles of water of crystallisation lost.

\_\_\_\_\_ [2]

Examiner Only

Marks Remark

(iv) Calculate the mass of the anhydrous magnesium sulfate.

\_\_\_\_\_ g [1]

(v) Calculate the number of moles of anhydrous magnesium sulfate.

\_\_\_\_\_ [1]

(vi) Using your answers to parts (iii) and (v), calculate the number of moles of water of crystallisation contained in one mole of hydrated magnesium sulfate.

\_\_\_\_\_ [2]

Examiner Only

Marks Remark



- (ii) Write a balanced symbol equation for the reaction between calcium carbonate and hydrochloric acid.

\_\_\_\_\_ [3]

- (iii) Describe the process of obtaining pure, dry crystals of hydrated calcium chloride from a solution of calcium chloride.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [3]

- (b) Calcium chloride may also be prepared by neutralising calcium hydroxide solution with dilute hydrochloric acid.  $25.0\text{ cm}^3$  of calcium hydroxide solution is placed in a conical flask with phenolphthalein indicator and hydrochloric acid is added.

- (i) Write an **ionic equation** for the neutralisation reaction. Include state symbols.

\_\_\_\_\_ [3]

- (ii) State the colour change of the indicator in this preparation.

From \_\_\_\_\_ to \_\_\_\_\_ [2]

- (iii) What common name is used for calcium hydroxide solution?

\_\_\_\_\_ [1]

- (iv) Name the piece of apparatus used to add the hydrochloric acid to the conical flask.

\_\_\_\_\_ [1]

Examiner Only

Marks Remark

- (c) A solution of  $0.015 \text{ mol/dm}^3$  hydrochloric acid was tested using a pH meter, red and blue litmus and universal indicator paper. The results are given below.

Test	Result
pH meter	1.82
red litmus	red
blue litmus	red
universal indicator paper	red

- (i) Explain how the result with universal indicator may be converted into a pH value.

\_\_\_\_\_ [1]

- (ii) Explain why the result with red litmus is not conclusive for the presence of an acid.

\_\_\_\_\_ [1]

- (iii) Based on the results in the table, select **two** pieces of evidence which would suggest that hydrochloric acid is a strong acid. Explain your answer.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [2]

Examiner Only

Marks Remark

- 6 A **mixture** of two ionic compounds was analysed to determine the ions present in the mixture. The two ionic compounds have the **same anion**. The results of the tests are given in the table below.

	Description of test	Observations
<b>Test 1</b>	A flame test was carried out on a solid sample of the mixture	yellow flame
<b>Test 2</b>	A sample of the mixture was dissolved in deionised water and sodium hydroxide solution was added	white precipitate which redissolves in excess sodium hydroxide solution
<b>Test 3</b>	A sample of the mixture was dissolved in deionised water and barium chloride solution was added	white precipitate

- (a) Describe how a flame test is carried out.

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[3]

Examiner Only

Marks Remark



(b) Use the information in the table to answer the questions which follow.

(i) Using the evidence from Test 1, name the cation which is present in the mixture.

\_\_\_\_\_ [1]

(ii) Using the evidence from Test 2, name **two** other cations which may be present in the mixture.

1. \_\_\_\_\_

2. \_\_\_\_\_ [2]

(iii) Using the evidence from Test 3, write the formula of the anion which is present in the mixture.

\_\_\_\_\_ [1]

(iv) Suggest the names of **two** compounds which may be present in the mixture.

1. \_\_\_\_\_

2. \_\_\_\_\_ [2]

(v) Write an **ionic equation** for the formation of the white precipitate in Test 3.

\_\_\_\_\_ [2]

Examiner Only

Marks Remark

7 Some chemical compounds such as potassium chloride dissolve very well in water and are said to have a high solubility.

(a) Explain what is meant by the term solubility.

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[4]

(b) A student carried out a series of experiments to determine the solubility of potassium chloride over a range of temperatures. The results were plotted on a graph and the solubility curve is shown opposite.

(i) Which temperature value should the student repeat?

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[1]

(ii) If a saturated solution of potassium chloride containing 50 g of water is cooled from 70 °C to 20 °C, what mass of solid crystallises out of the solution?

Mass of solid \_\_\_\_\_ g [4]

(c) A factory situated beside a river takes water from the river and uses it as a coolant. The warm water is returned to the river and causes thermal pollution.

What effect does this thermal pollution have on the dissolved oxygen gas content of the river and on the aquatic life of the river?

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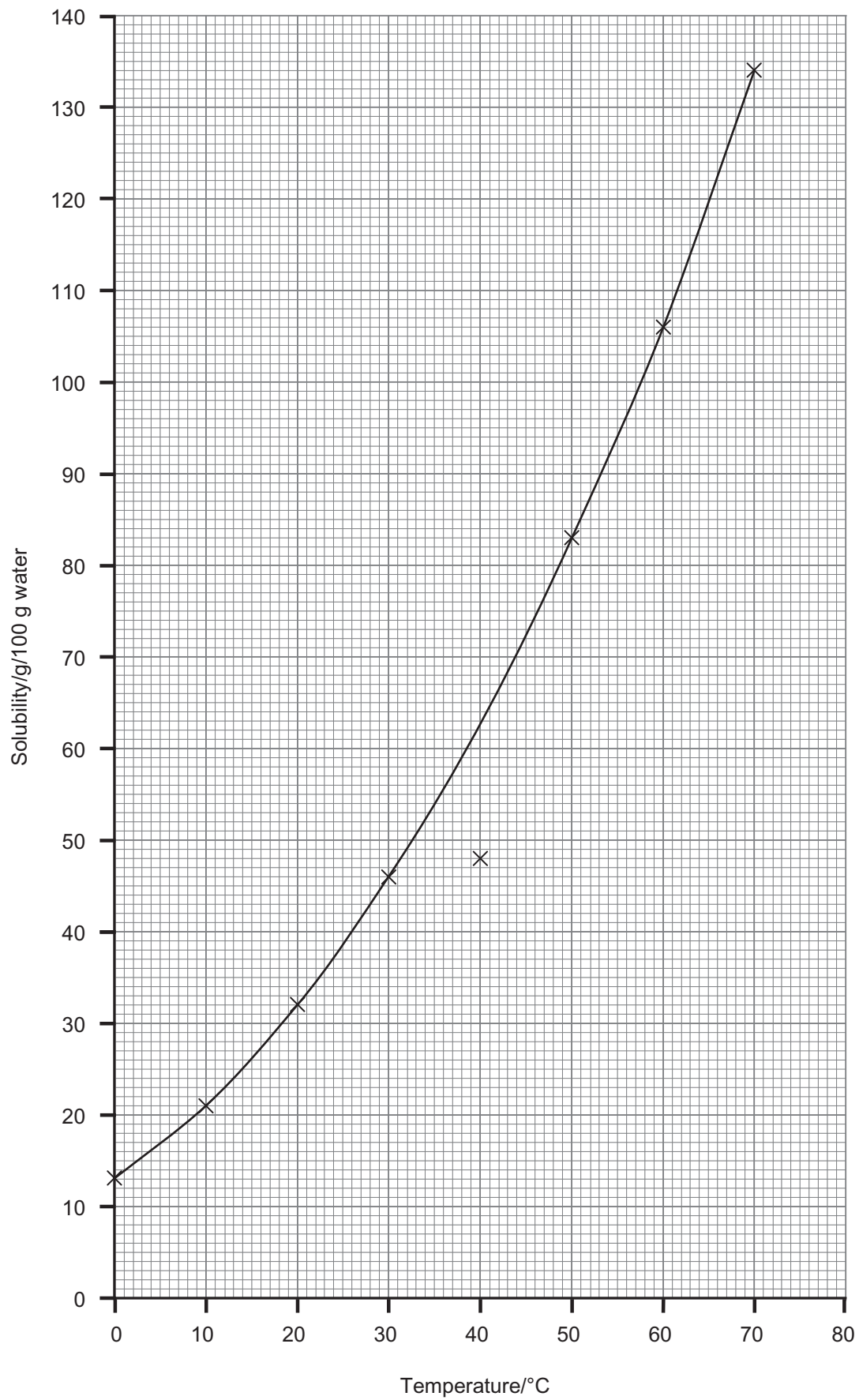
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Remark



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