



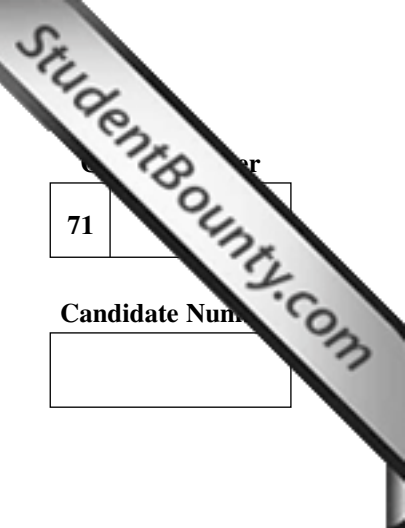
General Certificate of Secondary Education  
2009

## Science: Chemistry

Paper 1  
Higher Tier

[G1403]

THURSDAY 4 JUNE, MORNING



71	
Candidate Number	
<input type="text"/>	

### 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 five** questions.

### INFORMATION FOR CANDIDATES

The total mark for this paper is 120.  
Quality of written communication will be assessed in question 4(d)(iii).  
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.  
A Data Leaflet which includes a Periodic Table of the Elements is provided.

For Examiner's use only	
Question Number	Marks
1	
2	
3	
4	
5	
<b>Total Marks</b>	

- 1 (a) All playstations and games consoles contain a microchip made from the **element** silicon which has the symbol Si and **atomic number** 14.



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- (i) What is meant by the term **element**?

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[2]

- (ii) What is meant by the term **atomic number**?

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[1]

- (b) An atom of silicon contains protons, electrons and neutrons. Complete the table below to show the relative mass and relative charge of each particle.

Particle	Relative mass	Relative charge
proton		
electron		
neutron		

[3]

Examiner Only

Marks Remark

(c) Silicon has 3 stable **isotopes**,  $^{28}\text{Si}$ ,  $^{29}\text{Si}$  and  $^{30}\text{Si}$ .

- (i) Complete the table below to give the number of protons, electrons and neutrons present in one atom of each of the isotopes of silicon.

Isotope	Number of protons	Number of electrons	Number of neutrons
$^{28}\text{Si}$			
$^{29}\text{Si}$			
$^{30}\text{Si}$			

[3]

- (ii) Explain what you understand by the term **isotope**.

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[2]

(d) Silicon is rarely found in nature in its uncombined form, but is found as silicon dioxide (quartz) or in minerals called silicates, many of which contain the silicate(IV) ion.

- (i) Complete the table to give information about silicon dioxide,  $\text{SiO}_2$  (quartz).

Type of bonding present in silicon dioxide	
Type of structure of silicon dioxide	

[2]

Examiner Only

Marks Remark

- (ii) Given that the formula of the silicate(IV) ion is  $\text{SiO}_4^{4-}$ , write the formula of sodium silicate.

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

- (iii) The structure of sodium silicate is a giant ionic lattice. State **two** physical properties of sodium silicate.

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

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

- (e) Very pure silicon is needed to make microchips. One method originally used to produce pure silicon involved reacting silicon tetrachloride,  $\text{SiCl}_4$ , with metallic zinc at  $950\text{ }^\circ\text{C}$ . The word equation for this reaction is:



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

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

- (ii) Describe the structure and bonding in zinc metal. You may use a labelled diagram to help answer this question.

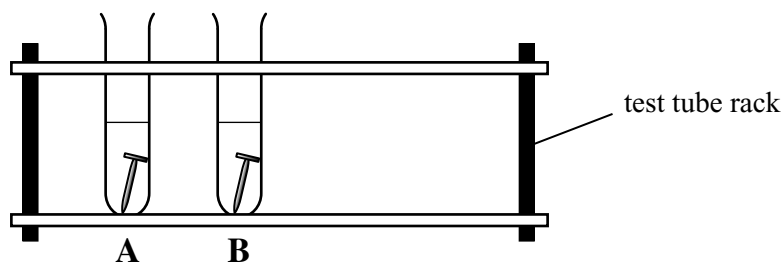
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [3]

Examiner Only

Marks Remark



- 2 (a) Two iron nails were placed in separate test tubes containing water. The nail in test tube **A** was galvanised, but the nail in test tube **B** was not. After a few days, the nail in test tube **B** had rusted.



- (i) State **one** observation which would indicate that rusting is a chemical reaction.

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

- (ii) What material is used to galvanise iron?

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

- (iii) State **two** other methods which could be used to prevent iron from rusting.

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

2. \_\_\_\_\_ [1]

- (iv) The chemical name for rust is hydrated iron(III) oxide. What is meant by the term **hydrated**?

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

Examiner Only	
Marks	Remark

- (b) Many chemical rust removers contain acids such as sulphuric acid. The rust is removed in a chemical reaction.

A rusty iron nail is placed in a solution of sulphuric acid for a few days. The rust disappears and the solution changes colour.

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

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

- (ii) The nail was removed from the solution and a few drops of aqueous ammonia solution were added to the remaining solution. What would you observe?

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

- (c) Copper metal is used for roofing. Copper reacts over time forming copper(II) oxide which reacts further with carbon dioxide in the air to form copper(II) carbonate. Acids will react with copper(II) carbonate.

- (i) Write a balanced symbol equation for the reaction of copper with oxygen in the air forming copper(II) oxide.

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

- (ii) Write a balanced symbol equation for the reaction of copper(II) oxide with carbon dioxide forming copper(II) carbonate.

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

- (iii) State the colours of:

copper \_\_\_\_\_

copper(II) oxide \_\_\_\_\_

copper(II) carbonate \_\_\_\_\_ [3]

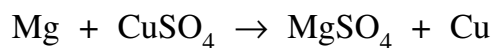
- (iv) Name the acid which reacts with copper(II) carbonate to form a solution of copper(II) sulphate.

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

Examiner Only

Marks Remark

(d) Magnesium reacts with copper(II) sulphate solution according to the equation



The reaction may be described as a redox reaction.

Explain in terms of electrons why this reaction may be described as a redox reaction. You may use ionic equations to help answer this question.

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[7]

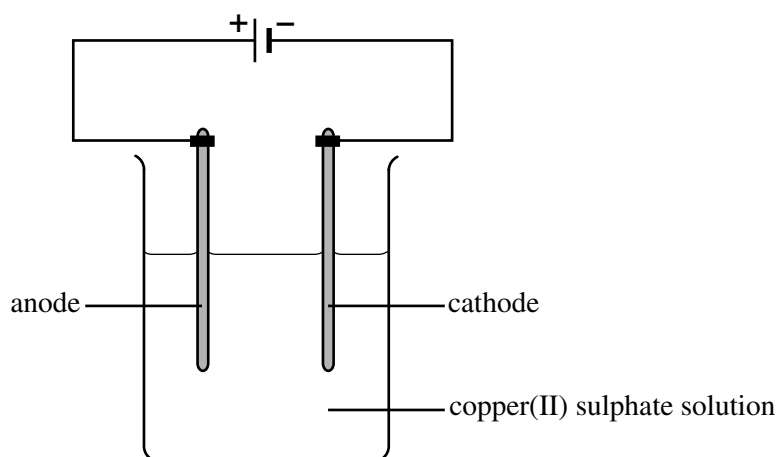
Examiner Only	
Marks	Remark



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**(Questions continue overleaf)**

- 3 (a) The diagram below shows the apparatus used to carry out the electrolysis of copper(II) sulphate solution. Graphite electrodes are used.



- (i) What is meant by the term **electrolysis**?

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[2]

- (ii) During the electrolysis of copper(II) sulphate solution, the ions present in the solution are attracted to the electrodes where they may be discharged.

The table below gives some of the details of the ions and the electrode to which they are attracted. Complete the table.

You may find your Data Leaflet useful in answering this question.

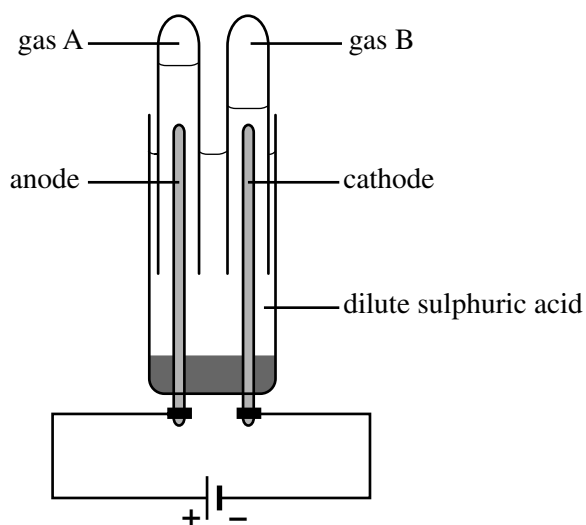
Name of ion	Formula of ion (including charge)	Attracted to positive electrode	Attracted to negative electrode
Copper(II)		X	✓
	$\text{SO}_4^{2-}$		
	$\text{H}^+$		
Hydroxide		✓	X

[6]

Examiner Only

Marks Remark

(b) The apparatus shown below is used to carry out the electrolysis of dilute sulphuric acid using platinum electrodes.



(i) Name gases A and B.

Gas A \_\_\_\_\_

Gas B \_\_\_\_\_ [2]

(ii) Write half equations for the reactions occurring at the anode and the cathode during the electrolysis of dilute sulphuric acid.

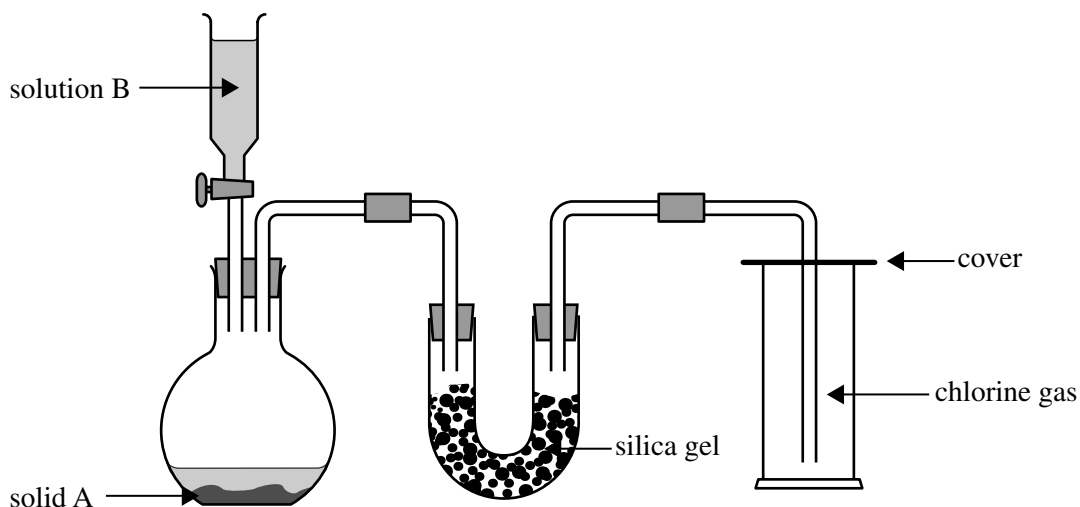
Anode \_\_\_\_\_ [3]

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

Examiner Only	
Marks	Remark

**4** In the laboratory, gases are made from the reaction between a solid and a solution. Two such gases are chlorine and hydrogen chloride.

**(a)** The diagram below shows apparatus used to prepare chlorine gas in the laboratory.



**(i)** Name solid A and solution B.

Solid A \_\_\_\_\_ [1]

Solution B \_\_\_\_\_ [2]

**(ii)** Suggest the purpose of the silica gel.

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

Examiner Only	
Marks	Remark

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(b) Chlorine gas reacts with hydrogen gas to form hydrogen chloride.

(i) Write a balanced symbol equation for the reaction between chlorine gas and hydrogen gas.

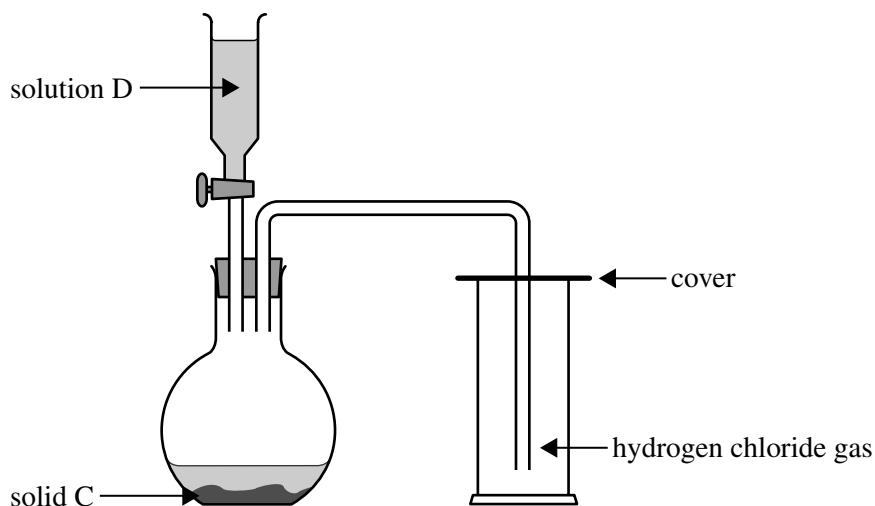
\_\_\_\_\_ [3]

(ii) Suggest **two** safety measures which should be taken when carrying out the reaction.

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

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

(c) The diagram below shows the apparatus commonly used to produce hydrogen chloride gas in the laboratory.



(i) Name solid C and solution D.

Solid C \_\_\_\_\_ [1]

Solution D \_\_\_\_\_ [2]

(ii) Describe what would be observed during the reaction.

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

Examiner Only

Marks Remark

(d) In industry, ammonia gas is made from the reaction between nitrogen gas and hydrogen gas in the Haber Process.

(i) Write a balanced symbol equation for the production of ammonia gas in the Haber Process.

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

(ii) Complete the table below, giving the operating conditions used in the Haber Process.

<b>Name of catalyst</b>	
<b>Temperature (°C)</b>	
<b>Pressure (atm)</b>	

 [3]

(iii) Describe a chemical test for ammonia gas and state the result for a positive test.

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ [4]

Quality of written communication [2]

Examiner Only

Marks Remark

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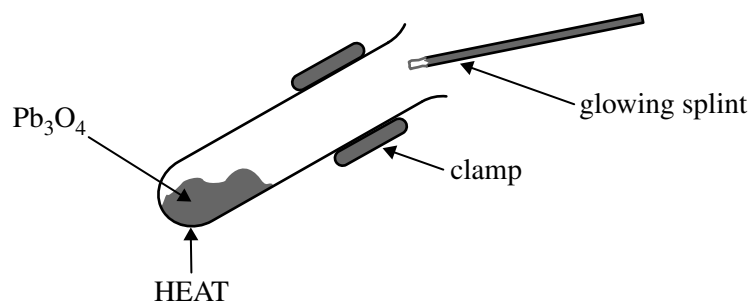
**(Questions continue overleaf)**

5 Oxides and hydroxides of metals are solids at room temperature and pressure. Many oxides of non-metals are gases.

- (a) 2.74 g of a sample of solid oxide of lead,  $\text{Pb}_3\text{O}_4$ , decomposes when heated according to the equation below.



The decomposition is carried out in a fume cupboard using the apparatus shown below.



Adapted from: <http://www.practicalchemistry.org/data/images/originals/heatingssolidstestubes-76.jpg>

- (i) What would happen to the glowing splint?

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

- (ii) Calculate the mass of  $\text{PbO}$  which would be formed on heating 2.74 g of  $\text{Pb}_3\text{O}_4$  to constant mass.  
(Relative atomic masses:  $\text{O} = 16$ ;  $\text{Pb} = 207$ )

[5]

Examiner Only

Marks Remark



- (iii)** Calculate the volume of oxygen gas which would be produced by heating this sample to constant mass.

(1 mole of any gas occupies a volume of 24 000 cm<sup>3</sup>)

Volume of oxygen gas = \_\_\_\_\_ cm<sup>3</sup> [2]

- (b)** Sulphur dioxide is an oxide of the non-metal sulphur. It can be produced in the reaction of sodium thiosulphate, Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>, with hydrochloric acid, HCl.



A solution of sodium thiosulphate is prepared by dissolving 5.53 g of Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub> in deionised water. The hydrochloric acid has a concentration of 2 mol/dm<sup>3</sup> (moles per litre).

- (i)** Calculate the number of moles of sodium thiosulphate used.  
(Relative atomic masses: Na = 23, S = 32, O = 16)

[2]

- (ii)** Calculate the number of moles of hydrochloric acid required to react with this number of moles of sodium thiosulphate in **(b)(i)**.

[2]

Examiner Only

Marks Remark

- (iii) Calculate the volume of hydrochloric acid required to react completely with the sodium thiosulphate solution.

[2]

- (c) An **insoluble unknown** metal hydroxide can be written  $M(OH)_2$  where M represents the metal M.

3.0 g of solid  $M(OH)_2$  is added to  $50.0\text{ cm}^3$  of  $1\text{ mol/dm}^3$  (moles per litre) hydrochloric acid with stirring. Some solid  $M(OH)_2$  is observed lying at the bottom.

The solution is filtered and the residue washed with some water and dried. The mass of unreacted  $M(OH)_2$  is 0.55 g.

- (i) What mass of  $M(OH)_2$  reacted with the hydrochloric acid?

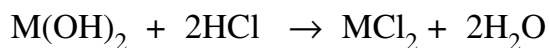
\_\_\_\_\_ [1]

- (ii) Calculate the number of moles of hydrochloric acid used.

[2]

Examiner Only	
Marks	Remark

(iii) Using the balanced symbol equation



Calculate the number of moles of  $\text{M(OH)}_2$  required to react with the hydrochloric acid.

[2]

(iv) Using the answers to (c)(i) and (c)(iii) above, calculate the Relative Formula Mass (RFM) of  $\text{M(OH)}_2$ .

[2]

(v) Determine the Relative Atomic Mass (RAM) of M and identify it using your Periodic Table.

RAM of M \_\_\_\_\_

\_\_\_\_\_

Identity of M \_\_\_\_\_ [2]

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**THIS IS THE END OF THE QUESTION PAPER**

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Marks

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