

Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

For Examiner's Use
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General Certificate of Secondary Education  
June 2009



**ADDITIONAL SCIENCE**  
**Unit Chemistry C2**

**CHY2F**  
**F**

**CHEMISTRY**  
**Unit Chemistry C2**

**Foundation Tier**

Thursday 4 June 2009 9.00 am to 9.45 am

<p><b>For this paper you must have:</b></p> <ul style="list-style-type: none"> <li>• a ruler</li> <li>• the Data Sheet (enclosed).</li> </ul> <p>You may use a calculator.</p>
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Time allowed: 45 minutes

**Instructions**

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- Do all rough work in this book. Cross through any work you do not want to be marked.

**Information**

- The maximum mark for this paper is 45.
- The marks for questions are shown in brackets.
- You are expected to use a calculator where appropriate.
- You are reminded of the need for good English and clear presentation in your answers.

**Advice**

- In all calculations, show clearly how you work out your answer.

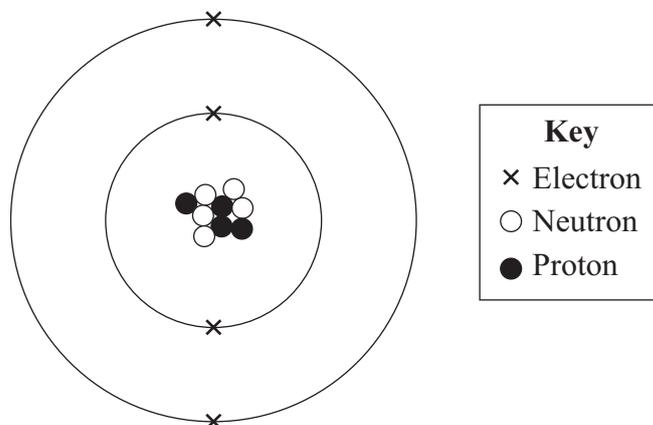
For Examiner's Use			
Question	Mark	Question	Mark
1		7	
2		8	
3			
4			
5			
6			
Total (Column 1)		→	
Total (Column 2)		→	
TOTAL			
Examiner's Initials			



J U N O 9 C H Y 2 F 0 1

Answer **all** questions in the spaces provided.

1 The diagram represents an atom of beryllium.



Use a number from the box to complete each sentence.

4	7	9	12
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1 (a) The atomic number (proton number) of this atom is  .

(1 mark)

1 (b) The mass number of this atom is  .

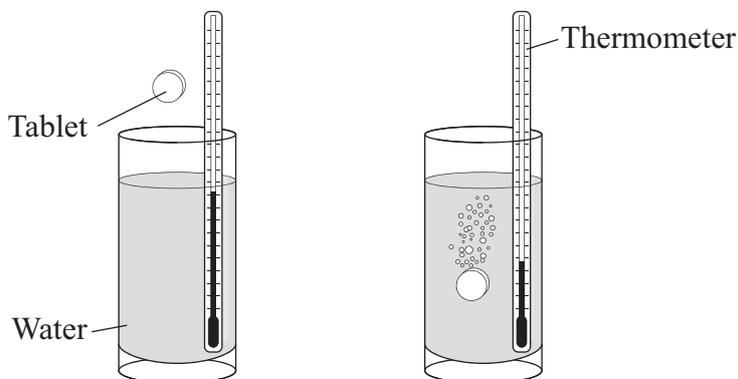
(1 mark)

2
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- 2 An indigestion tablet contains sodium hydrogencarbonate and citric acid.

When the tablet is added to cold water a chemical reaction takes place and there is a lot of fizzing.



- 2 (a) The formula of the gas that causes the fizzing is  $\text{CO}_2$

Name this gas ..... (1 mark)

- 2 (b) This chemical reaction is endothermic.

- 2 (b) (i) Tick (✓) the statement which describes what happens to the temperature of the solution.

Statement	Tick (✓)
The temperature of the solution will increase.	
The temperature of the solution will decrease.	
The temperature of the solution will stay the same.	

(1 mark)

- 2 (b) (ii) Tick (✓) the statement which describes what happens to the energy during the reaction.

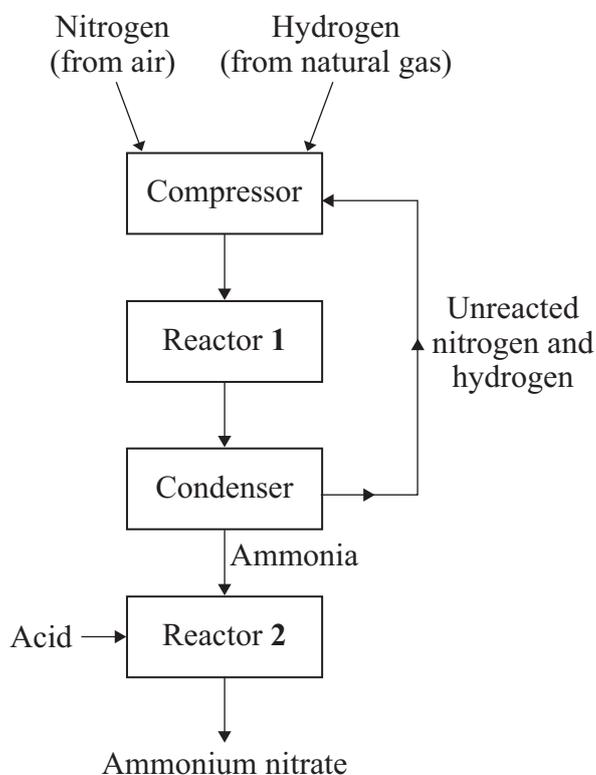
Statement	Tick (✓)
Energy is given out to the surroundings.	
Energy is taken in from the surroundings.	
No energy is given out to or taken from the surroundings.	

(1 mark)



- 3 Ammonium nitrate is an important chemical. The diagram shows the main stages in the manufacture of ammonium nitrate.

Study the diagram and then answer the questions.



Draw a ring around the correct answer in each box to complete the sentences.

- 3 (a) The compressor increases the

pressure
temperature
volume

to 200 atmospheres.

(1 mark)

- 3 (b) In reactor 1 ammonia is made by reacting

air
natural gas
nitrogen

with

air.
hydrogen.
natural gas.

(2 marks)



3 (c) In the condenser the mixture is

cooled  
heated  
reduced

and the ammonia is

separated as a liquid.

(1 mark)

3 (d) In reactor 2 ammonium nitrate is made by reacting ammonia

with

hydrochloric  
sulfuric  
nitric

acid.

(1 mark)

5

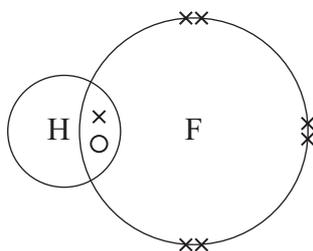
**Turn over for the next question**

**Turn over ►**



4 This question is about fluorine and some of its compounds.

4 (a) The diagram represents a molecule of hydrogen fluoride.



Draw a ring around the type of bonding that holds the hydrogen and fluorine atoms together in this molecule.

**covalent      ionic      metallic**

*(1 mark)*

4 (b) Fluorine is made in industry by the electrolysis of a mixture of potassium fluoride and hydrogen fluoride.

4 (b) (i) Use **one** word from the box to complete the sentence.

<b>gas</b>	<b>liquid</b>	<b>solid</b>
------------	---------------	--------------

To allow electrolysis to take place the mixture of potassium fluoride and hydrogen fluoride must be .....

*(1 mark)*



- 4 (b) (ii) The mixture of potassium fluoride and hydrogen fluoride contains fluoride ions ( $F^-$ ), hydrogen ions ( $H^+$ ) and potassium ions ( $K^+$ ).

Use **one** word from the box to complete the sentence.

fluorine	hydrogen	potassium
----------	----------	-----------

During electrolysis the element formed at the **positive** electrode is

.....

(1 mark)

- 4 (c) Fluoride ions are sometimes added to drinking water. It is thought that these ions help to reduce tooth decay.

- 4 (c) (i) Tick (✓) **one** question that **cannot** be answered by scientific investigation alone.

Question	Tick (✓)
Do fluoride ions in drinking water reduce tooth decay?	
Are fluoride ions in drinking water harmful to health?	
Should fluoride ions be added to drinking water?	

(1 mark)

- 4 (c) (ii) Explain why you have chosen this question.

.....  
 .....

(1 mark)

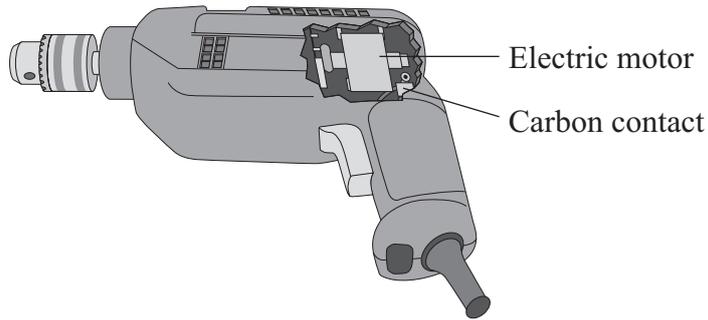
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**Turn over for the next question**

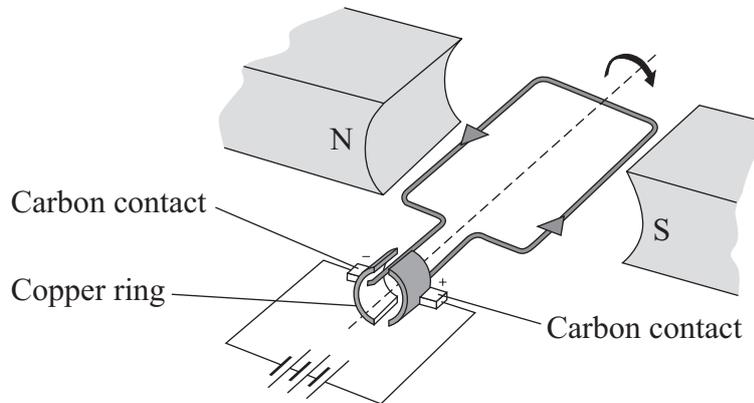
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5 This drill contains an electric motor.



The diagram below shows the main parts of an electric motor.



The carbon contacts are made of graphite. Springs push the contacts against the copper ring. The carbon contacts conduct electricity to the copper ring. The copper ring rotates rapidly but does not stick or become worn because the graphite is soft and slippery.

5 (a) Using this information give **two** properties that make graphite suitable for making the carbon contacts.

1.....

.....

2.....

.....

(2 marks)



- 5 (b) (i) Draw a ring around the correct word in each box to complete the sentence.

Each carbon atom in graphite is joined to

two

three

four

other carbon atoms by

covalent

ionic

metallic

bonds.

(2 marks)

- 5 (b) (ii) Tick (✓) the statement which explains why graphite is soft and slippery.

Statement	Tick (✓)
It is made of layers of atoms.	
It is made of small molecules.	
It is an ionic compound.	

(1 mark)

5
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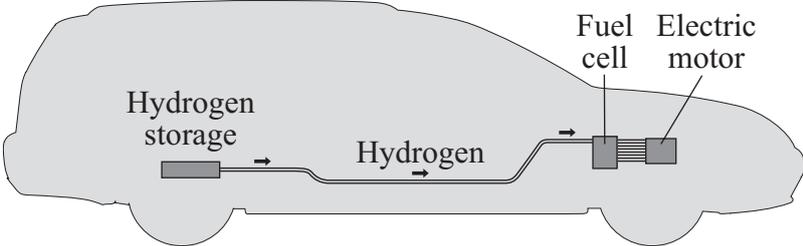
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**Turn over ►**



6 Read the article and then answer the questions that follow.

**Hydrogen fuel for cars?**



Hydrogen is an excellent fuel. On combustion it reacts with oxygen from the air to release a large amount of energy. The only product of combustion is water which does not cause pollution. Hydrogen gas can be stored under pressure in a cylinder but a leak of the gas could cause an explosion.

It has been found that lithium nitride can absorb and then release large volumes of hydrogen. Hydrogen stored in lithium nitride will not explode.

The problem is that the rate at which hydrogen is absorbed and then released from normal sized particles of lithium nitride is slow.

Recently scientists have made ‘nanosized’ particles of lithium nitride. The ‘nanosized’ particles have the advantage that they absorb and release the hydrogen much faster when needed in the fuel cell.



6 (a) Use information from the article to help you to answer these questions.

6 (a) (i) Give **two** reasons why hydrogen is an excellent fuel.

1 .....

.....

2 .....

.....

(2 marks)

6 (a) (ii) Hydrogen stored in lithium nitride is safer in an accident than a cylinder full of hydrogen gas.

State why.

.....

.....

(1 mark)

6 (a) (iii) What is the advantage of using 'nanosized' particles of lithium nitride instead of normal sized particles for storing hydrogen?

.....

.....

(1 mark)

**Question 6 continues on the next page**

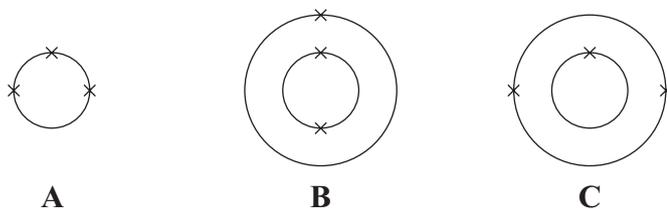
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6 (b) Lithium nitride is an ionic compound that contains lithium ions ( $\text{Li}^+$ ) and nitride ions ( $\text{N}^{3-}$ ).

6 (b) (i) The periodic table on the Data Sheet may help you to answer this question.

Which diagram, **A**, **B** or **C**, represents the electronic structure of a lithium atom?  
Write your answer in the box.



Diagram

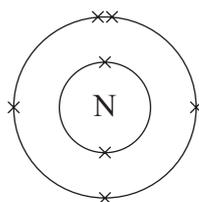
(1 mark)

6 (b) (ii) Tick (✓) the statement which describes how a lithium atom ( $\text{Li}$ ) changes into a lithium ion ( $\text{Li}^+$ ).

Statement	Tick (✓)
A lithium atom loses a neutron.	<input type="checkbox"/>
A lithium atom loses an electron.	<input type="checkbox"/>
A lithium atom loses a proton.	<input type="checkbox"/>

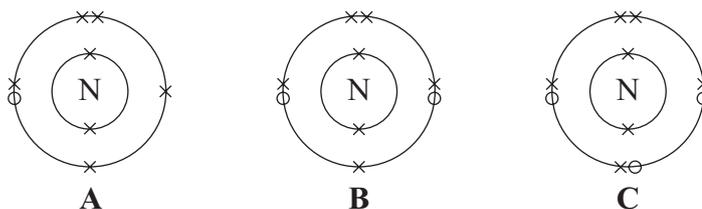
(1 mark)

6 (b) (iii) The diagram shows the electronic structure of a nitrogen atom.



Which diagram, **A**, **B** or **C**, represents the electronic structure of a nitride ion ( $\text{N}^{3-}$ )?

Write your answer in the box.

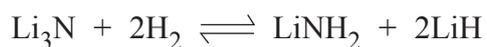


Diagram

(1 mark)



- 6 (c) The equation for the reaction of lithium nitride with hydrogen is:



What does the  $\rightleftharpoons$  symbol mean?

Draw a ring around your answer.

**reversible reaction**

**endothermic reaction**

**neutralisation**

(1 mark)

- 6 (d) Draw a ring around the correct answer in each box to complete the sentences.

- 6 (d) (i) 'Nanosized' particles of lithium nitride will be

much larger

a little larger

much smaller

than normal sized particles of lithium nitride.

(1 mark)

- 6 (d) (ii) One of the reasons why 'nanosized' particles have different properties

from normal sized particles is that they have a greater

density

mass

surface area

than normal sized particles of lithium nitride.

(1 mark)

10

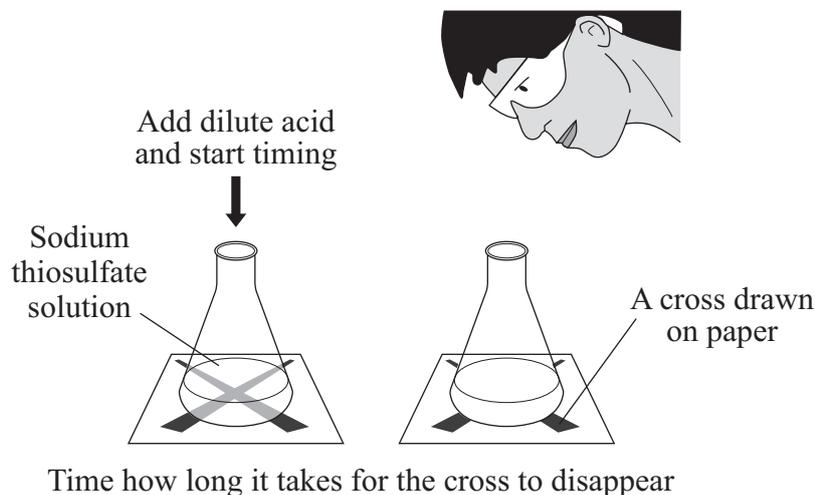
**Turn over for the next question**

**Turn over ►**



- 7 Sodium thiosulfate solution reacts with hydrochloric acid. As the reaction takes place the solution slowly turns cloudy.

The diagram shows a method of measuring the rate of this reaction.



A student used this method to investigate how changing the concentration of the sodium thiosulfate solution affects the rate of this reaction.

The student used different concentrations of sodium thiosulfate solution. All the other variables were kept the same.

The results are shown on the graph on the opposite page.

- 7 (a) (i) Draw a line of best fit on the graph. (1 mark)

- 7 (a) (ii) Suggest **two** reasons why all of the points do not lie on the line of best fit.

1 .....

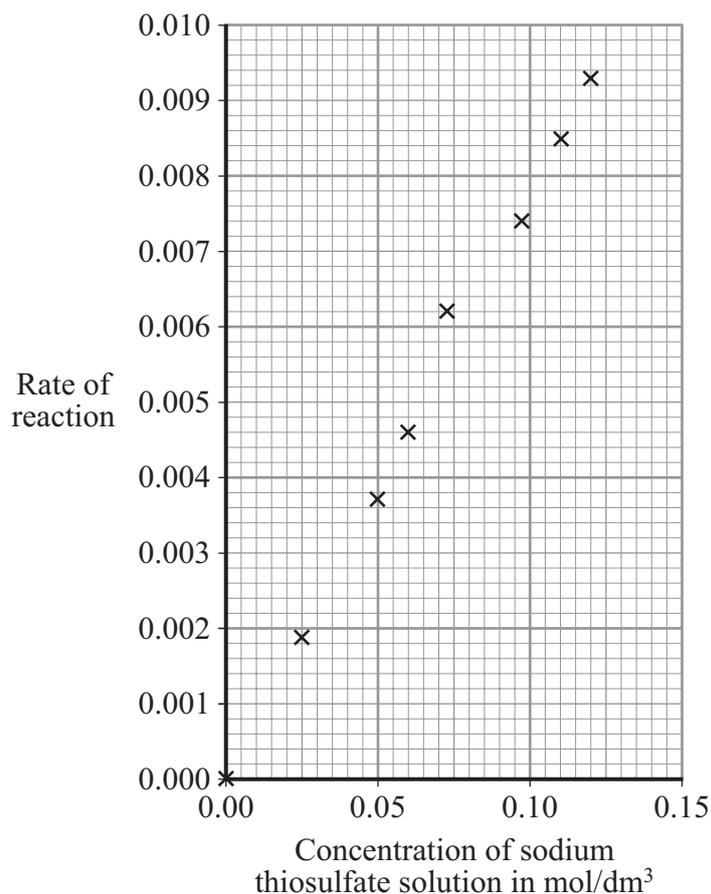
.....

2 .....

.....

(2 marks)





- 7 (b) (i) In a conclusion to the investigation the student stated that:

‘The rate of this reaction is directly proportional to the concentration of the sodium thiosulfate solution.’

How does the graph support this conclusion?

.....  
 .....  
 (1 mark)

- 7 (b) (ii) Explain, in terms of particles, why the rate of reaction increases when the concentration of sodium thiosulfate is increased.

.....  
 .....  
 .....  
 .....  
 (2 marks)

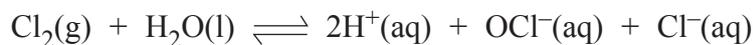
6
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Turn over ►



8 This question is about methods of treating water.

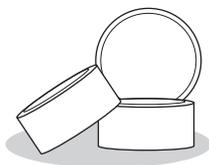
8 (a) Chlorine is used to kill microorganisms in water. When chlorine is added to water a chemical reaction takes place. The equation for this reaction is shown below.



An acidic solution is produced when chlorine reacts with water.

Which ion, shown in the equation, makes the solution acidic? .....  
(1 mark)

8 (b) Calcium hypochlorite tablets are added to water in some swimming pools to kill microorganisms.



The formula of calcium hypochlorite is  $\text{CaCl}_2\text{O}_2$

8 (b) (i) Calculate the relative formula mass ( $M_r$ ) of calcium hypochlorite.

Relative atomic masses: O = 16; Cl = 35.5; Ca = 40.

.....  
.....

Relative formula mass ( $M_r$ ) of calcium hypochlorite = .....  
(2 marks)

8 (b) (ii) Calculate the percentage by mass of chlorine in calcium hypochlorite.

.....  
.....

Percentage by mass of chlorine in calcium hypochlorite = ..... %  
(2 marks)



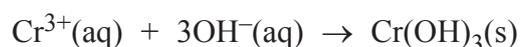
- 8 (b) (iii) Calculate the mass of chlorine in a 20 g tablet of calcium hypochlorite.

.....  
 .....

Mass of chlorine = ..... g  
 (1 mark)

- 8 (c) Waste water from some industrial processes sometimes contains harmful metal ions, such as chromium ions. These ions must be removed from the water before it can be returned to a river.

A method of removing chromium ions ( $\text{Cr}^{3+}$ ) from water is represented by this equation.



- 8 (c) (i) What type of substance would be added to the water to provide the  $\text{OH}^{-}$  ions?

.....  
 .....

(1 mark)

- 8 (c) (ii) A *precipitate* is formed in this reaction.

What is a *precipitate*?

.....  
 .....

(1 mark)

- 8 (c) (iii) What method could be used to separate the precipitate from the solution?

.....  
 .....

(1 mark)

**END OF QUESTIONS**

9
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## Data Sheet

### 1. Reactivity Series of Metals

Potassium	most reactive
Sodium	↑
Calcium	
Magnesium	
Aluminium	
<i>Carbon</i>	
Zinc	
Iron	
Tin	
Lead	
<i>Hydrogen</i>	
Copper	
Silver	
Gold	
Platinum	↓
	least reactive

(elements in italics, though non-metals, have been included for comparison)

### 2. Formulae of Some Common Ions

Positive ions		Negative ions	
Name	Formula	Name	Formula
Hydrogen	$H^+$	Chloride	$Cl^-$
Sodium	$Na^+$	Bromide	$Br^-$
Silver	$Ag^+$	Fluoride	$F^-$
Potassium	$K^+$	Iodide	$I^-$
Lithium	$Li^+$	Hydroxide	$OH^-$
Ammonium	$NH_4^+$	Nitrate	$NO_3^-$
Barium	$Ba^{2+}$	Oxide	$O^{2-}$
Calcium	$Ca^{2+}$	Sulfide	$S^{2-}$
Copper(II)	$Cu^{2+}$	Sulfate	$SO_4^{2-}$
Magnesium	$Mg^{2+}$	Carbonate	$CO_3^{2-}$
Zinc	$Zn^{2+}$		
Lead	$Pb^{2+}$		
Iron(II)	$Fe^{2+}$		
Iron(III)	$Fe^{3+}$		
Aluminium	$Al^{3+}$		

**Turn over ►**

### 3. The Periodic Table of Elements

	1	2	3	4	5	6	7	0													
	<div style="border: 1px solid black; padding: 2px; display: inline-block;">                     1 <b>H</b> hydrogen 1                 </div>							<div style="border: 1px solid black; padding: 2px; display: inline-block;">                     4 <b>He</b> helium 2                 </div>													
	<div style="border: 1px solid black; padding: 2px; display: inline-block;">                     relative atomic mass <b>atomic symbol</b> name atomic (proton) number                 </div>																				
7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4	23 <b>Na</b> sodium 11	24 <b>Mg</b> magnesium 12	39 <b>K</b> potassium 19	40 <b>Ca</b> calcium 20	45 <b>Sc</b> scandium 21	48 <b>Ti</b> titanium 22	51 <b>V</b> vanadium 23	52 <b>Cr</b> chromium 24	55 <b>Mn</b> manganese 25	56 <b>Fe</b> iron 26	59 <b>Co</b> cobalt 27	59 <b>Ni</b> nickel 28	63.5 <b>Cu</b> copper 29	65 <b>Zn</b> zinc 30	70 <b>Ga</b> gallium 31	73 <b>Ge</b> germanium 32	75 <b>As</b> arsenic 33	79 <b>Se</b> selenium 34	80 <b>Br</b> bromine 35	84 <b>Kr</b> krypton 36
85 <b>Rb</b> rubidium 37	88 <b>Sr</b> strontium 38	133 <b>Cs</b> caesium 55	137 <b>Ba</b> barium 56	89 <b>Y</b> yttrium 39	89 <b>La*</b> lanthanum 57	139 <b>La*</b> lanthanum 57	178 <b>Hf</b> hafnium 72	181 <b>Ta</b> tantalum 73	184 <b>W</b> tungsten 74	186 <b>Re</b> rhenium 75	[98] <b>Tc</b> technetium 43	101 <b>Ru</b> ruthenium 44	103 <b>Rh</b> rhodium 45	106 <b>Pd</b> palladium 46	112 <b>Cd</b> cadmium 48	115 <b>In</b> indium 49	119 <b>Sn</b> tin 50	122 <b>Sb</b> antimony 51	128 <b>Te</b> tellurium 52	127 <b>I</b> iodine 53	131 <b>Xe</b> xenon 54
[223] <b>Fr</b> francium 87	[226] <b>Ra</b> radium 88	[227] <b>Ac*</b> actinium 89	[227] <b>Ac*</b> actinium 89	[261] <b>Rf</b> rutherfordium 104	[261] <b>Rf</b> rutherfordium 104	[262] <b>Db</b> dubnium 105	[262] <b>Db</b> dubnium 105	[266] <b>Sg</b> seaborgium 106	[264] <b>Bh</b> bohrium 107	[268] <b>Mt</b> meitnerium 109	[271] <b>Ds</b> darmstadtium 110	[272] <b>Rg</b> roentgenium 111	[272] <b>Rg</b> roentgenium 111	201 <b>Hg</b> mercury 80	204 <b>Tl</b> thallium 81	207 <b>Pb</b> lead 82	209 <b>Bi</b> bismuth 83	[209] <b>Po</b> polonium 84	[210] <b>At</b> astatine 85	[222] <b>Rn</b> radon 86	Elements with atomic numbers 112 – 116 have been reported but not fully authenticated

\* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

**Cu** and **Cl** have not been rounded to the nearest whole number.