

Candidate Forename		Candidate Surname	
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Centre Number						Candidate Number				
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**OXFORD CAMBRIDGE AND RSA EXAMINATIONS  
GENERAL CERTIFICATE OF SECONDARY EDUCATION**

**A322/02**

**TWENTY FIRST CENTURY SCIENCE  
CHEMISTRY A**

**UNIT 2: Modules C4 C5 C6  
(Higher Tier)**

**MONDAY 28 JUNE 2010: Morning  
DURATION: 40 minutes**

**SUITABLE FOR VISUALLY IMPAIRED CANDIDATES**

**Candidates answer on the Question Paper  
A calculator may be used for this paper**

**OCR SUPPLIED MATERIALS:**

**None**

**OTHER MATERIALS REQUIRED:**

**Pencil**

**Ruler (cm/mm)**

**READ INSTRUCTIONS OVERLEAF**

## **INSTRUCTIONS TO CANDIDATES**

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes on the first page.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer ALL the questions.
- Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your Candidate Number, Centre Number and question number(s).

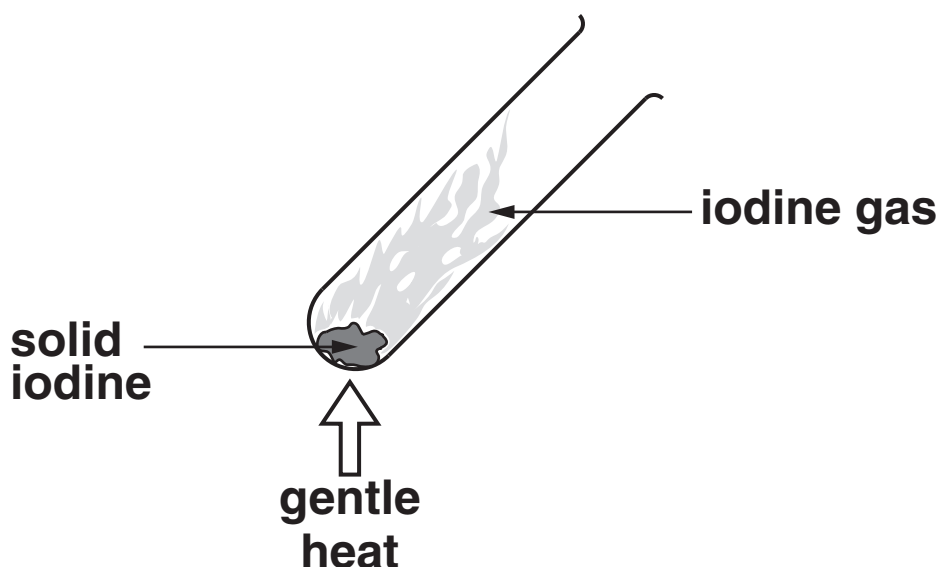
## **INFORMATION FOR CANDIDATES**

- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 42.
- The Periodic Table is printed on the back page.

Answer ALL the questions.

1 Iodine is a halogen in Group 7 of the Periodic Table.

Marty warms a small crystal of iodine in a test tube.



(a) What colour change will Marty SEE when solid iodine changes into iodine gas?

Choose words from the list to complete the sentence.

DARK GREY

ORANGE

BROWN

PURPLE

GREEN

The colour changes from \_\_\_\_\_

to \_\_\_\_\_ .

[1]

(b) Iodine dissolves in water to form a dilute solution.

Give the FORMULA and STATE SYMBOL for iodine solution.

formula \_\_\_\_\_

state symbol \_\_\_\_\_ [1]

(c) Marty finds some information about other halogens in Group 7.

NAME OF HALOGEN	MELTING POINT IN °C	BOILING POINT IN °C	REACTIVITY	FORMULA OF POTASSIUM SALT
fluorine	-220	-188	most reactive halogen	_____
chlorine	-101	-35	less reactive than fluorine more reactive than bromine	KCl
bromine	-7	59	less reactive than chlorine more reactive than iodine	KBr

(i) Fill in the missing formula for potassium fluoride. [1]

**(ii) Use information from the table to describe the trends in properties of the elements down Group 7.**

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**[3]**

(d) Astatine is another halogen. It is below iodine in Group 7.

Marty makes some predictions about the properties of astatine based on its position in the Periodic Table.

Which of the following predictions about astatine are LIKELY TO BE TRUE and which are LIKELY TO BE FALSE?

Put a tick (✓) in the correct box in each row.

	LIKELY TO BE TRUE	LIKELY TO BE FALSE
Astatine is a gas at room temperature.		
Astatine has a lower melting point than bromine.		
Astatine has one electron in its outer shell.		
Astatine forms an ion with a single negative charge.		
Astatine reacts with iron more slowly than iodine does.		

[3]

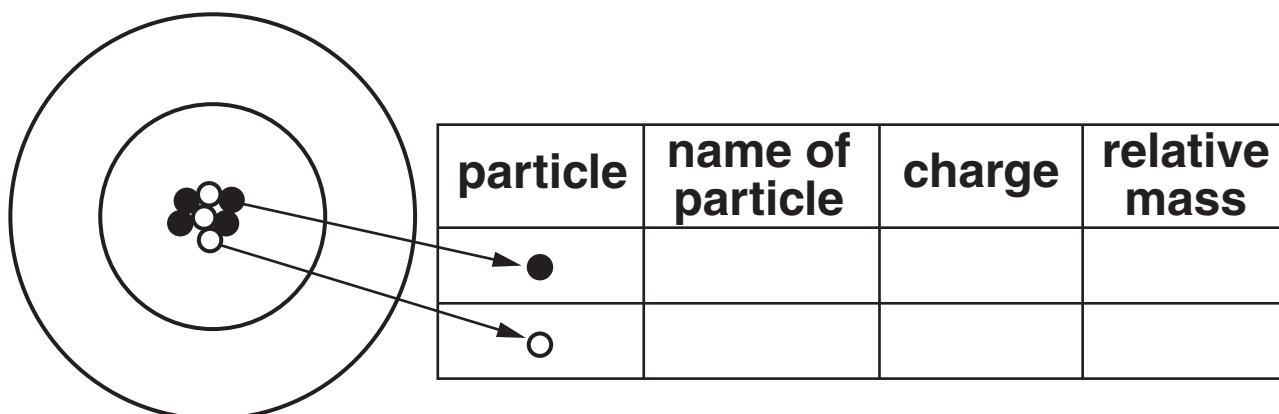
[Total: 9]

## 2 Lithium is in Group 1.

(a) The Periodic Table shows this information for lithium.

7
<b>Li</b>
lithium
3

The diagram shows the particles in the nucleus of a lithium atom and two electron shells.



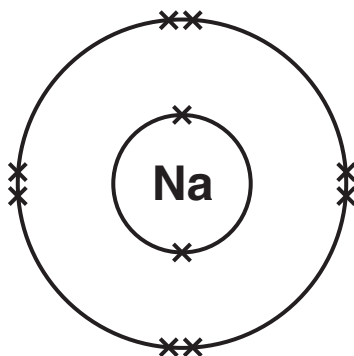
(i) Complete the table of information about the particles in the nucleus. [2]

(ii) On the diagram, show the arrangement of electrons.

Use an x for each electron. [1]

**(b) Sodium is another element in Group 1.**

**The diagram shows the arrangement of electrons in a sodium ION.**





Which of the following statements about a sodium ion are TRUE and which are FALSE?

Put a tick (✓) in the correct box in each row.

	<u>TRUE</u>	<u>FALSE</u>
A sodium ion has a larger relative mass than a sodium atom.	<input type="checkbox"/>	<input type="checkbox"/>
The total charge on the nucleus of a sodium ion is greater than the total charge on the electrons.	<input type="checkbox"/>	<input type="checkbox"/>
Sodium ions have more protons and electrons than sodium atoms.	<input type="checkbox"/>	<input type="checkbox"/>
A sodium atom forms a sodium ion by gaining one electron.	<input type="checkbox"/>	<input type="checkbox"/>
A sodium ion has fewer shells of electrons than a sodium atom.	<input type="checkbox"/>	<input type="checkbox"/>

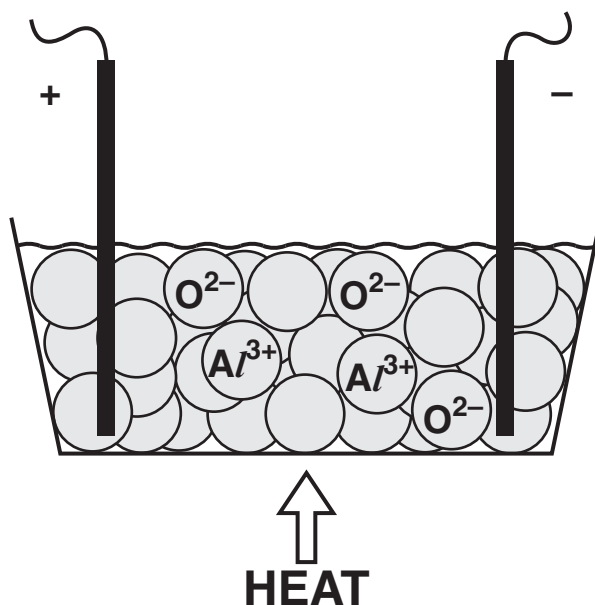
[2]

[Total: 5]

**3 Bauxite is an ore of aluminium.**

**Bauxite contains the ionic compound, aluminium oxide.**

**Aluminium is extracted from aluminium oxide by electrolysis.**



**(a) Describe what happens to the oxide ions during the electrolysis.**

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**[2]**

(b) The formula for aluminium oxide is  $Al_2O_3$ .

The relative formula mass of aluminium oxide can be worked out like this.

relative atomic masses:

$$Al = 27 \quad O = 16$$

relative formula mass of  $Al_2O_3$ :

$$(2 \times 27) + (3 \times 16) = \underline{102}$$

(i) What is the maximum mass of aluminium that can be made from 204 tonnes of aluminium oxide,  $Al_2O_3$ ?

mass = \_\_\_\_\_ tonnes [1]

**(ii) Which one of the following statements about the electrolysis of aluminium oxide is true?**

**Put a tick (✓) in the box next to the correct statement.**

**Aluminium ions give up electrons during the electrolysis.**

**More atoms of aluminium are formed than atoms of oxygen.**

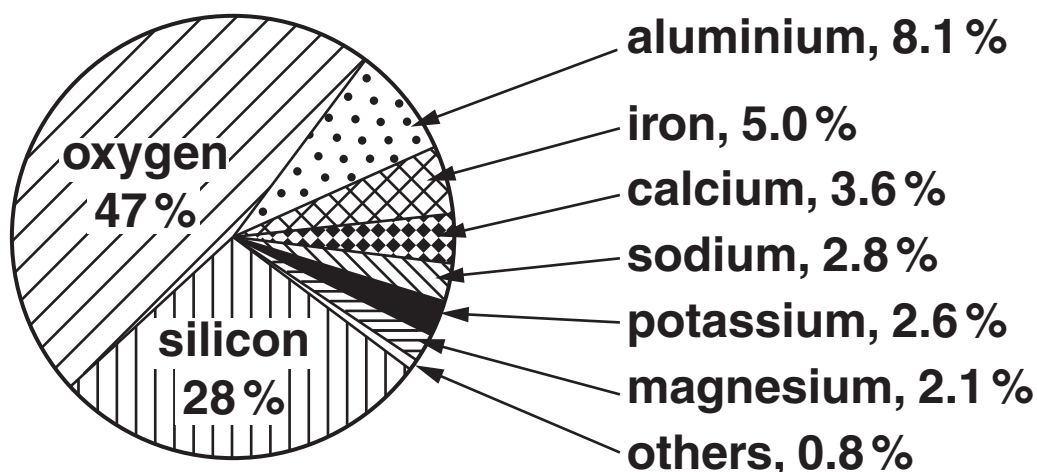
**The same total number of electrons is involved in the reaction at each electrode.**

**Aluminium forms at the positive electrode.**

**[1]**

**[Total: 4]**

- 4 The pie chart shows the percentages of common elements found in the Earth's crust.

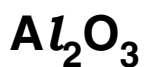


- (a) Three elements make up most of the Earth's crust.

The list below shows compounds found in the Earth's crust.

Which two compounds, when taken together, contain ALL THREE of these most common elements?

Put a ring around the TWO correct answers.



[2]

- (b) Sodium chloride, NaCl, is found in some parts of the Earth's crust. It is left behind when sea water evaporates.

Sodium appears in the pie chart of common elements in the Earth's crust but chlorine does not.

Which of the following statements explain why?

Put ticks (✓) in the boxes next to the TWO best answers.

There is much less chlorine than sodium in the Earth's crust.

Chlorine is a gas.

Sodium occurs in other compounds, not only sodium chloride.

The pie chart only shows metals.

There is only a very small amount of chlorine in the sea.

[2]

[Total: 4]

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**TURN OVER FOR QUESTION 5**

- 5 The information describes part of the nitrogen cycle in a garden pond.

**NITROGEN CYCLE IN A GARDEN POND**

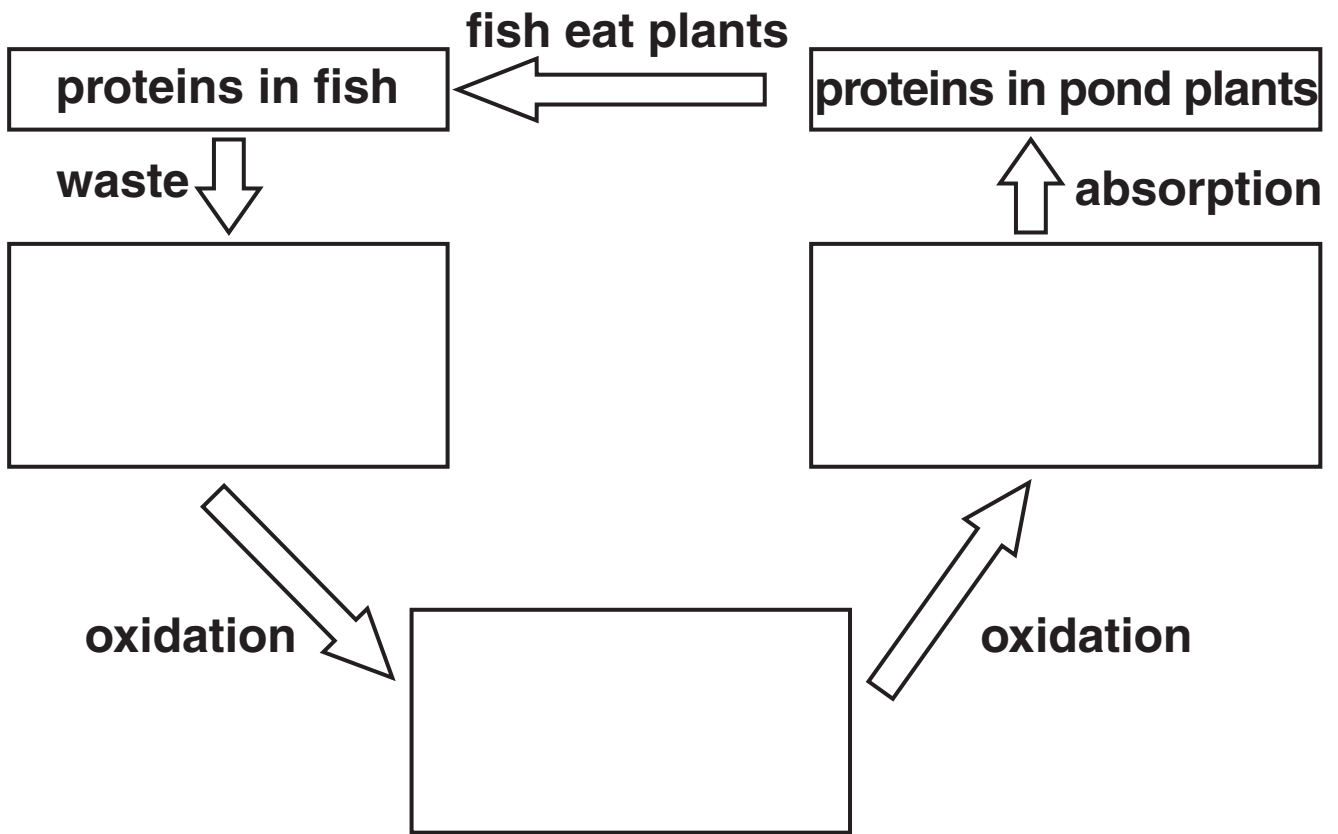
Nitrogen compounds in plants and fish are part of a cycle of changes. Plants in the pond take in (absorb) nitrate ions ( $\text{NO}_3^-$ ) from the water and use them to produce plant proteins. The nitrate ions are formed by the oxidation of nitrite ions ( $\text{NO}_2^-$ ) in the water. Fish eat plant proteins and convert them into proteins in their bodies. They pass out waste nitrogen compounds that contain ammonium ions ( $\text{NH}_4^+$ ) that are easily oxidised to nitrite ions in the water.

- (a) The chemical changes in the nitrogen cycle in the pond can be represented in a flow chart.

Use the information to complete the flow chart.

In each box write the NAME and the FORMULA of the correct nitrogen ion.

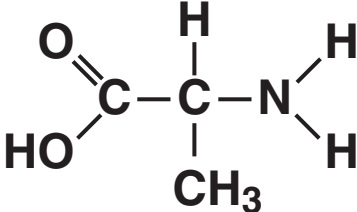




[2]

**(b) Proteins are made from amino acids.**

**The table shows some information about the amino acid, alanine.**

<b>alanine</b>	
	
<b>name of atom</b>	<b>percentage by mass in formula</b>
<b>carbon</b>	<b>40%</b>
<b>hydrogen</b>	<b>8%</b>

- (i) Explain how and why the PERCENTAGE BY MASS of hydrogen and carbon in alanine seems to disagree with the NUMBER OF ATOMS of these elements in the formula.

Your answer should include

- how the number of atoms of carbon and of hydrogen in the molecule are different
- how the percentage by mass of carbon and of hydrogen are different
- the reasons why these seem to disagree.

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[3]

(ii) Alanine is typical of molecules found in living things.

Which statement is the best reason why?

Put a tick (✓) in the box next to the **BEST** answer.

Alanine has a low melting point.

Alanine is soluble in water.

Alanine contains carbon, hydrogen and oxygen.

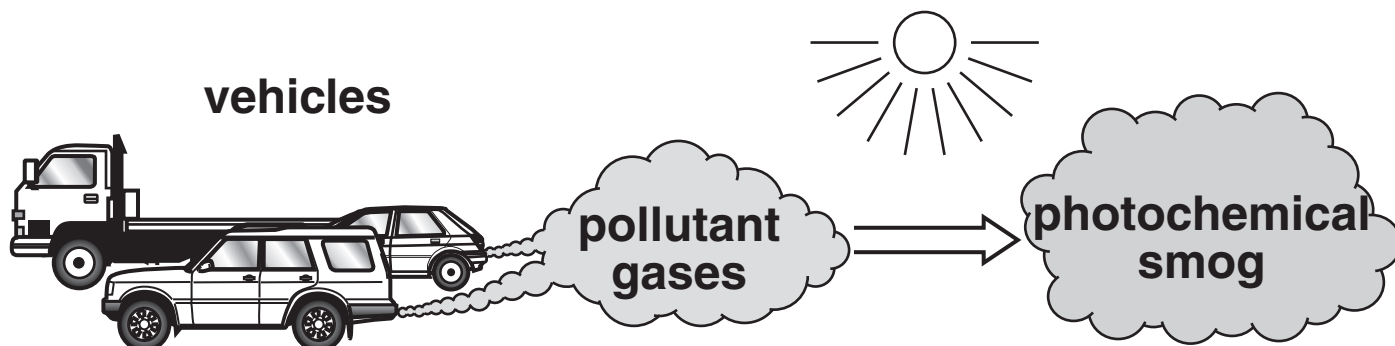
Alanine is non-toxic.

[1]

[Total: 6]

**6 Photochemical smog forms when pollutant gases react together in strong sunlight.**

**The pollutant gases build up in cities where there are a large number of vehicles.**



**(a) When the concentration of pollutant gases increases, the rate of the reactions that form the smog changes.**

**What effect does an increase in concentration have on rate of reaction?**

**Use ideas about colliding particles to explain your answer.**

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**[3]**

**(b) A new type of city pavement has a catalyst coating.**

**The pollutant gases break down when they are in contact with the coating to form less harmful products.**

**The new pavements are expensive, but the coating keeps working for a very long time.**

**Explain why the catalyst keeps on working.**

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

**(c) One of the pollutant gases is nitrogen dioxide.**

**Nitrogen dioxide makes nitric acid when it dissolves in water. Nitric acid is very acidic.**

**How does the pH of the water change if a large volume of nitrogen dioxide is bubbled through it?**

**Put a ring around the correct answer in EACH ROW.**

**Pure water has a pH of**

**1      5      7      9      14**

**When a large volume of nitrogen dioxide is bubbled through water the pH changes to**

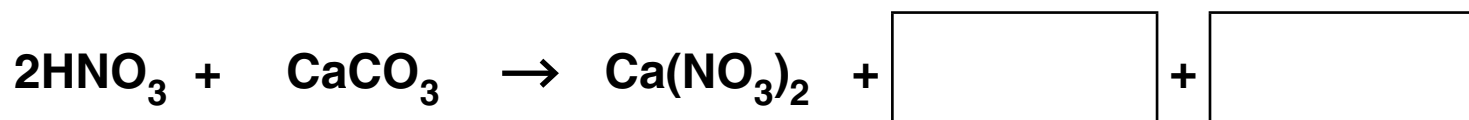
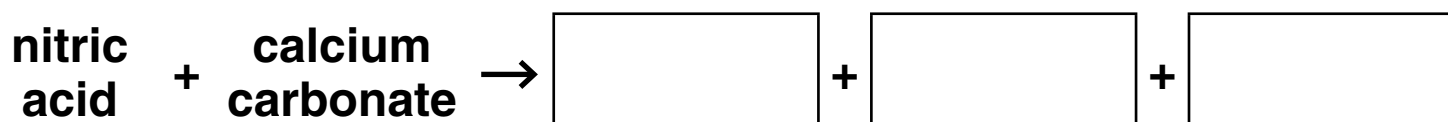
**1      5      7      9      14**

**[1]**

(d) Concrete contains calcium carbonate.

Nitric acid in rain water damages concrete because it reacts with calcium carbonate.

Complete the WORD and SYMBOL equations for this reaction by filling in the empty boxes.

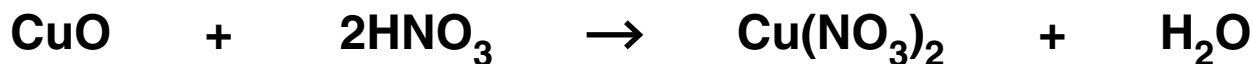


[3]

[Total: 8]

7 Copper nitrate is a salt that is used to give green colours in fireworks.

Eve makes some copper nitrate by reacting copper oxide with nitric acid.



(a) Eve carries out some calculations on her experiment.

The box shows some of her working.

(i) Fill in the missing relative formula mass of copper nitrate,  $\text{Cu}(\text{NO}_3)_2$ .

**RELATIVE ATOMIC MASS:**

Cu = 64

O = 16

H = 1

N = 14

**RELATIVE FORMULA MASS:**

CuO = 80

HNO<sub>3</sub> = 63

Cu(NO<sub>3</sub>)<sub>2</sub> = \_\_\_\_\_

H<sub>2</sub>O = 18

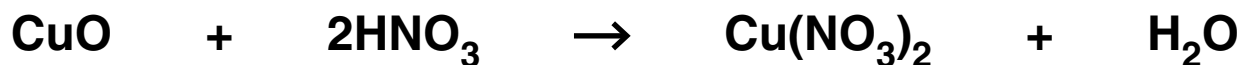
[1]



(ii) Eve weighs out 0.8 g of copper oxide.

She uses the equation and the relative formula masses to work out the mass of nitric acid that will react exactly with 0.8 g copper oxide.

Complete Eve's working by calculating the mass of nitric acid she needs.



0.8 g CuO reacts with \_\_\_\_\_ g HNO<sub>3</sub> [2]

**(b) The formula for copper nitrate is  $\text{Cu}(\text{NO}_3)_2$ .**

**The symbol for a nitrate ion is  $\text{NO}_3^-$**

**(i) What is the symbol for a copper ion?**

**answer \_\_\_\_\_ [1]**

**(ii) Some fireworks also contain copper sulfate.**

**Which acid would Eve need to add to copper oxide to make copper sulfate?**

**answer \_\_\_\_\_ acid [1]**

**(iii) Lithium nitrate is added to some fireworks to give a red colour.**

**The symbol for a lithium ion is  $\text{Li}^+$ .**

**What is the formula for lithium nitrate?**

**answer \_\_\_\_\_ [1]**

**[Total: 6]**

**END OF QUESTION PAPER**



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# The Periodic Table of the Elements

	1	2	3	4	5	6	7	8		
	7 <b>Li</b> lithium 3	9 <b>Be</b> beryllium 4	11 <b>B</b> boron 5	12 <b>C</b> carbon 6	14 <b>N</b> nitrogen 7	16 <b>O</b> oxygen 8	19 <b>F</b> fluorine 9	20 <b>Ne</b> neon 10	4 <b>He</b> helium 2	
	23 <b>Na</b> sodium 11	24 <b>Mg</b> magnesium 12	27 <b>Al</b> aluminium 13	28 <b>Si</b> silicon 14	31 <b>P</b> phosphorus 15	32 <b>S</b> sulfur 16	35.5 <b>Cl</b> chlorine 17	40 <b>Ar</b> argon 18		
	39 <b>K</b> potassium 19	40 <b>Ca</b> calcium 20	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	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		
	133 <b>Cs</b> caesium 55	137 <b>Ba</b> barium 56	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		
	[223] <b>Fr</b> francium 87	[226] <b>Ra</b> radium 88	Elements with atomic numbers 112-116 have been reported but not fully authenticated			Elements with atomic numbers 112-116 have been reported but not fully authenticated			Elements with atomic numbers 112-116 have been reported but not fully authenticated	
			65 <b>Zn</b> zinc 30	112 <b>Cd</b> cadmium 48	201 <b>Hg</b> mercury 80	[272] <b>Rg</b> roentgenium 111	197 <b>Au</b> gold 79	201 <b>Hg</b> mercury 80		
			59 <b>Ni</b> nickel 28	106 <b>Pd</b> palladium 46	195 <b>Pt</b> platinum 78	[271] <b>Ds</b> darmstadtium 110	195 <b>Pt</b> platinum 78	201 <b>Hg</b> mercury 80		
			59 <b>Co</b> cobalt 27	103 <b>Rh</b> rhodium 45	192 <b>Ir</b> iridium 77	[268] <b>Mt</b> meitnerium 109	192 <b>Ir</b> iridium 77	201 <b>Hg</b> mercury 80		
			56 <b>Fe</b> iron 26	101 <b>Ru</b> ruthenium 44	190 <b>Os</b> osmium 76	[277] <b>Hs</b> hassium 108	190 <b>Os</b> osmium 76	201 <b>Hg</b> mercury 80		
			55 <b>Mn</b> manganese 25	[98] <b>Tc</b> technetium 43	186 <b>Re</b> rhenium 75	[264] <b>Bh</b> bohrium 107	186 <b>Re</b> rhenium 75	201 <b>Hg</b> mercury 80		
			52 <b>Cr</b> chromium 24	96 <b>Mo</b> molybdenum 42	184 <b>W</b> tungsten 74	[266] <b>Sg</b> seaborgium 106	184 <b>W</b> tungsten 74	201 <b>Hg</b> mercury 80		
			51 <b>V</b> vanadium 23	93 <b>Nb</b> niobium 41	181 <b>Ta</b> tantalum 73	[262] <b>Db</b> dubnium 105	181 <b>Ta</b> tantalum 73	201 <b>Hg</b> mercury 80		
			48 <b>Ti</b> titanium 22	91 <b>Zr</b> zirconium 40	178 <b>Hf</b> hafnium 72	[261] <b>Rf</b> rutherfordium 104	178 <b>Hf</b> hafnium 72	201 <b>Hg</b> mercury 80		
			45 <b>Sc</b> scandium 21	89 <b>Y</b> yttrium 39	139 <b>La*</b> lanthanum 57	[227] <b>Ac*</b> actinium 89	139 <b>La*</b> lanthanum 57	201 <b>Hg</b> mercury 80		

1 <b>H</b> hydrogen 1
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**Key**  
 relative atomic mass  
 atomic symbol  
 name  
 atomic (proton) number

\* *The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.*

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.