OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY

Foundation Chemistry

2811

Wednesday **11 JANUARY 2006** Morning 1 hour

Candidates answer on the question paper.
Additional materials:
Data Sheet for Chemistry
Scientific calculator

Candidate Name

Centre Number

Candidate Number

TIME 1 hour

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in blue or black ink, in the spaces provided on the question paper.
- Pencil may be used for diagrams and graphs **only**.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do not write in the bar code. Do not write in the grey area between the pages.
- **DO NOT** WRITE IN THE AREA **OUTSIDE** THE BOX BORDERING EACH PAGE. ANY WRITING IN THIS AREA WILL NOT BE MARKED.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry*.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	20	
2	14	
3	12	
4	14	
TOTAL	60	

This question paper consists of 11 printed pages and 1 blank page.

SP (SLM/KS) S87699/5

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[Turn over

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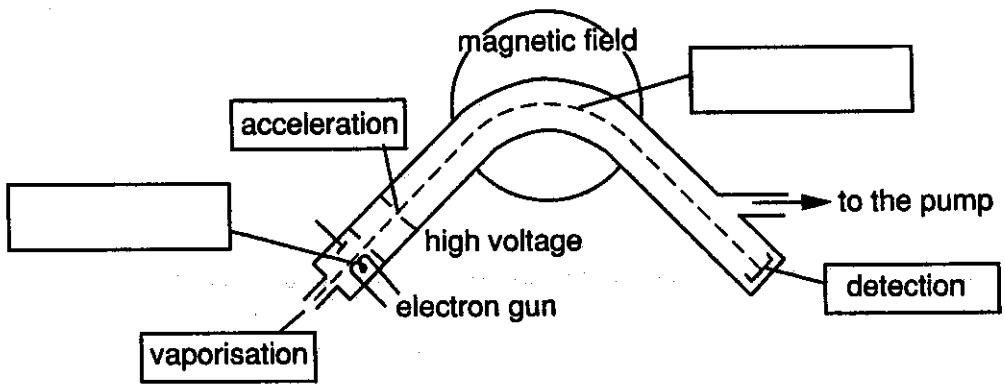
Answer **all** the questions.

1 Magnesium exists naturally as a mixture of its isotopes, ^{24}Mg, ^{25}Mg and ^{26}Mg.

(a) The isotopes in magnesium can be separated by mass spectrometry. The diagram below shows a mass spectrometer.

(i) Complete the diagram by adding the names of the two missing processes in the boxes.



[2]

(ii) Complete the table below to show the composition of the ^{25}Mg and ^{26}Mg isotopes.

	protons	neutrons	electrons
^{25}Mg			
^{26}Mg			

[2]

(iii) Complete the electronic configuration of an atom of ^{24}Mg.

$1s^2$ .....[1]

(iv) Results from the mass spectrum of a sample of magnesium are shown below.

isotope	^{24}Mg	^{25}Mg	^{26}Mg
relative isotopic mass	24.00	25.00	26.00
% abundance	78.60	10.11	11.29

Calculate the relative atomic mass of the sample of magnesium.
Give your answer to two decimal places.

answer .....[2]

[Turn over

(b) Magnesium has a giant metallic structure held together by metallic bonding.

(i) Draw a **labelled** diagram to show metallic bonding.

[2]

(ii) Use your diagram to explain how magnesium conducts electricity.

.....

.....

.....[1]

(c) Magnesium reacts with oxygen to form magnesium oxide.

$$2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$$

(i) Use oxidation numbers to show that oxygen has been reduced in its reaction with magnesium.

.....

.....

.....[2]

(ii) Draw a '*dot-and-cross*' diagram to show the arrangement of electrons in magnesium oxide. Show outer electron shells only and include any charges.

[2]

(d) Old samples of magnesium oxide become contaminated with magnesium carbonate.

(i) Suggest how this contamination takes place.

.....

.....[1]

(ii) A student added an excess of hydrochloric acid to an old sample of magnesium oxide that is contaminated with magnesium carbonate.

State **two** observations that the student would make.

.....

.....[2]

(iii) Explain, with the aid of equations, why the resulting solution contained only one dissolved compound of magnesium.

.....

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.....[3]

[Total: 20]

2 This question is about the simple molecular compounds water, ammonia and sulphur dioxide.

(a) Pairs of electrons in molecules may be present as *bonding pairs* or as *lone pairs*.

(i) Complete the table below for water, ammonia and sulphur dioxide.

molecule	H_2O	NH_3	SO_2
number of bonding pairs of electrons			4 (2 double bonds)
number of lone pairs of electrons around central atom			1

[2]

(ii) Use your answers to **(a)(i)** to help you draw the shape of a molecule of NH_3 and of SO_2. Clearly show values of the bond angles in your diagrams.

molecule	NH_3	SO_2
shape of molecule with bond angles		

[4]

(b) The O—H bonds in water and the N—H bonds in ammonia have dipoles.

(i) Why do these bonds have dipoles?

.....

.....

.....[1]

(ii) Molecules of NH_3 are able to form hydrogen bonds. Draw a diagram to show the hydrogen bonding in ammonia. Include any relevant lone pairs and dipoles.

[2]

(c) Describe and explain the density of ice compared with water.

.....

.....

.....

.....

.....[2]

(d) Water, ammonia and sulphur dioxide react together to form a compound **A** which has the following percentage composition by mass:

N, 24.12%;

H, 6.94%;

S, 27.61%;

O, 41.33%.

(i) Calculate the empirical formula of compound **A**.

[2]

(ii) Suggest a balanced equation for the formation of compound **A** from the reaction of water, ammonia and sulphur dioxide.

.....[1]

[Total: 14]

3 A student carried out three experiments using chlorine gas, $Cl_2(g)$.

(a) In a first experiment, the student bubbled chlorine through an aqueous solution of potassium bromide, KBr(aq). A reaction took place.

(i) What colour is the solution after the reaction has taken place?

.....[1]

(ii) Write an equation for this reaction.

.....[2]

(iii) This reaction takes place because chlorine has a stronger oxidising power than bromine. Explain why chlorine has a stronger oxidising power than bromine.

.....

.....

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.....

.....[3]

(b) In a second experiment, the student bubbled chlorine through 120 cm^3 of an aqueous solution of 0.275 mol dm^{-3} sodium hydroxide, NaOH(aq).

The equation for this reaction is shown below.

$$Cl_2(g) + 2NaOH(aq) \longrightarrow NaCl(aq) + NaClO(aq) + H_2O(l)$$

Under the reaction conditions, 1 mole of $Cl_2(g)$ occupies 24.0 dm^3.

(i) What is meant by the term *the mole*?

.....

.....

.....[1]

(ii) How many moles of NaOH were in the 120 cm^3 volume of NaOH(aq)?

answer ..... mol [1]

(iii) Calculate the volume of $Cl_2(g)$ that was needed to react with the NaOH(aq) used.

answer .....[2]

(iv) What is a common use for the solution that the student prepared?

.....[1]

(c) In a third experiment, the student repeated the procedure in **(b)** but with hot concentrated sodium hydroxide. A different reaction took place in which sodium chlorate(V) was formed instead of NaClO.

Suggest the formula of sodium chlorate(V).

.....[1]

[Total: 12]

4 In this question, you are provided with information about ionisation energies of elements. You are also provided with some additional information that will help you answer part **(b)**.

(a) Define the term *first ionisation energy*.

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.....[3]

(b) In this question, one mark is available for the quality of use and organisation of scientific terms.

Table 4.1 provides data on elements in **Period 2** of the Periodic Table.

Table 4.2 shows the first 6 successive ionisation energies of an element **X**, which is in **Period 3** of the Periodic Table.

- Using Table 4.1, describe and explain the trend in first ionisation energies shown by the Period 2 elements, Li–N.
- Using Table 4.2, identify element **X**. Explain how you decided on your answer.

[10]

element	Li	Be	B	C	N
number of protons	3	4	5	6	7
electron configuration	$1s^2\,2s^1$	$1s^2\,2s^2$	$1s^2\,2s^2\,2p^1$	$1s^2\,2s^2\,2p^2$	$1s^2\,2s^2\,2p^3$
1st ionisation energy / kJ mol^{-1}	520	900	801	1086	1402

Table 4.1

element	ionisation energy / kJ mol^{-1}					
	1st	2nd	3rd	4th	5th	6th
X	578	1817	2745	11 578	14 831	18 378

Table 4.2

Quality of Written Communication [1]

[Total: 14]

END OF QUESTION PAPER