OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

CHEMISTRY 2811

Foundation Chemistry

Tuesday **11 JANUARY 2005** 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 the spaces provided on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

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	17	
2	14	
3	17	
4	12	
TOTAL	60	

This question paper consists of 10 printed pages and 2 blank pages.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 Carbon is in the p-block of the Periodic Table. Naturally occurring carbon contains a mixture of two isotopes, ^{12}C and ^{13}C.

(a) Complete the table below for the atomic structure of the isotopes ^{12}C and ^{13}C.

isotope	protons	neutrons	electrons
^{12}C			
^{13}C			

[2]

(b) A sample of carbon was found to contain 95% of ^{12}C and 5% of ^{13}C.

(i) How could this information be obtained experimentally?

.....[1]

(ii) The ^{13}C isotope has a relative isotopic mass of 13.00.
Define the term *relative isotopic mass*.

.....

.....

.....[2]

(iii) Calculate the relative atomic mass of this sample of carbon to three significant figures.

A_r = ... [2]

(c) Complete the electronic configuration of carbon.

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

(d) The burning of fossil fuels containing carbon produces carbon dioxide.
Draw a '*dot-and-cross*' diagram of carbon dioxide, showing outer shell electrons only.

[2]

(e) Lime water is used as the common laboratory test for carbon dioxide.

(i) State the name or formula of the chemical that is dissolved in water to make lime water.

.....[1]

(ii) Write the chemical equation that takes place in this test for carbon dioxide. Include state symbols.

.....[2]

(f) Carbon dioxide can be prepared easily in the laboratory by the action of heat on most carbonates.
Construct an equation to illustrate this reaction.

.....[1]

(g) In 2000, the mass of CO_2 emitted in the UK was equivalent to 1 kg per person in every hour.

(i) Calculate the volume of 1 kg of carbon dioxide. Assume that 1 mole of CO_2 occupies 24 dm^3.

volume = ... dm^3 [2]

(ii) The UK has set a target to cut CO_2 emissions by 60% of the 2000 value by 2050. Calculate the reduction needed in the volume of CO_2 emissions each hour per person if the target is to be met.

answer: ..... dm^3
[1]

[Total: 17]

2 A student prepared an aqueous solution of calcium chloride by reacting calcium with hydrochloric acid. Calcium chloride contains Ca^{2+} and Cl^- ions.

(a) Complete and balance the following equation for this reaction.

.....Ca(s) + ...HCl(aq) $\longrightarrow$ .....$CaCl_2$(aq) + ...

[2]

(b) This is a redox reaction.
Use oxidation states to show that calcium has been oxidised.

.....

.....

.....[2]

(c) Draw a '*dot-and-cross*' diagram for $CaCl_2$.

[2]

(d) Aqueous silver nitrate was added to the solution of $CaCl_2$.

(i) State what you would expect to **see**.

.....

.....[1]

(ii) Write an ionic equation for this reaction.

.....[1]

(e) To prepare the aqueous calcium chloride, the student added the exact amount of calcium so that all the hydrochloric acid had reacted. She used 50 cm^3 of 2.0 mol dm^{-3} HC*l*.

(i) How many moles of HC*l* had she used?

[1]

(ii) Calculate the mass of calcium that she used.

[2]

(iii) The student added some more calcium and she was surprised that a reaction still took place.

- Explain this observation.
- Write a balanced equation for this reaction.

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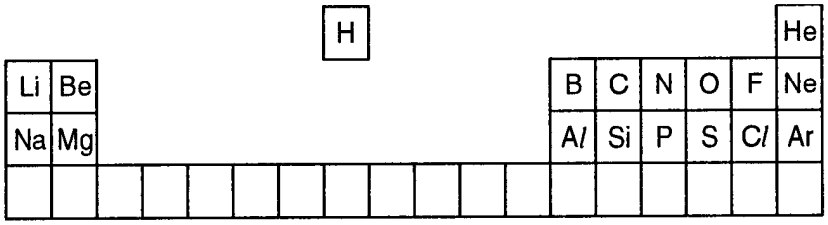
.....[3]

[Total: 14]

3 This question refers to the elements in the first three periods of the Periodic Table:



(a) Identify an element from the first three periods that fits each of the following descriptions.

(i) The element that forms a 2– ion with the same electronic configuration as Ne.

..... [1]

(ii) The element that forms a 3+ ion with the same electronic configuration as Ne.

..... [1]

(iii) The element that has the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^3$.

..... [1]

(iv) An element that forms a compound with hydrogen with tetrahedral molecules.

..... [1]

(v) An element that forms a compound with hydrogen with pyramidal molecules.

..... [1]

(vi) The element that forms a chloride XCl_2 with a molar mass of 95.3 g mol^{-1}.

..... [1]

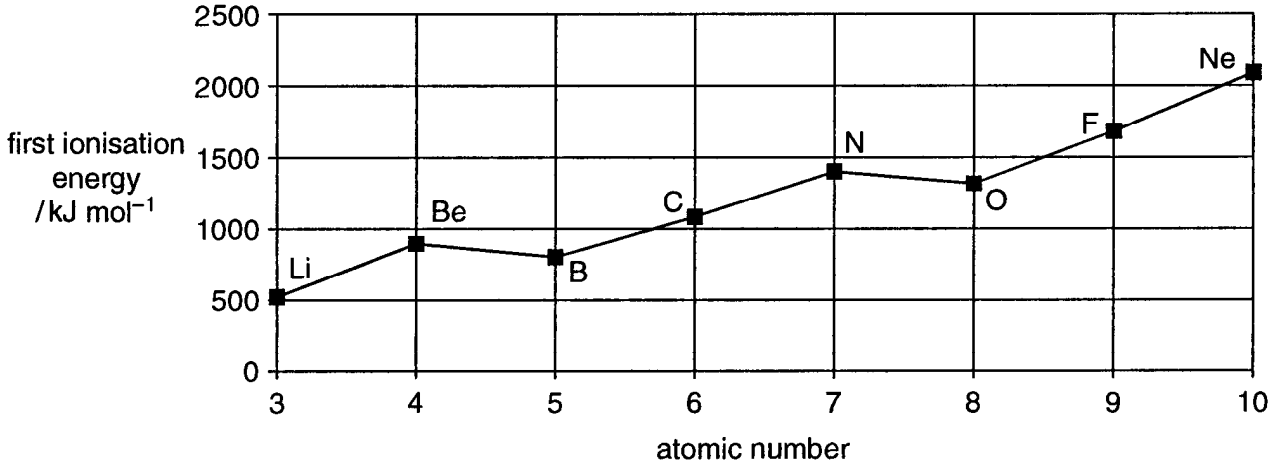
(vii) The element with the largest atomic radius.

..... [1]

(viii) The element in Period 3 with the highest boiling point.

..... [1]

(b) The diagram below shows the variation in the first ionisation energies of elements across Period 2 of the Periodic Table.



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

.....

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.....[3]

(ii) Explain why the first ionisation energies show a **general** increase across Period 2.

.....

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.....[2]

(iii) Explain why the first ionisation energy of B is **less** than that of Be.

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.....[2]

(iv) Estimate a value for the first ionisation energy of the element with atomic number 11. Explain how you made your choice.

First ionisation energy = ... kJ mol^{-1}

.....

.....

.....[2]

[Total: 17]

4 In this question, one mark is available for the quality of spelling, punctuation and grammar.

The halogens chlorine, bromine and iodine each exist as diatomic molecules at room temperature and pressure.

(a) The halogens all have van der Waals' forces.

- Explain how van der Waals' forces are formed.
- Explain the trend in volatilities of the halogens chlorine, bromine and iodine.

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For Examiner's Use

(b) Describe and explain the relative reactivity of the halogens chlorine, bromine and iodine in displacement reactions involving halides, using reactions on a test tube scale.

Include equations and observations in your answer.

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.....[5]

Quality of Written Communication [1]

[Total: 12]

END OF QUESTION PAPER

RECOGNISING ACHIEVEMENT

Subject: Foundation Chemistry Code: 2811

Session: January Year: 2005

FINAL

MAXIMUM MARK	60

Mark Scheme

ADVICE TO EXAMINERS ON THE ANNOTATION OF SCRIPTS

1. Please ensure that you use the **final** version of the Mark Scheme.
   You are advised to destroy all draft versions.

2. Please mark all post-standardisation scripts in red ink. A tick (✓) should be used for each answer judged worthy of a mark. Ticks should be placed as close as possible to the point in the answer where the mark has been awarded. The number of ticks should be the same as the number of marks awarded. If two (or more) responses are required for one mark, use only one tick. Half marks (½) should never be used.

3. The following annotations may be used when marking. No comments should be written on scripts unless they relate directly to the mark scheme. Remember that scripts may be returned to Centres.

   x = incorrect response (errors may also be underlined)
   ^ = omission mark
   bod = benefit of the doubt (where professional judgement has been used)
   ecf = error carried forward (in consequential marking)
   con = contradiction (in cases where candidates contradict themselves in the same response)
   sf = error in the number of significant figures

4. The marks awarded for each part question should be indicated in the margin provided on the right hand side of the page. The mark total for each question should be ringed at the end of the question, on the right hand side. These totals should be added up to give the final total on the front of the paper.

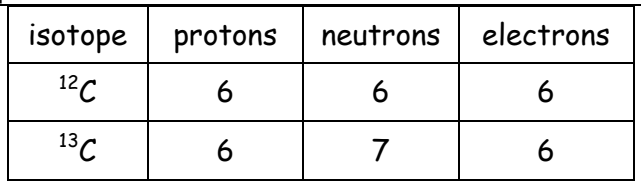
5. In cases where candidates are required to give a specific number of answers, (e.g. 'give three reasons'), mark the first answer(s) given up to the total number required. Strike through the remainder. In specific cases where this rule cannot be applied, the exact procedure to be used is given in the mark scheme.

6. Correct answers to calculations should gain full credit even if no working is shown, unless otherwise indicated in the mark scheme. (An instruction on the paper to 'Show your working' is to help candidates, who may then gain partial credit even if their final answer is not correct.)

7. Strike through all blank spaces and/or pages in order to give a clear indication that the whole of the script has been considered.

8. An element of professional judgement is required in the marking of any written paper, and candidates may not use the exact words that appear in the mark scheme. If the science is correct and answers the question, then the mark(s) should normally be credited. If you are in doubt about the validity of any answer, contact your Team Leader/Principal Examiner for guidance.

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ___ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument

Question	Expected Answers	Marks
1 (a)		**[2]**
(b) (i)	mass spectrometry ✓	**[1]**
(ii)	mass of an isotope compared with carbon-12 ✓ 1/12th of mass of carbon-12/on a scale where carbon-12 is 12 ✓ *mass of 1 mole of the isotope/mass of 1 mole of carbon-12 is equivalent to the first mark* *"mass of the isotope that contains the same number of atoms as are in 1 mole of carbon-12" ⟶ 1 mark (mark lost because of mass units)*	**[2]**
(iii)	12 x 95/100 + 13 x 5/100 OR 12.05 ✓ = 12.1 (mark for significant figures) ✓ (12.1 scores both marks)	**[2]**
(c)	$1s^2 2s^2 2p^2$ ✓	**[1]**
(d)	CO_2: correct covalent bonds around carbon ✓ outer shell electrons correct ✓ (must be 'dot AND cross' or electron source clearly shown (different coloured for source?)	**[2]**
(e) (i)	calcium hydroxide/$Ca(OH)_2$ ✓	**[1]**
	$Ca(OH)_2(aq) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$ ✓✓ 1st mark for $CaCO_3(s)$ State symbol essential here 2nd mark for rest of equation. Ignore state symbols	**[2]**
(f)	$CaCO_3 \longrightarrow CaO + CO_2$ ✓ state symbols not required	**[1]**
(g) (i)	moles CO_2 = 1000 /44 mol = 22.7 mol ✓ volume CO_2 in 2000 = 22.7 x 24 = 545 dm^3 ✓	**[3]**
(ii)	reduction = 545 x 60/100 = 327 dm^3 ✓	
		Total: 17

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Question	**Expected Answers**	**Marks**
2 (a)	……Ca(s) + …..2 ✓HCl(aq) …….$CaCl_2$(aq) + .H_2(g). ✓ (g) not required for H_2	**[2]**
(b)	In Ca, oxidation state = 0 ✓ and In $CaCl_2$, oxidation state = +2 ✓ Oxidation number increases from Ca to $CaCl_2$	**[2]**
(c)	correct dot and crosses ✓ correct charges ✓	**[2]**
(d) (i)	white precipitate/goes white ✓	**[1]**
(ii)	$Ag^+ + Cl^- \longrightarrow AgCl$ ✓ *state symbols not required*	**[1]**
(e) (i)	moles HCl = 2.0 x 50/1000 = 0.10 ✓	**[1]**
(ii)	moles Ca = $\frac{1}{2}$ x moles HCl = 0.050 ✓ mass Ca = 40.1 x 0.050 = 2.00 g / 2.005 g ✓ (accept 40 x 0.050 = 2.0 g) (mass Ca of 4.0 g would score 1 mark as 'ecf' as molar ratio has not been identified)	**[2]**
(iii)	Ca has reacted with water ✓ $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$ ✓✓ *state symbols not required* 1st mark for H_2 2nd mark is for the rest of the balanced equation	**[3]**
		Total: 14

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Question	**Expected Answers**	**Marks**
3 (a) (i)	O ✓	**[1]**
(ii)	Al ✓	**[1]**
(iii)	P ✓	**[1]**
(iv)	C/Si ✓	**[1]**
(v)	N/P ✓	**[1]**
(vi)	Mg ✓	**[1]**
(vii)	Na ✓	**[1]**
(viii)	Si ✓	**[1]**
(b) (i)	Energy change when each atom in 1 mole ✓ of gaseous atoms ✓ loses an electron ✓ (to form 1 mole of gaseous 1+ ions).	**[3]**
(ii)	increasing nuclear charge/number of protons ✓ electrons experience greater attraction or *pull* / atomic radius decreases / electrons added to same shell /same or similar shielding ✓	**[2]**
(iii)	In B, electron being removed is at a higher energy / In Be, electron being removed is at a lower energy ✓ An s electron is lost in Be AND a p electron is lost in B ✓	**[2]**
(iv)	IE (of Na): 100 - 500 kJ mol^{-1} ✓ electron is in a different shell /further from nucleus/new shell/ more shielding ✓ (***not*** *sub-shell or orbital*) /	**[2]**
		Total: 17

Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit ___ = (underlining) key words which **must** be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument	
Question	**Expected Answers**	**Marks**
4 (a)	uneven distribution of electrons ✓ instantaneous /oscillating/changing/temporary/transient/ dipole on one atom ✓ causes an induced/resultant dipole on another molecule/atom ✓ chlorine gas; bromine liquid; iodine solid/ volatility decreases from $Cl_2 \longrightarrow Br_2 \longrightarrow I_2$/ boiling point increases from $Cl_2 \longrightarrow Br_2 \longrightarrow I_2$/ stronger forces are broken from $Cl_2 \longrightarrow Br_2 \longrightarrow I_2$ ✓ number of electrons increases down group ✓ greater/more van der Waals' forces / induced dipole-dipole interactions / forces between the molecules ✓	**[6]**
(b)	Reactivity decreases down group/ $Cl_2 > Br_2 > I_2$ / Cl_2 displaces Br_2 AND Br_2 displaces I_2 ✓ chlorine: Cl_2 + bromide $\longrightarrow$ yellow ……/ orange ……. ✓ bromine: Br_2 + iodide $\longrightarrow$ darker orange/brown ✓ or purple in organic solvent $Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$ ✓ $Br_2 + 2I^- \rightarrow I_2 + 2Br^-$ ✓ (*or full equations*) Cl_2 is stronger oxidising agent than Br_2 AND Br_2 is stronger oxidising agent than I_2 / Cl_2 has greater ability to 'attract in' or gain an electron than Br_2 AND Br_2 has greater ability to 'attract in' or gain an electron than I_2 ✓	**[5 max]**
QoWC:	**At least two sentences** that show legible text with accurate spelling, punctuation and grammar so that the meaning is clear. ✓ (Mark this from anywhere within Q4)	**[1]**
		Total: 12