OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY 2811

Foundation Chemistry

Thursday **10 JUNE 2004** 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	13	
2	14	
3	10	
4	12	
5	11	
TOTAL	60	

This question paper consists of 12 printed pages.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 A fifty pence coin contains nickel alloyed with a metal **A**.

(a) Nickel exists as a mixture of three isotopes, nickel-58, nickel-60 and nickel-62.

Complete the table below to show the atomic structures of the isotopes in metallic nickel.

isotope	protons	neutrons	electrons
nickel-58			
nickel-60			
nickel-62			

[3]

(b) Metal **A** can be identified from its relative atomic mass.

Analysis of a fifty pence coin showed that two isotopes of metal **A** were present with the following percentage abundances.

isotope	isotope 1	isotope 2
relative isotopic mass	63.0	65.0
% abundance	77.2	22.8

(i) What analytical method is used to obtain this information?

.....[1]

(ii) Define the term *relative atomic mass.*

.....

.....

.....

.....[3]

(iii) Calculate the relative atomic mass of the sample of metal **A**.

Give your answer to three significant figures.

answer .....[2]

(iv) Use your answer to **(b)(iii)** and the *Data Sheet* to suggest the identify of metal **A**.

.....[1]

(c) Nickel makes up 25% of the total mass of a fifty pence coin. A fifty pence coin has a mass of 8.0 g.

(i) Calculate how many **moles** of nickel atoms are in a fifty pence coin.

answer ..... mol [2]

(ii) Calculate the **number** of atoms of nickel in a fifty pence coin.

$L = 6.02 \times 10^{23} \text{mol}^{-1}$

answer ..... atoms [1]

[Total: 13]

2 Magnesium, fluorine and magnesium fluoride have different types of bonding and different properties.

(a) Magnesium has metallic bonding.

(i) Draw a diagram to show what is meant by *metallic* bonding.

Label the diagram.

[2]

(ii) Why is magnesium a good conductor of electricity?

.....

.....[1]

(b) Fluorine, F_2, has covalent bonding.

(i) State what is meant by a *covalent* bond.

.....

.....[2]

(ii) Draw a '*dot-and-cross*' diagram to show the covalent bonding in fluorine. Show outer electron shells only.

[1]

(c) Magnesium fluoride, MgF_2, has ionic bonding.

(i) How does *ionic bonding* hold particles in MgF_2 together?

.....

.....[2]

(ii) Draw a '*dot-and-cross*' diagram for magnesium fluoride, MgF_2. Show outer electron shells only.

[2]

(iii) Magnesium fluoride is produced when magnesium reacts with fluorine.

Complete the half-equations below to show the formation of the ions in magnesium fluoride in this reaction.

Mg $\longrightarrow$ ..... + ...

F_2 + ... $\longrightarrow$ ..... [2]

(iv) A student found that magnesium fluoride has different electrical conductivities when solid and when dissolved in water.

Explain these **two** observations.

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.....[2]

[Total: 14]

[Turn over

3 A household bleach contains sodium chlorate(I), NaC*l*O, as its active ingredient.

The concentration of NaC*l*O in the bleach can be found by using its reaction with hydrogen peroxide, H_2O_2.

$$NaClO(aq) + H_2O_2(aq) \longrightarrow O_2(g) + NaCl(aq) + H_2O(l)$$

(a) Chlorine has been reduced in this reaction.

Use oxidation numbers to prove this.

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.....[2]

(b) A student added an excess of aqueous hydrogen peroxide to 5.0 cm^3 of the bleach. 84 cm^3 of oxygen gas were released.

(i) How many moles of O_2 were released?

Assume that, under the laboratory conditions, 1.00 mol of gas molecules occupies 24 dm^3.

answer ..... mol [1]

(ii) How many moles of NaC*l*O were in 5.0 cm^3 of the bleach?

answer ..... mol [1]

(iii) What was the concentration, in mol dm^{-3}, of NaC*l*O in the bleach?

answer ..... mol dm^{-3} [1]

(c) The label on the bottle of household bleach states that the bleach contains a minimum of 4.5 g per 100 cm^3 of NaC*l*O.

Use your answer to **(b)(iii)** to decide whether or not the information on the label is correct.

[3]

(d) It is extremely important that household bleach is not used with acids. This is because a reaction takes place that releases toxic chlorine gas.

Suggest an equation for the reaction of an excess of hydrochloric acid with household bleach.

.....[2]

[Total: 10]

4 This question is about elements and compounds of Group 2 of the Periodic Table.

(a) When calcium is added to water, a vigorous reaction takes place, releasing hydrogen gas.

$$Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$$

(i) Suggest a value for the pH of the solution formed in this reaction.

.....[1]

(ii) Complete the electronic configuration of calcium in

$Ca(s)$ $1s^2 2s^2 2p^6$ .....

$Ca(OH)_2(aq)$ $1s^2 2s^2 2p^6$ ..... [2]

(b) Carbon dioxide is bubbled through aqueous calcium hydroxide.

(i) A milky white precipitate **A** forms.

Identify precipitate **A** and write down an equation for its formation.

identity of precipitate **A** .....

equation .....[2]

(ii) As more carbon dioxide is bubbled through the solution, precipitate **A** disappears and a colourless solution **B** forms.

Identify solution **B** and write down an equation for its formation.

identity of solution **B** .....

equation .....[2]

(iii) Dilute hydrochloric acid is added to solution **B**. A gas is given off and a colourless solution **C** forms.

Suggest the identity of solution **C**.

.....[1]

(c) When barium metal is added to water, the reaction taking place is much more vigorous than with calcium.

Explain why barium is more reactive than calcium.

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.....[4]

[Total: 12]

For Examiner's Use

5 In this question, one mark is available for the quality of written communication.

(a) Describe the intermolecular bonding in CH_4 and in H_2O.

Use clear diagrams in your answer. [6]

(b) State and explain **two anomalous** properties of H_2O that depend on its intermolecular forces. [4]

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Quality of Written Communication [1]

[Total: 11]

RECOGNISING ACHIEVEMENT

Subject: Foundation Chemistry Code: 2811

Session: June Year: 2004

Final Mark Scheme

MAXIMUM MARK	60

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)	isotope / protons / neutrons / electrons nickel-58 / 28 / 30 / 28 nickel-60 / 28 / 32 / 28 nickel-62 / 28 / 34 / 28 ✓ ✓ ✓ For ecf, 3rd column same as first column.			**[3]**
(b) (i)	mass spectrometry ✓ mass spec… /mass spectrometer should also be credited			**[1]**
(ii)	average mass/weighted mean mass **of an atom** ✓ compared with carbon-12 ✓ 1/12th of mass of carbon-12/on a scale where carbon-12 is 12 ✓ *mass of 1 mole **of atoms** (of an element) mass of 1 mole of carbon-12 is equivalent to first two marks* *"mass of the element that contains the same number of atoms as are in 1 mole of carbon-12" ⟶ 2 marks (mark lost because of mass units)*			**[3]**
(iii)	63.0 x 77.2/100 + 65.0 x 22.8/100 / 63.456 ✓ = 63.5 (mark for significant figures) ✓			**[2]**
(iv)	copper/ Cu ✓			**[1]**
(c) (i)	mass of Ni = 2.0 g ✓ moles of Ni = 2.0/58.7 mol = 0.0341/0.034 mol ✓ (1 mark would typically result from no use of 25% → 0.136 mol) 2nd mark is for the mass of Ni divided by 58.7			**[2]**
(ii)	number of atoms of Ni = $6.02 \times 10^{23} \times 0.0341$ = 2.05×10^{22} / 2.1×10^{22} atoms ✓ Can be rounded down to 2.1 or 2.0 or 2 (if 2.0) From 8 g, ans = $8.18/8.2 \times 10^{22}$ (and other consequential responses)			**[1]**
				Total: 13

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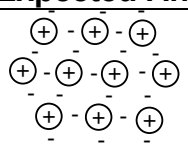
Question	**Expected Answers**	**Marks**
2 (a) (i)	 positive ions/cations ✓ and negative electrons ✓ Can be described in words only for both marks	**[2]**
(ii)	contain free/mobile/delocalised electrons ✓	**[1]**
(b) (i)	shared **pair of** ✓electrons ✓ *i.e. 'shared electrons' is worth 1 mark. pair of electrons for second marks*	**[2]**
(ii)	correct dot-and cross diagram ✓	**[1]**
(c) (i)	electrostatic attraction ✓ between oppositely charged ions ✓ (charged or electrostatic for 1st mark)	**[2]**
(ii)	correct dot-and cross diagram ✓ correct charges ✓	**[2]**
(iii)	$Mg \longrightarrow Mg^{2+} + 2e^-$ ✓ $F_2 + 2e^- \longrightarrow 2F^-$ ✓ *– sign not required with electron*	**[2]**
(iv)	solid: ions cannot move /in fixed positions in lattice ✓ solution: ions are free to move ✓	**[2]**
		Total: 14

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Question	**Expected Answers**	**Marks**
3 (a)	NaClO, oxidation state = +1 ✓ NaCl, oxidation state = –1 ✓ OR Oxidation number decreases from NaClO ⟶ NaCl ✓ by 2 ✓	**[2]**
(b) (i)	84/24000 = 3. 5 x 10^{-3} mol ✓	**[1]**
(ii)	3.5 x 10^{-3} mol ✓ *ans to (i)*	**[1]**
(iii)	3.5 x 10^{-3} x 1000/5 = 0.70 mol dm^{-3} ✓ *ans to (ii) x 1000/5*	**[1]**
(c)	molar mass of NaClO = 23 + 16 + 35.5 = 74.5 (g mol^{-1}) ✓ concentration = 0.70 x 74.5 = 52.15 g (dm^{-3}) ✓ *ans to (iii) x 74.5* bleach is 5.215 g per 100 cm^3 and the information is correct (as this value exceeds 4.5%) ✓ *response depends upon answer to (b)(iii). Could be opposite argument if ans < 4.5%* *OR* molar mass of NaClO = 23 + 16 + 35.5 = 74.5 (g mol^{-1}) ✓ moles of NaOCl = 4.5/74.5 = 0.0604 mol (in 100 cm^3) ✓ bleach is 10 x 0.0604 = 0.604 mol dm^{-3} which is less than answer to (b)(iii) and therefore label is correct. ✓ *response depends upon answer to (b)(iii). Could be opposite argument if ans 0.604*	**[3]**
(d)	$2HCl + NaClO \longrightarrow Cl_2 + NaCl + H_2O$ ✓✓ *Award one mark for:* $HCl + NaClO \longrightarrow Cl_2 + NaOH$	**[2]**
		Total: 10

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Question	**Expected Answers**	**Marks**
4 (a) (i)	Answer is inclusive of 9 – 14 inclusive ✓	**[1]**
(ii)	Ca(s): $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$ ✓ $Ca(OH)_2(aq)$: $1s^2 2s^2 2p^6 3s^2 3p^6$ ✓	**[2]**
(b) (i)	Identity of precipitate A: calcium carbonate / $CaCO_3$ ✓ Equation: $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$ ✓ *equation alone would score 2 marks unless contradicted by identity*	**[2]**
(ii)	Formula of solution B: $Ca(HCO_3)_2$ ✓ Equation: $CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$ ✓ *equation alone would score 2 marks unless contradicted by identity*	**[2]**
(iii)	$CaCl_2$ ✓	**[1]**
(c)	barium atoms are larger ✓ barium atoms have more shielding ✓ this outweighs the increase in nuclear charge ✓ barium electrons are lost more easily /less energy required /ionisation energy decreases ✓	**[4]**
		Total: 12

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**
5 (a)	H_2O H bonding from O of 1 molecule to H of another ✓ dipoles shown or described ✓ with lone pair of O involved in the bond ✓ CH_4 van der Waals' forces from oscillating dipoles/ temporary dipoles/ transient dipoles/ instantaneous dipoles ✓ leading to induced dipoles ✓ caused by uneven distribution of electrons ✓	**[3]** **[3]** **sub-total: 6**
(b)	Two properties from: Ice is less dense/lighter than water/floats on water/ max density at 4°C ✓ *explanation:* H bonds hold H_2O molecules apart / open lattice in ice / H-bonds are longer ✓ Higher melting/boiling point than expected ✓ *Not just high* *Accept: 'unusually high/strangely high/relatively high'* *explanation*: H bonds need to be broken ✓ *must imply that intermolecular bonds are broken* High surface tension ✓ *explanation* strength of H bonds across surface ✓	**[2]** **[2]** **[2]** **mark 2 properties only ⟶ 4 max**
	QoWC over whole question – legible text with accurate spelling, punctuation and grammar ✓	**[1]**
		Total: 11