OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY 2811

Foundation Chemistry

Wednesday **4 JUNE 2003** 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	11	
2	11	
3	15	
4	12	
5	11	
TOTAL	60	

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

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 This question is about two elements, **A** and **B**, in the Periodic Table.

(a) Each atom of element **A** has 15 electrons.

(i) Identify element **A**.

..... [1]

(ii) Complete the electronic configuration of an atom of **A**.

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

(iii) Predict the charge on an ion of **A** and complete its electronic configuration.

charge on ion .....

electronic configuration of ion of **A** $1s^2$ ..... [2]

(b) Element **B** exists as a mixture of three isotopes.

(i) What is the difference between the atomic structures of isotopes?

..... [1]

(ii) The atoms of element **B** have eight electrons in the 3d sub-shell.

Identify element **B**.

..... [1]

(c) A sample of element **B** was analysed in a mass spectrometer. The relative atomic mass of element **B** can be calculated from the results shown in Table 1.1 below.

Table 1.1

	isotope 1	isotope 2	isotope 3
relative isotopic mass	58.0	60.0	62.0
percentage composition / %	68.2	27.3	4.5

(i) Explain what is meant by the *relative atomic mass of element **B***.

.....

.....

.....

..... [3]

(ii) Using the information in Table 1.1, calculate the relative atomic mass of this sample of **B**. Give your answer to three significant figures.

[2]

[Total: 11]

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

(a) Draw a '*dot-and-cross*' diagram of a bromine molecule, showing outer electrons only.

[1]

(b) The boiling points of the halogens chlorine to iodine are shown below.

halogen	boiling point/°C
chlorine	–35
bromine	59
iodine	184

Explain why the halogens show this trend in boiling points.

.....

.....

.....

..... [3]

(c) When chlorine, Cl_2, is added to aqueous sodium bromide, NaBr, a reaction takes place.

(i) State what you would see in this reaction.

..... [1]

(ii) Write an equation for this reaction.

..... [1]

(iii) What happens to electrons during this reaction?

.....

.....

..... [2]

(iv) Why does no reaction take place when bromine is added to aqueous sodium chloride?

.....

..... [1]

(v) Describe a simple test to confirm the presence of iodide ions in aqueous sodium iodide.

.....

.....

..... [2]

[Total: 11]

3 Calcium oxide, CaO, is used for making cement which is widely used in the construction industry. Calcium oxide can be prepared as 'quicklime' by heating limestone in a lime kiln to about 550 °C. The calcium carbonate in the limestone decomposes into calcium oxide and carbon dioxide.

$$CaCO_3 \longrightarrow CaO + CO_2$$

(a) Draw a '*dot-and-cross*' diagram of calcium oxide, showing outer electrons only.

[2]

(b) In $CaCO_3$, what is the oxidation state of

(i) Ca,

..... [1]

(ii) C?

..... [1]

(c) Calculate the mass of CaO that could be made from limestone containing 20 tonnes of $CaCO_3$.

molar masses: $CaCO_3$, 100 g mol^{-1}; CaO, 56 g mol^{-1}.

1 tonne = 10^6 g.

[2]

(d) When water is added to quicklime, a vigorous reaction takes place forming slaked lime, $Ca(OH)_2$.

Write an equation for the formation of slaked lime in this reaction.

..... [1]

(e) Farmers often add 'lime' to acid soils. The lime is mostly present as slaked lime.

A chemist neutralised 25.0 cm^3 0.200 mol dm^{-3} HCl with slaked lime.

$$Ca(OH)_2(s) + 2HCl(aq) \longrightarrow CaCl_2(aq) + 2H_2O(l)$$

(i) What is the molar mass of $Ca(OH)_2$?

[1]

(ii) How many moles of HCl were neutralised?

[1]

(iii) Calculate the mass of $Ca(OH)_2$ that neutralises this HCl.

[2]

(iv) The chemist neutralised the same amount of HCl with NaOH. Explain why the chemist would need to use more moles of NaOH than $Ca(OH)_2$.

.....

.....

..... [2]

(f) A clear solution of slaked lime in water was made by dissolving $Ca(OH)_2$ in an excess of water. When this solution was left exposed to the air, the solution slowly became milky as a fine white precipitate formed.

Suggest why this happened.

.....

.....

..... [2]

[Total: 15]

4 Chemicals show a range of different structures. The table below shows four types of structure.

structure	example
giant metallic	
giant ionic	
giant molecular	
simple molecular	

(a) Complete the table by giving an example of each type of structure. Write its name or formula in the second column.

[4]

(b) A giant metallic structure has metallic bonding.

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

[2]

(ii) How does a substance with a giant metallic structure conduct electricity?

.....

..... [1]

(c) Explain why a substance with a giant ionic lattice conducts electricity when molten but **not** when solid.

.....

.....

.....

..... [2]

(d) Explain why a substance with a **giant** molecular structure has a higher boiling point than a substance with a **simple** molecular structure.

.....

.....

.....

..... [3]

[Total: 12]

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

Explain how you can predict the shapes of, and bond angles in, simple molecules. In your answer, you should choose examples of **four** different molecular shapes.

[10]

Quality of Written Communication [1]

[Total: 11]

2811 Foundation Chemistry

June 2003

Mark Scheme

The following annotations may be used when marking:

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

Abbreviations, annotations and conventions used in the Mark Scheme:

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

1. (a) (i) P ✓

[1]

(ii) $1s^2 2s^2 2p^6 3s^2 3p^3$ ✓

[1]

(iii) charge on ion: 3– ✓

[1]

electronic configuration of ion of **A**: $1s^2 2s^2 2p^6 3s^2 3p^6$ ✓

[1]

(b) (i) different number of neutrons ✓

[1]

(ii) Ni ✓

[1]

(c) (i) average **atomic** mass/weighted mean/average mass ✓

compared with carbon-12 ✓
1/12th of mass of carbon-12/on a scale where carbon-12 is 12 ✓

OR
The mass of 1 mole of **atoms** of an element ✓
compared with 12 g ✓
of carbon-12 ✓

[3]

(ii) 58.0x68.2/100 + 60.0x27.3/100 + 62.0x4.5/100 / 58.726 ✓

= 58.7 ✓ *(to 3 sig figs: allow full marks for answer.* 58.726 *(calc) gets 1 mark only)*

[2]

[Total: 11 marks]

2. **(a)** correct dot and cross ✓

[1]

(b) number of electrons increases down group ✓

$\longrightarrow$ greater van der Waals' forces/intermolecular forces ✓

more energy/higher temperature needed to break these intermolecular forces ✓

[3]

(c) **(i)** brown/orange/yellow colour ✓

[1]

(ii) $2NaBr + Cl_2 \longrightarrow Br_2 + 2NaCl$ *balanced equation* ✓

or ionic equation: $2Br^- + Cl_2 \longrightarrow Br_2 + 2Cl^-$

[1]

(iii) Cl/Cl_2 gains electron(s) ✓ Br^- loses an electron ✓

[2]

(iv) Cl is more reactive/more powerful oxidising agent than Br ✓

[1]

(v) add $AgNO_3$ / Ag^+ ✓

yellow precipitate ✓

OR

add Cl_2 / Br_2 ✓

purple in hexane / blue-black in starch ✓

[2]

[Total: 11 marks]

3. **(a)** correct dot and cross ✓ correct charges ✓

[2]

(b) **(i)** Ca: (+)2 ✓

[1]

(ii) C: (+)4 ✓

[1]

(c) moles $CaCO_3$ = 20 x 10^6/100 = 200 000 mol ✓

mass CaO = 200 000 x 56 = 11 200 000 g / 1.12 x 10^7 g / 11.2 tonnes ✓

use of 56 x 20/100 OR 56/5 is worth 1 mark
decimal point in wrong place i.e. 1.12 x 10^x is worth 1 mark.
units needed for 2nd mark.

[2]

(d) $CaO + H_2O \longrightarrow Ca(OH)_2$ ✓

[1]

(e) **(i)** molar mass = 40.1 + (16 + 1) x 2 = 74.1 (g mol^{-1}) ✓

[1]

(ii) moles HCl = 0.200 x 25.0/1000 = 0.005 mol ✓

[1]

(iii) moles $Ca(OH)_2$ = 0.5 x 0.005 = 0.0025 mol ✓

mass $Ca(OH)_2$ = 0.0025 x 74.1 = 0.185 g ✓ accept from 0.19 g to 0.18525 g

i.e. 0.0025 x answer to (i)

candidate who does not use 0.5 will get 0.37 g – worth 1 mark

[2]

(iv) 1 mol NaOH reacts with 1 mol HCl

/ $Ca(OH)_2$ Has more OHs / OHs needed to neutralise ✓

Therefore twice the number of moles of NaOH are needed

/ twice number of OHs in $Ca(OH)_2$ ✓

[2]

(f) solution reacted with CO_2 ✓ forming $CaCO_3$ ✓

[2]

[Total: 15 marks]

4. **(a)** 4 valid examples ✓✓✓✓

Can be names or formulae. If a formula is used, it must be correct for the structure: i.e. for simple molecular, H_2, P_4, S_8, etc is feuqired.

[4]

(b) **(i)** positive ions/metal ions/cations ✓

surrounded by free/delocalised/sea of electrons ✓

[2]

(ii) electrons move ✓

[1]

(c) solid lattice, ions are in fixed positions ✓

molten, ions are free to move and conduct ✓

[2]

(d) giant has stronger forces/simple has weaker forces ✓ *(i.e. comparison of forces)*

giant: covalent bonds break ✓
simple: molecules/intermolecular forces break / van der Waals break ✓

[3]

[Total: 12 marks]

5. electron pairs repel ✓

as far apart as possible ✓

lone pair repulsion > bonded pair repulsion / lone pair reduces bond angle ✓

[3]

4 examples, for each: shape ✓✓✓✓

either

a named molecule that matches a correct shape

or

correct number and type of electron pairs to match shape

3 correct bond angles ✓ ✓✓

[7]

[Sub-total: 10]

qowc: technical words of **three** shapes:

i.e. linear

non-linear / V-shaped / angular / bent

trigonal planar / planar triangle

tetrahedral / tetrahedron

pyramid(al) / trigonal pyramid(al)

[Sub-total: 1]

[Total: 11 marks]

Further notes on Question 5

1. Three marks that explain the theory:

electron pairs repel ✓

- This could simply be within 'electron pair repulsion theory' or 'lone pairs repel'

lone pairs repel **more** ✓

repelled as far apart as possible ✓

2. Seven marks for shapes and bond angles

Bond angles

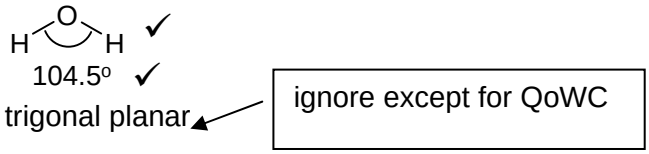
- Credit up to three correct bond angles for chosen examples. i.e. 3 max

Shapes

(a) If a candidate has drawn shapes of molecules,

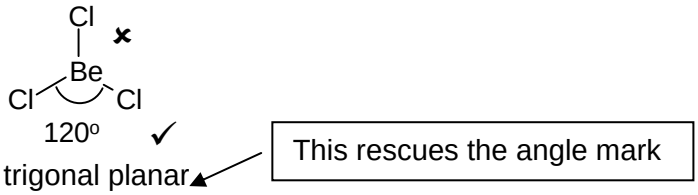
- mark the shapes irrespective of any words that describe them.
- only look at the words (pyramidal, etc) for the QoWC mark (see below)
- do **not** use an incorrect name as a 'con' or we will be looking for both the shape **and** the name for the mark.

e.g.



(b) If a candidate has drawn a 'correct' shape but for a molecule that does **not** exist, then the shape mark cannot be awarded. e.g. $BeCl_3$ shown as a trigonal planar molecule would not score the shape (but could score an angle mark of 120 ° if 'trigonal planar' is used as a fall back). The example below is certainly worth something!

e.g.



(c) If a candidate has not drawn a diagram,

- the shape mark is still possible if the correct technical word is used. If this tactic has been used then you can still award the technical words as part of the QoWC mark (see below).

e.g. CH_4 has a tetrahedral shape ✓ with a bond angle of 109.5 ° ✓

QoWC One mark

Use of any three of the 'shape technical words' with correct shapes.

i.e. testing 'correct usage' of technical words.