

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY

2811

Foundation Chemistry

Friday

17 JANUARY 2003

Morning

1 hour

Candidates answer on the question paper.

Additional materials:

Scientific calculator

Data Sheet for Chemistry

Candidate Name	Centre Number	Candidate Number												
	<table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> </tr> </table>							<table border="1" style="display: inline-table; border-collapse: collapse;"> <tr> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> <td style="width: 15px; height: 15px;"></td> </tr> </table>						

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 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	12	
2	17	
3	14	
4	8	
5	9	
TOTAL	60	

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

Answer all the questions.

1 Gallium, atomic number 31, exists naturally as a mixture of its isotopes, ^{69}Ga and ^{71}Ga .

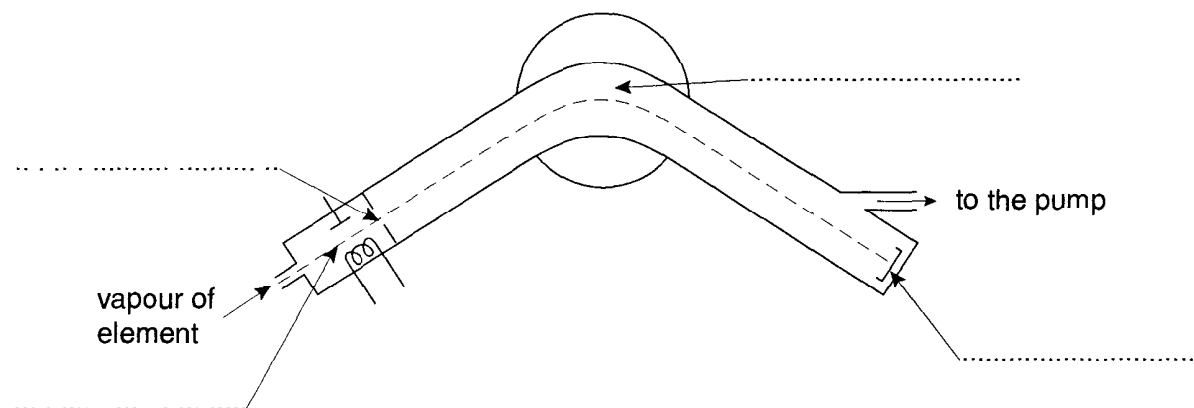
(a) Complete the table below to show the atomic structure of each isotope of gallium.

isotope	number of		
	protons	neutrons	electrons
^{69}Ga			
^{71}Ga			

[2]

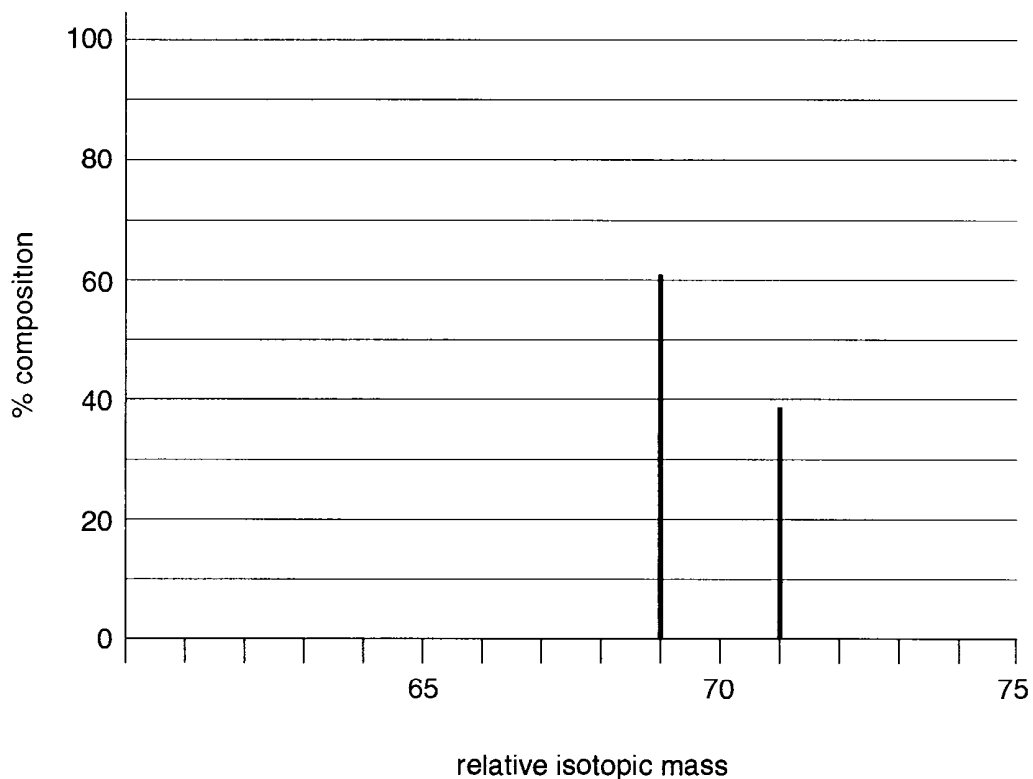
(b) A mass spectrometer can be used to identify the isotopes in a sample of an element. The diagram below shows a mass spectrometer.

Complete the diagram by adding the names of the processes that take place in each of the four labelled regions.



[4]

- (c) A sample of gallium was analysed in a mass spectrometer to produce the mass spectrum below. The relative atomic mass of gallium can be calculated from this mass spectrum.



- (i) Define the term *relative atomic mass*.

.....

.....

.....

..... [3]

- (ii) Estimate the percentage composition of each isotope present in the sample.

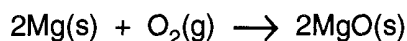
[1]

- (iii) Calculate the relative atomic mass of this sample of gallium. Your answer should be given to three significant figures.

answer [2]

..... [Total : 12]

- 2 When magnesium is heated in air, it reacts with oxygen to form magnesium oxide.



- (a) Complete the electronic configuration of a magnesium atom.

1s² [1]

- (b) What is the oxidation state of magnesium in

(i) Mg [1]

(ii) MgO? [1]

- (c) When magnesium is heated in air, it also reacts with nitrogen to form solid magnesium nitride, Mg₃N₂.

- (i) Construct an equation, with state symbols, for this reaction between magnesium and nitrogen.

..... [2]

- (ii) Suggest why magnesium reacts with air to form much more MgO than Mg₃N₂.

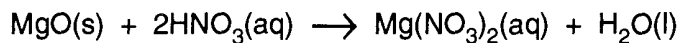
.....
..... [1]

- (d) Magnesium oxide has an extremely high melting point which makes it suitable as a lining for furnaces.

Explain, in terms of its structure and bonding, why magnesium oxide has this property.

.....
.....
.....
..... [3]

- (e) When magnesium oxide is added to warm dilute nitric acid, a reaction takes place forming a solution of magnesium nitrate.



A student reacted 0.0500 mol MgO with 0.400 mol dm⁻³ nitric acid.

- (i) What would you see during this reaction?

.....
..... [1]

- (ii) Calculate the mass of MgO that reacted.

[2]

- (iii) Calculate the volume of 0.400 mol dm⁻³ HNO₃ required to react exactly with this amount of MgO.

[2]

- (f) The solution formed in this reaction contains ions.

- (i) Why does this solution conduct electricity?

.....
..... [1]

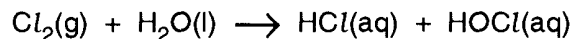
- (ii) State the formulae of **two** ions present in this solution.

..... [2]

[Total : 17]

3 This question is about chlorine and chlorine compounds.

(a) Chlorine reacts with water to form a solution.



(i) Why is chlorine added to water on a large scale?

..... [1]

(ii) Green universal indicator is added to this solution.

What colour changes would you see

immediately [1]

after some time? [1]

(b) Describe a simple test that you could carry out to show that chloride ions are present in a sample of sea water.

reagent

observation

equation

[3]

(c) Some dry-cleaning solvents include the chlorine compound *Perc*.

Perc has the following percentage composition by mass: Cl, 85.6%; C, 14.4%.

The relative molecular mass of *Perc* is 166.

(i) Calculate the molecular formula of *Perc*.

[3]

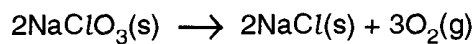
(ii) Suggest why *Perc* would **not** react in the test in (b).

.....

..... [1]

(d) Sodium chlorate, NaClO_3 , is a chlorine compound used as a weed killer.

When heated, NaClO_3 releases oxygen gas.



Calculate the volume of O_2 that can be formed at room temperature and pressure by heating 4.26 g of NaClO_3 .

1 mol of gas molecules occupies 24.0 dm^3 at room temperature and pressure.

[4]

[Total : 14]

- 4 The first six successive ionisation energies of an element **D** are shown in Table 4.1 below.

Table 4.1

element	ionisation energy / kJ mol^{-1}					
	1st	2nd	3rd	4th	5th	6th
D	1086	2353	4621	6223	37832	47278

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

.....

 [3]

- (b) Write an equation, with state symbols, to represent the **third** ionisation energy of element **D**.

..... [2]

- (c) Use Table 4.1 to deduce which group of the Periodic Table contains element **D**. Explain your answer.

group

explanation

.....
 [3]

[Total : 8]

Subject: Chemistry Foundation

Code: 2811

Session: January

Year: 2003

Final Mark Scheme

25/1/2003

MAXIMUM MARK	60
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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	

1. (a)

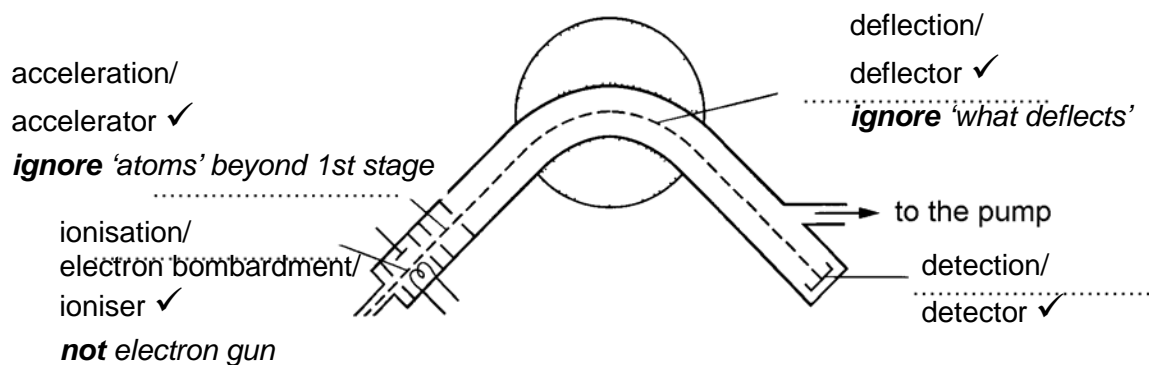
✓

✓

isotope	number of		
	protons	neutrons	electrons
⁶⁹ Ga	31	38	31
⁷¹ Ga	31	40	31

[2]

(b)



[4]

(c) (i) average mass/weighted mean/average mass of an **atom / the isotopes** ✓
compared with carbon-12 ✓

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

not 12 g

or... mass of 1 mole of atoms ✓
compared with carbon-12 ✓

1/12th of mass of 1 mol of carbon-12/on a scale where carbon-12 is 12 **g** ✓

[3]

(ii) ⁶⁹Ga: 61%; ⁷¹Ga: 39% ✓ (*allow 62/38* → 69.76 below)

[1]

(iii) $A_r = 69 \times 61/100 + 71 \times 39/100 = 69.78 \checkmark = 69.8 \checkmark$

ignore g / grammes

[2]

[Total: 12 marks]

- 2 (a) $1s^2 2s^2 2p^6 3s^2$ ✓ [1]
- (b) (i) Mg: 0 ✓ [1]
- (ii) MgO: +2 / 2 / II ✓ [1]
- (c) (i) $3\text{Mg(s)} + \text{N}_2\text{(g)} \longrightarrow \text{Mg}_3\text{N}_2\text{(s)}$ ✓✓
 1 for correct formulae and balancing; 1 for correct state symbols [2]
- (ii) N_2 is less reactive than O_2 /
 bond between N atoms is stronger than bond between O atoms /
 nitrogen has a triple bond **and** oxygen has a double bond
 activation energy of N > activation energy of O ✓
The emphasis here should be a comparison for the mark [1]
- (d) MgO has a giant structure ✓
 MgO is ionic / charged magnesium **and** oxide ions shown ✓
 strong forces ✓ [3]
- (e) (i) MgO dissolves/disappears ✓ [1]
- (ii) $m(\text{MgO}) = 24.3 + 16 = 40.3 \text{ (g mol}^{-1}\text{)}$ ✓ (accept 40)
 mass MgO = $0.0500 \times 40.3 = 2.015 \text{ g} / 2.02 \text{ g} / 2.01 \text{ g} / 2 \text{ g}$ ✓
g is needed here [2]
- (iii) moles $\text{HNO}_3 = 2 \times 0.0500 = 0.100 \text{ mol}$ ✓
right or wrong for 1st mark
 volume $\text{HNO}_3 = 0.25 \text{ dm}^3 / 250 \text{ cm}^3$ ✓
i.e. moles $\text{HNO}_3 / 0.400 \text{ dm}^3 / 1000 \times \text{moles $\text{HNO}_3 / 0.400 \text{ cm}^3$$
 $0.05 / 0.400 \longrightarrow 0.125 \text{ dm}^3 / 125 \text{ cm}^3$ would score 1 mark as molar ratio not used [2]
- (f) (i) ions move / free ions ✓ [1]
- (ii) $\text{Mg}^{2+} / \text{NO}_3^- / \text{H}^+ / \text{OH}^-$ ✓✓ 2 max [2]

[Total: 17 marks]

3. (a) (i) purification/sterilisation/kills or removes germs/disinfects ✓
not 'to make bleach' not 'cleans the water'

[1]

(ii) turns red / yellow / orange ✓

then colourless / bleaches ✓

colourless then 'nothing' scores 1 mark

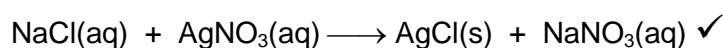
colourless then 'red' does **not** score because overall bleaching is not implied.

[2]

(b) reagent silver nitrate/Ag⁺ ions ✓

observation white (precipitate) / goes white ✓

equation Ag⁺(aq) + Cl⁻(aq) → AgCl(s) /



(state symbols not required)

Fluorine for reagent + 'correct' displacement equation scores 1 mark)

} mark independently

[3]

(c) (i) Cl : C = 85.6/35.5 : 14.4/12 ✓ = 2.4 : 1.2

= 2 : 1 ✓

Cl₂C has mass of 83. 166 = 2 x 83

molecular formula = Cl₄C₂ ✓

Cl : C = 85.6/17 : 14.4/12 → Cl₄C scores 1 mark /

Cl : C = 85.6/17 : 14.4/6 → Cl₂C scores 1 mark

Cl : C = 85.6/35.5 : 14.4/6 → ClC scores 1 mark

[3]

(ii) perc is covalent / perc is **not** ionic / C-Cl bond in perc is covalent

/ no Cl⁻ ions / perc is molecular ✓

[1]

(d) m(NaClO₃) = 106.5 g mol⁻¹ ✓

moles NaClO₃ = 4.26/106.5 = 0.04 mol ✓

moles O₂ = 0.06 mol ✓

volume O₂ = 0.06 x 24 = 1.44 (dm³) ✓

If no molar ratio has been used, ans → 0.96 dm³ : worth 3 marks

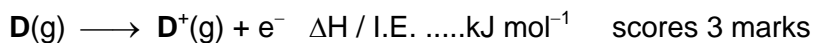
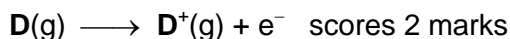
[4]

[Total:14 marks]

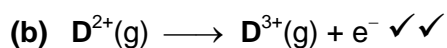
-
-
4. (a) Energy change when **each atom in 1 mole** ✓
of **gaseous atoms** ✓

loses an electron ✓ (to form 1 mole of gaseous 1+ ions).

1 mole of gaseous atoms loses 1 mole of electrons would score all 3 marks



[3]



(1st mark for equation; 2nd mark for state symbols

'-' not required in e^- ; ignore wrong 'D' except if H or He used; X is acceptable

[2]

- (c) Group 4 ✓

Sharp rise in successive ionisation energy between 4th and 5th IE ✓

marking a change to a new shell/energy level / there are 4 electrons in the outer shell ✓

mention of 'orbital' or 'sub-shell cancels the 'shell mark'

Each marking point in (c) is independent

[3]

[Total: 8 marks]

5. **Group 2**

atomic radii increases down group ✓

down group, electrons added to a new shell / more shells ✓

down group, **more** shielding ✓ : *'more' is essential*

increased nuclear charge outweighed / despite increased nuclear charge ✓

Period 3

atomic radii decrease across period ✓

number of protons/nuclear charge increases ✓

across period, electrons added to same shell / same or similar shielding ✓

nuclear attraction increases / shell drawn in by increased nuclear charge ✓

*watch for distinction between nuclear **attraction** and nuclear **charge** in candidates' scripts.*

[8]

Quality of Written Communication

At least **two** complete sentences that are legible and where the spelling, punctuation and grammar allow the meaning to be clear. ✓

[1]

[Total: 9 marks]

