

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**
**Advanced Subsidiary GCE**
**CHEMISTRY**
**2811**

Foundation Chemistry

Wednesday

**29 MAY 2002**

Morning

1 hour

Candidates answer on the question paper.

Additional materials:

Scientific calculator

Data Sheet for Chemistry

Candidate Name	Centre Number	Candidate Number										
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**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.

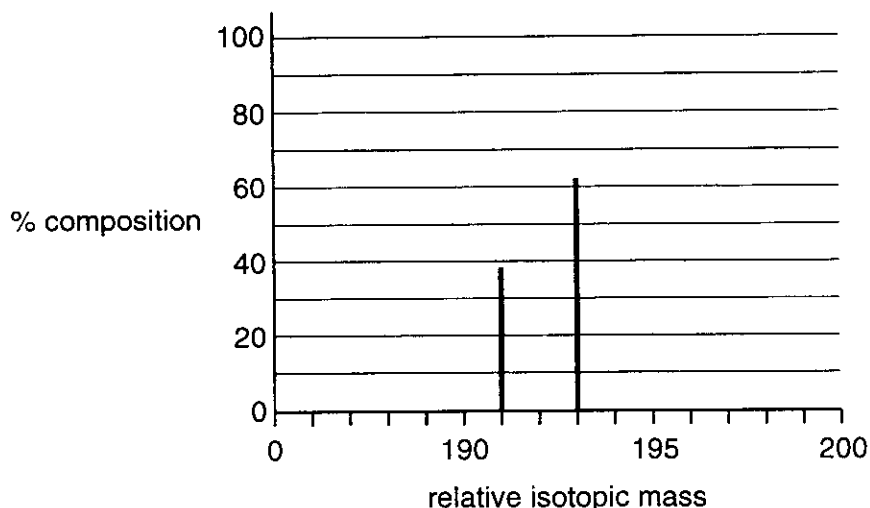
FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	13	
2	8	
3	14	
4	17	
5	8	
<b>TOTAL</b>	<b>60</b>	

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

Answer all questions

- 1 Iridium, atomic number 77, is a very dense metal. Scientists believe that meteorites have deposited virtually all the iridium present on Earth. A fragment of a meteorite was analysed using a mass spectrometer and a section of the mass spectrum showing the isotopes present in iridium is shown below.



- (a) Explain the term *isotopes*.

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

- (b) Use the mass spectrum to help you complete the table below for each iridium isotope in the meteorite.

isotope	percentage composition	number of	
		protons	neutrons
$^{191}\text{Ir}$			
$^{193}\text{Ir}$			

[3]

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

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

- (ii) Calculate the relative atomic mass of the iridium in this meteorite. Give your answer to **one** decimal place.

[2]

- (d) Iridium reacts with fluorine to form a yellow solid **Y** with the percentage composition by mass: Ir, 62.75%; F, 37.25%.

The empirical formula of **Y** can be calculated from this information.

- (i) Define the term *empirical formula*.

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

- (ii) Calculate the empirical formula of **Y**.

[2]

- (iii) Write a balanced equation for the reaction between iridium and fluorine.

.....[1]

[Total : 13]

2 This question concerns elements and compounds from Group 2 of the Periodic Table.

(a) State the trend in reactivity of the Group 2 elements with oxygen. Explain your answer.

*trend in reactivity* .....

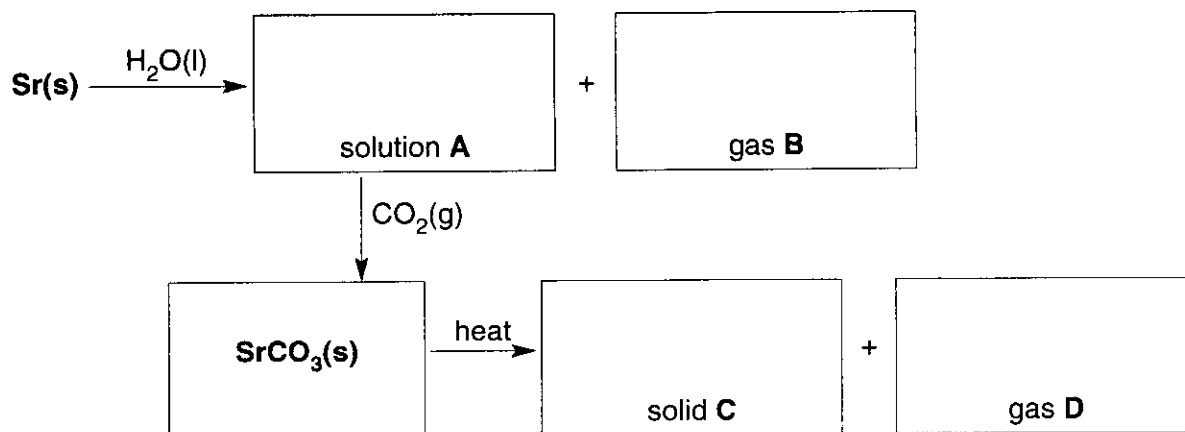
*explanation* .....

.....

.....

.....[4]

(b) The reactions of strontium are typical of a Group 2 element. Write the formulae for substances **A–D** in the flow chart below.



[4]

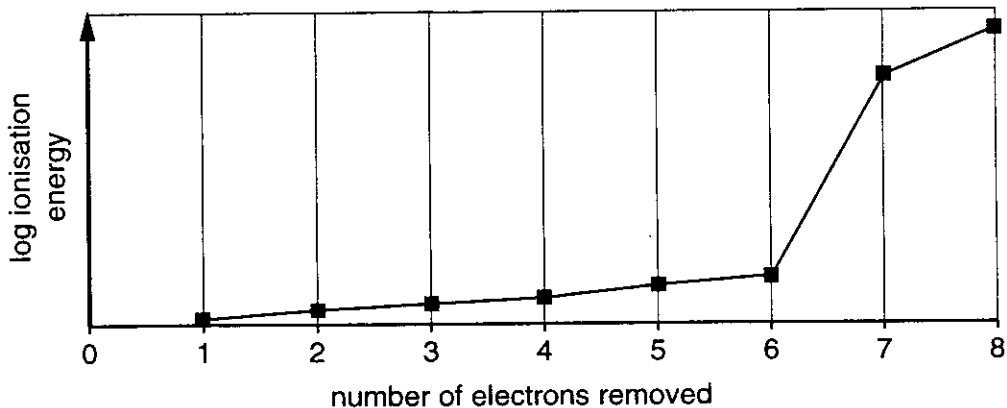
[Total : 8]

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3 This question is about aluminium oxide,  $Al_2O_3$ .

(a) Successive ionisation energies provide evidence for the arrangement of electrons in atoms.

The graph below shows the 8 successive ionisation energies of **oxygen**.



(i) Write an equation, including state symbols, to represent the **second** ionisation energy of oxygen.

.....[2]

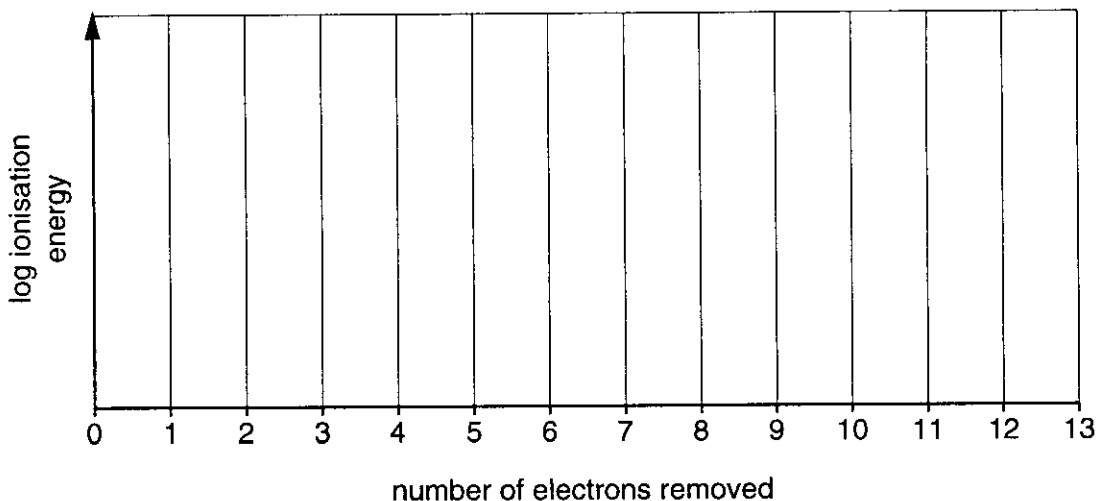
(ii) How does this graph provide evidence for the existence of two electron shells in oxygen?

.....  
 .....  
 .....[2]

(b) (i) Complete the electronic configuration for an **aluminium** atom.

$1s^2$  .....

(ii) On the axes below, sketch a graph to show the **thirteen** successive ionisation energies of aluminium. [2]



(c) Aluminium oxide can be formed by reacting together aluminium and oxygen.

(i) Write an equation, including state symbols, for this reaction.

.....[2]

(ii) The bonding in aluminium oxide is intermediate between ionic and covalent bonding. Explain why aluminium oxide has intermediate bonding.

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

(d) Gemstones such as rubies, sapphires and topaz mainly contain aluminium oxide. Artificial rubies can be made by heating aluminium oxide with very small traces of transition metal oxides and cooling slowly. The traces of these oxides give the rubies their colours.

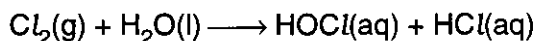
Calculate how many moles of  $Al_2O_3$  are needed to make a 25.0 g ruby.

Assume that all the mass of this ruby is aluminium oxide.

Answer ..... mol  
[2]

[Total : 14]

- 4 A major use of chlorine is in the purification of drinking water. When chlorine is added to water, the following reaction takes place.



- (a) Determine the oxidation number of chlorine in

HOCl, .....

HCl .....[2]

- (b) HOCl has covalently bonded molecules.

Draw a 'dot-and-cross' diagram of a molecule of HOCl.

[2]

- (c) (i) Outline how the electron pair repulsion theory can be used to predict the shape of a covalent molecule.

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

- (ii) Using your answers to (b) and (c)(i), draw a diagram to show the likely shape of a molecule of HOCl. Predict the bond angle in this molecule and show this clearly on your diagram.

[2]

- (d) Chlorine,  $\text{Cl}_2$ , is a strong oxidising agent and oxidises aqueous iodide ions,  $\text{I}^-(\text{aq})$ , to iodine,  $\text{I}_2$ .

- (i) What is meant by the term *oxidation*?

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

- (ii) Suggest what you would expect to see when  $\text{Cl}_2(\text{g})$  is bubbled through a solution containing  $\text{I}^-(\text{aq})$ .

.....[1]



- (iii) Write a balanced **ionic** equation for the oxidation of  $I^{-}(aq)$  by  $Cl_2(g)$ .

.....[1]

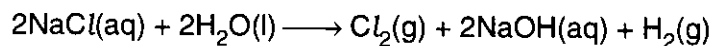
- (e) Industrially, chlorine,  $Cl_2(g)$ , is prepared by passing an electric current through a concentrated solution of sodium chloride,  $NaCl$ , known as brine.

In this question, assume brine has a concentration of  $NaCl$  of  $4.00 \text{ mol dm}^{-3}$ .

- (i) Calculate the mass of  $NaCl$  dissolved in  $1.00 \text{ dm}^3$  of brine.

Answer ..... g  
[2]

- (ii) Calculate the volume of  $Cl_2(g)$  obtained from  $1.00 \text{ dm}^3$  of brine.



Assume that 1 mole of  $Cl_2(g)$  occupies  $24.0 \text{ dm}^3$ .

Answer .....  $\text{dm}^3$   
[2]

- (iii) Every day in the UK  $2.5 \times 10^9 \text{ dm}^3$  of  $Cl_2(g)$  are produced for many uses, including water treatment and the manufacture of plastics.

Assuming that all  $Cl_2$  is produced from brine, calculate the volume of brine required for  $Cl_2$  production each day in the UK.

Assume that 1 mole of  $Cl_2(g)$  occupies  $24.0 \text{ dm}^3$ .

Answer .....  
[1]

[Total : 17]





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