

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

**CHEMISTRY**

**2811**

Foundation Chemistry

Wednesday

**8 JUNE 2005**

Morning

1 hour

Candidates answer on the question paper.

Additional materials:

*Data Sheet for Chemistry*

Scientific Calculator

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 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	16	
2	13	
3	8	
4	7	
5	16	
<b>TOTAL</b>	<b>60</b>	

**This question paper consists of 8 printed pages.**

Answer **all** the questions.

- 1 The element titanium, Ti, atomic number 22, is a metal that is used in the aerospace industry for both airframes and engines.

A sample of titanium for aircraft construction was analysed using a mass spectrometer and was found to contain three isotopes,  $^{46}\text{Ti}$ ,  $^{47}\text{Ti}$  and  $^{48}\text{Ti}$ . The results of the analysis are shown in Table 1.1 below.

**Table 1.1**

isotope	$^{46}\text{Ti}$	$^{47}\text{Ti}$	$^{48}\text{Ti}$
relative isotopic mass	46.00	47.00	48.00
percentage composition	8.9	9.8	81.3

- (a) (i) Explain the term *isotopes*.

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

- (ii) Complete the table below for atoms of two of the titanium isotopes.

isotope	protons	neutrons	electrons
$^{46}\text{Ti}$			
$^{47}\text{Ti}$			

[2]

- (b) Using the information in Table 1.1, calculate the relative atomic mass of this sample of titanium.

Give your answer to three significant figures.

[2]

- (c) Complete the electronic configuration of a titanium atom.

$1s^22s^22p^6$  .....[1]

(d) Titanium has metallic bonding.

(i) Explain what is meant by *metallic bonding*. Use a diagram in your answer.

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

(ii) How does metallic bonding allow titanium to conduct electricity?

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

(e) A student reacted 1.44 g of titanium with chlorine to form 5.70 g of a chloride X.

(i) How many moles of Ti atoms were reacted?

[1]

(ii) How many moles of Cl atoms were reacted?

[2]

(iii) Determine the empirical formula of X.

[1]

(iv) Construct a balanced equation for the reaction between titanium and chlorine.

.....[1]

(v) At room temperature, X is a liquid which does **not** conduct electricity. What does this information suggest about the bonding and structure in X?

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

[Total: 16]

- 2 The Group 2 element radium, Ra, is used in medicine for the treatment of cancer. Radium was discovered in 1898 by Pierre and Marie Curie by extracting radium chloride from its main ore pitchblende.

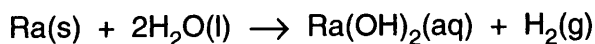
(a) Predict the formula of radium chloride.

.....[1]

(b) Pierre and Marie Curie extracted radium from radium chloride by reduction. Explain what is meant by *reduction*, using this reaction as an example.

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

(c) Radium reacts vigorously when added to water.



(i) Use the equation to predict **two** observations that you would **see** during this reaction.

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

(ii) Predict a pH value for this solution.

.....[1]

(d) Reactions of the Group 2 metals involve removal of electrons. The electrons are removed more easily as the group is descended and this helps to explain the increasing trend in reactivity.

(i) The removal of one electron from each atom in 1 mole of gaseous radium atoms is called the .....[2]

The equation for this process in radium is:

.....[2]

(ii) Atoms of radium have a greater nuclear charge than atoms of calcium.

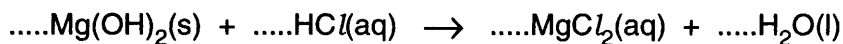
Explain why, despite this, **less** energy is needed to remove an electron from a radium atom than from a calcium atom.

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

[Total: 13]

- 3 A student had a stomach-ache and needed to take something to neutralise excess stomach acid. He decided to take some Milk of Magnesia, which is an aqueous suspension of magnesium hydroxide,  $\text{Mg}(\text{OH})_2$ .

- (a) The main acid in the stomach is hydrochloric acid,  $\text{HCl}(\text{aq})$ , and the unbalanced equation for the reaction that takes place with Milk of Magnesia is shown below.



Balance the equation by adding numbers where necessary in the unbalanced equation above. [1]

- (b) The student's stomach contained  $500 \text{ cm}^3$  of stomach fluid with an acid concentration of  $0.108 \text{ mol dm}^{-3}$ . The student swallowed some Milk of Magnesia containing  $2.42 \text{ g}$   $\text{Mg}(\text{OH})_2$ . He wondered whether this dose was sufficient to neutralise the stomach acid.

Assume that all the acid in the stomach fluid was  $0.108 \text{ mol dm}^{-3}$  hydrochloric acid.

- (i) How many moles of  $\text{HCl}$  were in the  $500 \text{ cm}^3$  of stomach fluid?

[1]

- (ii) Calculate the mass of  $\text{Mg}(\text{OH})_2$  necessary to neutralise this stomach fluid.

[3]

- (iii) Determine whether the student swallowed too much, too little, or just the right amount of Milk of Magnesia to neutralise the stomach acid.

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

- (c) Chewing chalk has been used for many years to combat excess stomach acid and indigestion tablets often contain calcium carbonate,  $\text{CaCO}_3$ . Suggest, with the aid of an equation, how these tablets work.

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

[Total: 8]

4 Chlorine is used in the preparation of many commercially important materials such as bleach and iodine.

(a) Bleach is a solution of sodium chlorate(I),  $\text{NaOCl}$ , made by dissolving chlorine in aqueous sodium hydroxide.



Determine the changes in oxidation number of chlorine during the preparation of bleach and comment on your results.

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

(b) Iodine is extracted commercially from seawater with chlorine gas. Seawater contains very small quantities of dissolved iodide ions, which are oxidised to iodine by the chlorine gas.

(i) Write an ionic equation for the reaction that has taken place.

.....[2]

(ii) Use your understanding of electronic structure to explain why chlorine is a stronger oxidising agent than iodine.

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

[Total: 7]

- 5 In this question, one mark is available for the quality of use and organisation of scientific terms.

Nitrogen and oxygen are elements in Period 2 of the Periodic Table. The hydrogen compounds of oxygen and nitrogen,  $H_2O$  and  $NH_3$ , both form hydrogen bonds.

- (a) (i) Draw a diagram containing two  $H_2O$  molecules to show what is meant by *hydrogen bonding*. On your diagram, show any lone pairs present and relevant dipoles.

[3]

- (ii) State and explain **two** anomalous properties of water resulting from hydrogen bonding.

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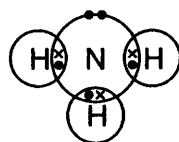
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.....[4]

- (b) The 'dot-and-cross' diagram of an ammonia molecule is shown below.



Predict, with reasons, the bond angle in an ammonia molecule.

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.....[4]

