

**ADVANCED GCE  
CHEMISTRY**

Trends and Patterns

**THURSDAY 25 JANUARY 2007**

**2815/01**

Afternoon

Time: 1 hour

Additional materials: Scientific calculator  
*Data Sheet for Chemistry* (Inserted)



Candidate  
Name

Centre  
Number

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Candidate  
Number

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**INSTRUCTIONS TO CANDIDATES**

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- **WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. ANSWERS WRITTEN ELSEWHERE WILL NOT BE MARKED.**

**INFORMATION FOR CANDIDATES**

- The number of marks for each question 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.
- A copy of the *Data Sheet for Chemistry* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.

**FOR EXAMINER'S USE**

Qu.	Max.	Mark
1	7	
2	6	
3	20	
4	12	
<b>TOTAL</b>	<b>45</b>	

This document consists of **12** printed pages and a *Data Sheet for Chemistry*.



Answer **all** the questions.

1 This question is about oxides of elements in Period 3.

chemical formula	Na <sub>2</sub> O	MgO	Al <sub>2</sub> O <sub>3</sub>	SiO <sub>2</sub>	P <sub>4</sub> O <sub>10</sub>	SO <sub>3</sub>
structure	giant	giant	giant	giant	simple	simple
bonding	ionic	ionic	intermediate	covalent	covalent	covalent

(a) Explain the trend in chemical formula shown in the table.

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

(b) Solid magnesium oxide is an electrical insulator. Explain this property in terms of structure and bonding.

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

(c) Solid aluminium oxide is amphoteric. This means it reacts with acids and bases.

(i) Write an equation to show the reaction between aluminium oxide and hot dilute hydrochloric acid.

..... [1]

(ii) Aluminium oxide reacts with hot aqueous sodium hydroxide. Balance this equation for the reaction shown below.



(d) Silicon(IV) oxide,  $\text{SiO}_2$ , has a high melting point. Explain this property in terms of structure and bonding.

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

(e) Use the information in the table to help you predict the action of water on  $\text{P}_4\text{O}_{10}$ .

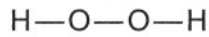
.....  
..... [1]

[Total: 7]





(c) Hydrogen peroxide has the following displayed formula.



- (i) Draw a 'dot-and-cross' diagram for a molecule of  $\text{H}_2\text{O}_2$  showing only the outer shell electrons.

[1]

- (ii) Use the 'dot-and-cross' diagram to predict the  $\text{H—O—O}$  bond angle in hydrogen peroxide. Explain your answer.

.....

.....

..... [2]

[Total: 6]





(c) A sample of iron is heated with a stream of dry hydrogen chloride. A different chloride of iron is formed that contains the  $\text{Fe}^{2+}$  ion. This chloride dissolves in water to form a pale green solution that contains the hexaaquairon(II) complex ion.

(i) Complete the electronic configuration of  $\text{Fe}^{2+}$ .

$1s^2 2s^2 2p^6$  ..... [1]

(ii) Draw the shape of the hexaaquairon(II) complex ion. Include the bond angles on your diagram.

[2]

(iii) Aqueous sodium hydroxide is added to a solution containing  $\text{Fe}^{2+}(\text{aq})$ .

State what you would observe.

.....

Write an ionic equation, with state symbols, for the reaction.

..... [2]



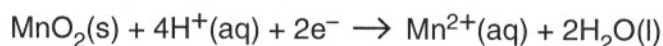




(e) The percentage purity of a sample of manganese(IV) oxide,  $\text{MnO}_2$ , can be determined by its reaction with acidified iron(II) ions.

- Stage 1 – A sample of known mass of the impure  $\text{MnO}_2$  is added to a conical flask.
- Stage 2 – The sample is reacted with a known excess amount of  $\text{Fe}^{2+}$  acidified with dilute sulphuric acid.
- Stage 3 – The contents of the flask are heated gently.
- Stage 4 – The cooled contents of the flask are titrated with aqueous potassium manganate(VII) in acidic conditions to find the amount of unreacted  $\text{Fe}^{2+}$ .

(i) The reduction half-equation for manganese(IV) oxide in the presence of dilute acid is shown below.



Construct the balanced equation for the redox reaction between  $\text{Fe}^{2+}(\text{aq})$ ,  $\text{MnO}_2(\text{s})$  and  $\text{H}^+(\text{aq})$ .

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

(ii) In Stage 1 and Stage 2 a student uses a 0.504 g sample of impure  $\text{MnO}_2$  and  $100 \text{ cm}^3$  of  $0.200 \text{ mol dm}^{-3} \text{ Fe}^{2+}$ .

In Stage 4 the student determines that the amount of unreacted  $\text{Fe}^{2+}$  is 0.0123 mol.

1 mol of  $\text{MnO}_2$  reacts with 2 mol of  $\text{Fe}^{2+}$ .

Calculate the percentage purity of the impure sample of  $\text{MnO}_2$ .

percentage purity = ..... % [3]

[Total: 20]



