

**ADVANCED GCE
CHEMISTRY**

Trends and Patterns

THURSDAY 24 JANUARY 2008

2815/01

Afternoon
Time: 1 hour

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

Candidate
Forename

Candidate
Surname

Centre
Number

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Candidate
Number

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INSTRUCTIONS TO CANDIDATES

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Do **not** write outside the box bordering each page.
- Write your answer to each question in the space provided.

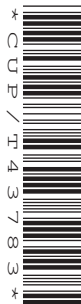
INFORMATION FOR CANDIDATES

- The number of marks for each question is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **45**.
- 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	14	
2	12	
3	6	
4	13	
TOTAL	45	

This document consists of **8** printed pages and a *Data Sheet for Chemistry*.



Answer **all** the questions.

- 1** Iron is a transition element. It forms compounds in which the oxidation number of iron is +2, +3 or +6.

(a) Give the electronic configuration of Fe^{2+} and use it to explain why iron is a transition element.

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

(b) Transition elements form complex ions.

Choose an example of a complex ion in which iron has the +2 oxidation state.

(i) Write the formula for your chosen complex ion formed by iron.

..... [1]

(ii) Draw the shape of your chosen complex ion. Indicate clearly the three-dimensional shape and the bond angles.

[2]

(iii) Describe the bonding within your chosen complex ion.

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

- (c) Complex ions containing transition elements often undergo ligand substitution reactions.

Describe one ligand substitution reaction of a complex ion containing iron in the +3 oxidation state.

Include in your answer:

- an equation;
- the colour change that is seen during the reaction.

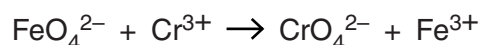
.....
 [2]

- (d) Describe how aqueous sodium hydroxide can be used to distinguish between aqueous solutions of iron(II) chloride and iron(III) chloride. Write an ionic equation, with state symbols, for **one** of the reactions you describe.

.....

 [2]

- (e) FeO_4^{2-} reacts with Cr^{3+} ions as shown in the following equation.



Use oxidation numbers to explain why this reaction involves both oxidation and reduction.

.....

 [2]

- (f) FeO_4^{2-} decomposes in the presence of hydrogen ions, forming iron(III) ions, oxygen and water.

Construct the ionic equation for this reaction.

.....
 [2]

[Total: 14]

2 Lattice enthalpy is a measure of ionic bond strength.

(a) Explain, with the aid of an equation, what is meant by the *lattice enthalpy of sodium oxide*, Na_2O .

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

(b) Magnesium oxide, MgO , is used to line furnaces.

Draw a Born-Haber cycle for MgO .

Include:

- state symbols;
- names of the energy changes involved.

[5]

- (c) Describe and explain the difference between the lattice enthalpies of magnesium oxide and magnesium carbonate.

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

- (d) Calcium carbonate is decomposed in a lime-kiln to make calcium oxide.

- (i) Write an equation for this decomposition.

..... [1]

- (ii) Explain why the decomposition temperature for calcium carbonate is much higher than for magnesium carbonate.

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

[Total: 12]

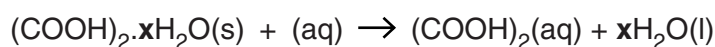
3 Ethanedioic acid is a poisonous substance found in rhubarb leaves.

A sample of ethanedioic acid was isolated as hydrated crystals with the formula $(\text{COOH})_2 \cdot x\text{H}_2\text{O}$.

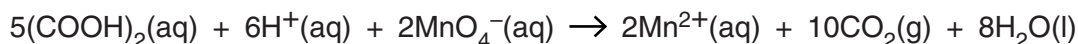
The value of x in $(\text{COOH})_2 \cdot x\text{H}_2\text{O}$ can be determined by its reaction with acidified manganate(VII) ions.

- **Stage 1** – A sample of known mass is added to a conical flask.
- **Stage 2** – The sample has 25.0 cm^3 of 1 mol dm^{-3} sulphuric acid added to it.
- **Stage 3** – The contents of the flask are heated to 60°C .
- **Stage 4** – The hot contents of the flask are titrated against $0.0200\text{ mol dm}^{-3}$ MnO_4^- .

In **stage 2** the hydrated crystals dissolve.



In **stage 4** the equation for the reaction between $(\text{COOH})_2$ and acidified MnO_4^- is shown below.



(a) Suggest what you would see at the end-point of this titration.

..... [1]

(b) In **stage 1** a student used 0.120 g of $(\text{COOH})_2 \cdot x\text{H}_2\text{O}$.

In **stage 4** the titre was 19.05 cm^3 .

Calculate the relative formula mass of $(\text{COOH})_2 \cdot x\text{H}_2\text{O}$. Hence determine the value of x .

relative formula mass =

$x =$ [4]

(c) Ethanedioic acid also reacts with magnesium. Write down the formula of the organic product of the reaction.

..... [1]

[Total: 6]

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

The chemical and physical properties of a chloride can be predicted from its structure and bonding.

- Describe, with the aid of '*dot-and-cross*' diagrams, the structure and bonding of magnesium chloride and of silicon(IV) chloride.
- Explain why the melting point of magnesium chloride is much higher than that of silicon(IV) chloride.
- Compare, using equations where appropriate, the action of cold water on magnesium chloride and on **phosphorus(V) chloride**. Include at least **one** observation for **each** chloride in your answer.

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[Total: 13]

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