OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY 2815/01

Trends and Patterns

Tuesday **29 JUNE 2004** Morning 1 hour

Candidates answer on the question paper.
Additional materials:
Data Sheet for Chemistry
Scientific calculator

Candidate Name	Centre Number	Candidate Number

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	11	
2	14	
3	7	
4	13	
TOTAL	45	

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

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[Turn over

For Examiner's Use

Answer **all** the questions.

1 The question below relates to oxides of some of the elements in Period 3 of the Periodic Table.

(a) Draw a '*dot-and-cross*' diagram to show the bonding in magnesium oxide. Only draw the outer shell electrons.

[2]

(b) **(i)** Draw a '*dot-and-cross*' diagram to show the bonding in a sulphur dioxide molecule. Only draw the outer shell electrons.

[1]

(ii) Predict the shape of, and bond angles in, a sulphur dioxide molecule. Explain your answer.

[3]

(c) The melting point of magnesium oxide is much higher than that of sulphur dioxide. Explain this difference in terms of structure and bonding.

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.....[2]

For Examiner's Use

(d) Magnesium oxide and sulphur dioxide react differently when added to water.

- Magnesium oxide reacts with water to give compound **X**.
- Sulphur dioxide reacts with water to give an aqueous solution of compound **Y**.

(i) Identify compound **X**.

.....[1]

(ii) Write an equation to show the formation of **Y**.

.....[1]

(iii) Compound **X** reacts with an aqueous solution of compound **Y**.
Suggest why.

.....

.....[1]

[Total: 11]

[Turn over

2 Aqueous iron(III) chloride contains the complex ion, $[Fe(H_2O)_6]^{3+}$.

(a) Draw the shape of the complex ion $[Fe(H_2O)_6]^{3+}$. Label the bond angles on your diagram.

[2]

(b) Explain how the water molecules are bonded to the metal ion in $[Fe(H_2O)_6]^{3+}$.

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.....[2]

(c) Aqueous iron(III) chloride, $FeCl_3$, reacts with aqueous ammonium thiocyanate, NH_4SCN, to give a blood-red solution.
A ligand substitution reaction occurs to form a complex with the formula $[Fe(SCN)_x(H_2O)_y]^{2+}$.

The formula of this complex ion can be determined using colorimetry.

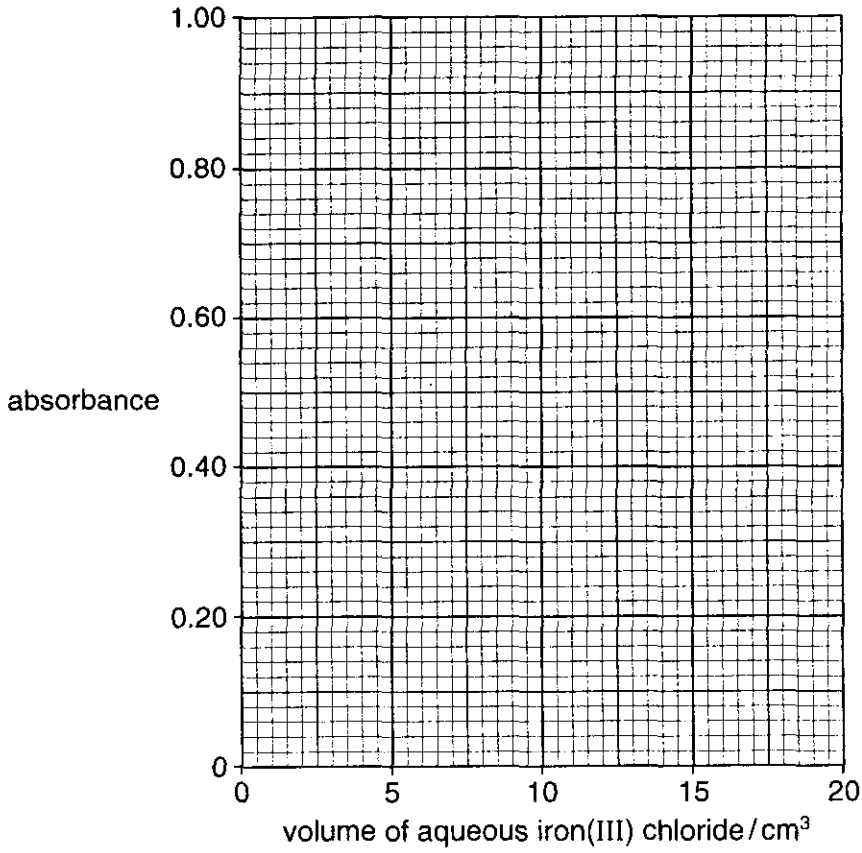
- A student makes up six different mixtures of 0.0500 mol dm^{-3} $FeCl_3$(aq) and 0.100 mol dm^{-3} NH_4SCN(aq).
- The student places each mixture into a colorimeter and measures the absorbance of each mixture.

The table below shows the absorbance of each mixture.

mixture	one	two	three	four	five	six
volume of 0.0500 mol dm^{-3} $FeCl_3$(aq) / cm^3	4.0	8.0	12.0	16.0	18.0	19.0
volume of 0.100 mol dm^{-3} NH_4SCN(aq) / cm^3	16.0	12.0	8.0	4.0	2.0	1.0
absorbance	0.23	0.46	0.68	0.46	0.23	0.11

For Examiner's Use

(i) Draw a graph of the absorbance against the volume of aqueous iron(III) chloride using the grid below.



[2]

(ii) Use the graph to estimate the volume of 0.0500 mol dm^{-3} aqueous iron(III) chloride that gives the maximum absorbance.

answer .....cm^3 [1]

(iii) How many moles of $Fe^{3+}(aq)$ are there in the volume in part **(ii)**?

answer .....mol [1]

(iv) Deduce the volume of 0.100 mol dm^{-3} aqueous ammonium thiocyanate that gives the maximum absorbance.

answer .....cm^3 [1]

(v) How many moles of $SCN^-(aq)$ are there in the volume in part **(iv)**?

answer .....mol [1]

(vi) Deduce the values **x** and **y** in the formula of the complex $[Fe(SCN)_x(H_2O)_y]^{2+}$.

x = ... and **y** = ... [1]

[Turn over

For Examiner's Use

(d) Another complex of iron is used as an anti-caking agent in table salt. Analysis of a sample of this complex shows that it contains 547 mg of potassium, 195 mg of iron, 252 mg of carbon and 294 mg of nitrogen.

(i) Calculate the empirical formula of the complex.

answer .....[2]

(ii) The complex is a potassium salt. The complex anion present has an octahedral shape and has iron in the +2 oxidation state. Suggest a possible formula for the complex ion.

.....[1]

[Total: 14]

For Examiner's Use

3 Sunglasses can be made from photochromic glass. Photochromic glass contains small amounts of silver chloride, AgCl, and copper(I) chloride, CuCl.

When bright light strikes photochromic glass, silver chloride decomposes to make silver atoms and chlorine atoms. This makes the glass darken. The chlorine atoms immediately react with copper(I) chloride to make copper(II) chloride.

When the exposure to bright light ends, silver atoms reduce copper(II) chloride back into copper(I) chloride and the glass lightens.

(a) Suggest which substance is formed to give the glass its dark colour.

.....[1]

(b) A sample of photochromic glass containing 0.0287 g of AgCl is placed in bright sunlight. Calculate the maximum mass, in g, of chlorine atoms that can be formed.

answer .....g [1]

(c) **(i)** Construct the equation for the reaction between silver and copper(II) chloride.

.....[1]

(ii) Use oxidation states to explain why this reaction involves both oxidation **and** reduction.

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.....[2]

(d) **(i)** Complete the electronic configuration of a copper(II) ion, Cu^{2+}.

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

(ii) Use the electronic configuration to explain why copper is a transition element.

.....

.....[1]

[Total: 7]

[Turn over

For Examiner's Use

4 In this question, one mark is available for the quality of written communication.

Lattice enthalpy is used to compare the strengths of ionic bonds.

- Define the term *lattice enthalpy*.
- Describe and explain the effect of ionic charge and ionic radius on the magnitude of a lattice enthalpy.
- Explain the trend in thermal decomposition of the carbonates of Group 2 elements.

For Examiner's Use

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.....[12]

Quality of Written Communication [1]

[Total: 13]

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