OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY

Trends and Patterns

2815/01

Wednesday **25 JANUARY 2006** Afternoon 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 blue or black ink, in the spaces provided on the question paper.
- Pencil may be used for diagrams and graphs **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 in the grey area between the pages.
- **DO NOT** WRITE IN THE AREA **OUTSIDE** THE BOX BORDERING EACH PAGE. ANY WRITING IN THIS AREA WILL NOT BE MARKED.

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	9	
2	8	
3	7	
4	8	
5	13	
TOTAL	45	

This question paper consists of 8 printed pages.

313046901

[Turn over

Answer **all** the questions.

1 All the carbonates of the elements in Group 2 thermally decompose to form oxides.

(a) Write the equation, including state symbols, for the thermal decomposition of magnesium carbonate.

.....[2]

(b) What is the trend in the ease of thermal decomposition of Group 2 carbonates?

.....

.....[1]

(c) Arrange the following compounds in order of their lattice enthalpy. Put the **most** exothermic first.

barium carbonate
barium oxide
magnesium oxide

.....

Explain your answer.

.....

.....

.....

.....[4]

(d) Aluminium carbonate does not exist at room temperature.
Suggest why in terms of polarisation.

.....

.....

.....

.....[2]

[Total: 9]

2 One of the largest uses of phosphorus is in boxes of safety matches. A safety match ignites when it is rubbed against the striking surface of the match box.

The friction between the match head and the striking surface generates enough heat for the phosphorus to burn. This in turn provides enough energy for the decomposition of potassium chlorate(V), $KClO_3$, on the match head.

$$2KClO_3(s) \longrightarrow 2KCl(s) + 3O_2(g)$$

Sulphur on the match stick ignites and sufficient heat is generated to ignite paraffin wax and then the wood in the match.

(a) When the phosphorus burns, phosphorus(V) oxide forms. What is the formula of phosphorus(V) oxide?

.....[1]

(b) Calculate the volume of oxygen, measured at room temperature and pressure, that forms when 0.368 g of potassium chlorate(V) is decomposed.
One mole of any gas occupies 24 000 cm^3 at room temperature and pressure.

volume .....[3]

(c) Suggest why the match head contains potassium chlorate(V).

.....

.....[1]

(d) Write the equation for the reaction between sulphur and oxygen.

.....[1]

(e) Phosphorus(V) oxide is a simple molecular oxide.

(i) Suggest a physical property of phosphorus(V) oxide.

.....[1]

(ii) Suggest a chemical property of phosphorus(V) oxide.

.....[1]

[Total: 8]

3 The compound $FeSO_4.7H_2O$ can be used to kill moss in grass. Iron(II) ions in a solution of $FeSO_4.7H_2O$ are slowly oxidised to form iron(III) ions.

(a) Describe a test to show the presence of iron(III) ions in a solution of $FeSO_4.7H_2O$.

.....

.....[1]

(b) The percentage purity of an impure sample of $FeSO_4.7H_2O$ can be determined by titration against potassium dichromate(VI), $K_2Cr_2O_7$, under acid conditions, using a suitable indicator.

During the titration, $Fe^{2+}(aq)$ ions are oxidised to $Fe^{3+}(aq)$ ions.

- Stage 1 – A sample of known mass of the impure $FeSO_4.7H_2O$ is added to a conical flask.
- Stage 2 – The sample is dissolved in an excess of dilute sulphuric acid.
- Stage 3 - The contents of the flask are titrated against $K_2Cr_2O_7(aq)$.

(i) The reduction half equation for acidified dichromate(VI) ions, $Cr_2O_7^{2-}$, is as follows.

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \longrightarrow 2Cr^{3+}(aq) + 7H_2O(l)$$

Construct the balanced equation for the redox reaction between $Fe^{2+}(aq)$, $Cr_2O_7^{2-}(aq)$ and $H^+(aq)$.

.....

.....

.....[2]

(ii) In Stage 1, a student uses a 0.655 g sample of impure $FeSO_4.7H_2O$.

In Stage 3, the student uses 19.6 cm^3 of 0.0180 mol dm^{-3} $Cr_2O_7^{2-}$ to reach the end-point.

One mole of $Cr_2O_7^{2-}$ reacts with 6 moles of Fe^{2+}.

Calculate the percentage purity of the impure sample of $FeSO_4.7H_2O$.

percentage purity ..... [4]

[Total: 7]

4 Dilute aqueous copper(II) sulphate contains $[Cu(H_2O)_6]^{2+}$ ions.

(a) Concentrated hydrochloric acid is added drop by drop to a small volume of dilute aqueous copper(II) sulphate. The equation for the reaction taking place is as follows.

$$[Cu(H_2O)_6]^{2+}(aq) + 4Cl^-(aq) \longrightarrow [CuCl_4]^{2-}(aq) + 6H_2O(l)$$

(i) Describe the observations that would be made during the addition of the concentrated hydrochloric acid.

.....[1]

(ii) Describe the bonding within the complex ion, $[CuCl_4]^{2-}$.

.....

.....

.....[2]

(b) Concentrated aqueous ammonia is added drop by drop to aqueous copper(II) sulphate until present in excess. Two reactions take place, one after the other, to produce the complex ion $[Cu(NH_3)_4(H_2O)_2]^{2+}(aq)$.

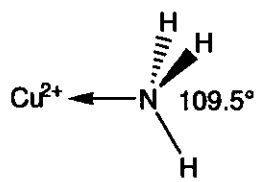
Describe the observations that would be made during the addition of concentrated aqueous ammonia.

.....

.....

.....[2]

(c) Ammonia is a simple molecule. The H—N—H bond angle in an isolated ammonia molecule is 107°.
The diagram shows part of the $[Cu(NH_3)_4(H_2O)_2]^{2+}$ ion and the H—N—H bond angle in the ammonia ligand.



Explain why the H—N—H bond angle in the ammonia ligand is 109.5° rather than 107°.

.....

.....

.....

.....[3]

[Total: 8]

5 In this question, one mark is available for the quality of spelling, punctuation and grammar.

The elements sodium, aluminium and phosphorus react with chlorine to form chlorides. The action of water on these chlorides is related to their structure and bonding.

Using only the elements sodium, aluminium and phosphorus,

- describe, with the aid of equations, the reactions of **two** of these elements with chlorine and use **one** of the reactions to explain what is meant by a redox reaction;
- describe and explain the action of water on the chlorides of sodium, aluminium and phosphorus.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....[12]

Quality of Written Communication [1]

[Total: 13]

END OF QUESTION PAPER