OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY **2815/01**

Trends and Patterns

Tuesday **25 JANUARY 2005** 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 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	**10**	
2	**15**	
3	**7**	
4	**13**	
TOTAL	**45**	

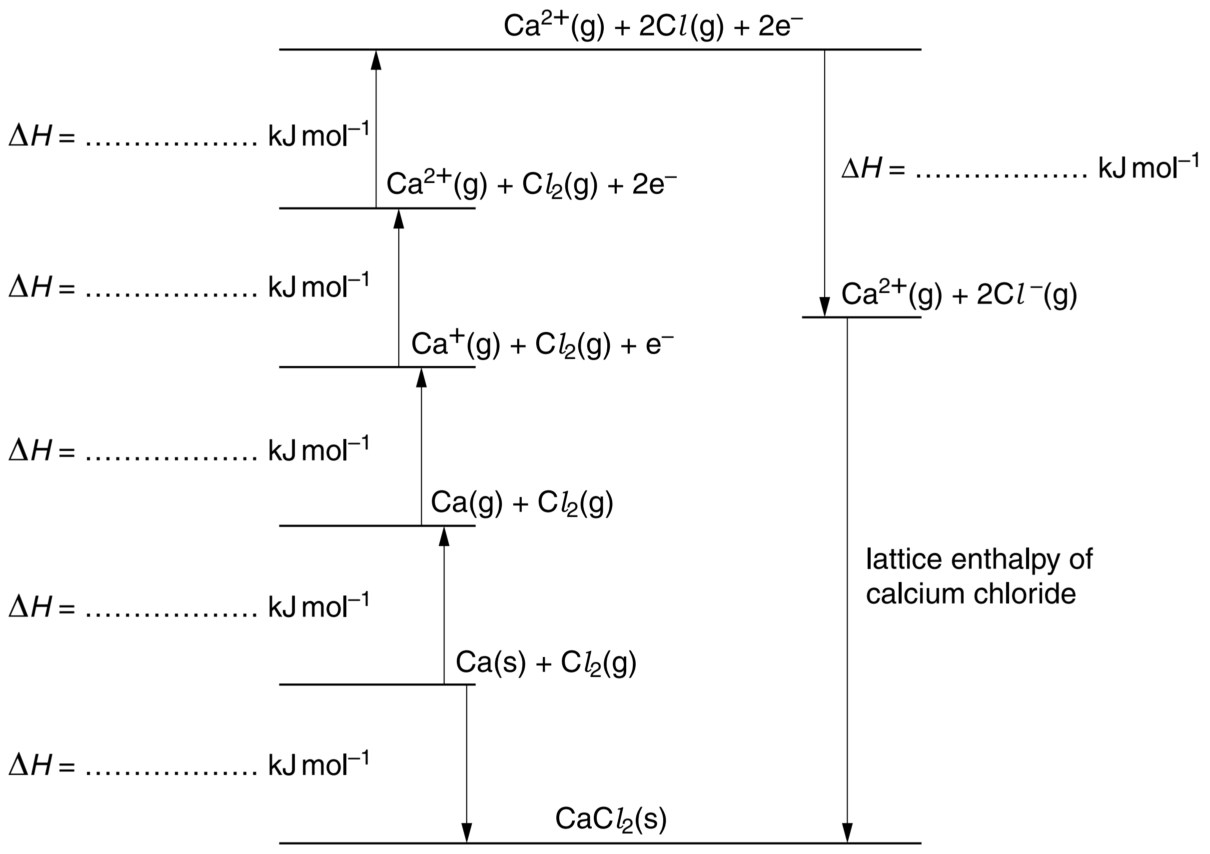
This question paper consists of 8 printed pages.

Answer **all** the questions.

1 The table below shows the enthalpy changes needed to calculate the lattice enthalpy of calcium chloride, $CaCl_2$.

process	enthalpy change / kJ mol^{-1}
first ionisation energy of calcium	+590
second ionisation energy of calcium	+1150
electron affinity of chlorine	–348
enthalpy change of formation for calcium chloride	–796
enthalpy change of atomisation for calcium	+178
enthalpy change of atomisation for chlorine	+122

(a) The Born-Haber cycle below can be used to calculate the lattice enthalpy for calcium chloride.



For Examiner's Use

(i) Use the table of enthalpy changes to complete the Born-Haber cycle by putting in the correct numerical values on the appropriate dotted line. [3]

(ii) Use the Born-Haber cycle to calculate the lattice enthalpy of calcium chloride.

answer .... $kJ\,mol^{-1}$ [2]

(iii) Describe how, and explain why, the lattice enthalpy of magnesium fluoride differs from that of calcium chloride.

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.... [3]

(b) Explain why the first ionisation energy of calcium is less positive than the second ionisation energy.

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.... [2]

[Total: 10]

[Turn over

For Examiner's Use

2 A moss killer contains iron(II) sulphate.

Some of the iron(II) sulphate gets oxidised to form iron(III) sulphate. During the oxidation iron(II) ions, Fe^{2+}, react with oxygen, O_2, and hydrogen ions to make water and iron(III) ions, Fe^{3+}.

(a) Complete the electronic configuration for Fe^{3+} and use it to explain why iron is a transition element.

Fe^{3+}:$1s^2 2s^2 2p^6$ ....

....

.... [2]

(b) State **two** typical properties of **compounds** of a transition element.

1 ....

2 .... [2]

(c) Describe how aqueous sodium hydroxide can be used to distinguish between aqueous iron(II) sulphate and aqueous iron(III) sulphate.

....

....

.... [2]

(d) Construct the equation for the oxidation of acidified iron(II) ions by oxygen.

.... [2]

For Examiner's Use

(e) The percentage by mass of iron in a sample of moss killer can be determined by titration against acidified potassium manganate(VII).

- Stage 1 – A sample of moss killer is dissolved in excess sulphuric acid.
- Stage 2 – Copper turnings are added to the acidified sample of moss killer and the mixture is boiled carefully for five minutes. Copper reduces any iron(III) ions in the sample to give iron(II) ions.
- Stage 3 – The reaction mixture is filtered into a conical flask to remove excess copper.
- Stage 4 – The contents of the flask are titrated against aqueous potassium manganate(VII).

(i) Suggest why it is important to remove all the copper in stage 3 before titrating in stage 4.

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.... [1]

(ii) The ionic equation for the redox reaction between acidified MnO_4^- and Fe^{2+} is given below.

$$MnO_4^-(aq) + 8H^+(aq) + 5Fe^{2+}(aq) \longrightarrow Mn^{2+}(aq) + 4H_2O(l) + 5Fe^{3+}(aq)$$

Explain, in terms of electron transfer, why this reaction involves both oxidation and reduction.

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.... [2]

(iii) A student analyses a 0.675 g sample of moss killer using the method described.

In stage 4, the student uses 22.5 cm^3 of 0.0200 mol dm^{-3} MnO_4^- to reach the end-point.

Calculate the percentage by mass of iron in the moss killer.

percentage .... [4]

[Total: 15]

For Examiner's Use

3 Aqueous copper(II) sulphate contains $[Cu(H_2O)_6]^{2+}$ ions. Aqueous ammonia is added drop by drop to a small volume of aqueous copper(II) sulphate. Two reactions take place, one after the other, as shown in the equations.

$$[Cu(H_2O)_6]^{2+}(aq) + 2OH^-(aq) \longrightarrow Cu(OH)_2(s) + 6H_2O(l)$$

$$Cu(OH)_2(s) + 2H_2O(l) + 4NH_3(aq) \longrightarrow [Cu(NH_3)_4(H_2O)_2]^{2+}(aq) + 2OH^-(aq)$$

(a) Describe the observations that would be made as ammonia is added drop by drop until it is in an excess.

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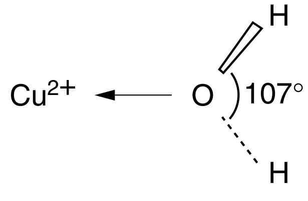
.... [2]

(b) Draw the shape for the $[Cu(H_2O)_6]^{2+}$ ion. Include the bond angles in your diagram.

[2]

(c) Water is a simple molecule. The H—O—H bond angle in an isolated water molecule is 104.5°.

The diagram shows part of the $[Cu(H_2O)_6]^{2+}$ ion and the H—O—H bond angle in the water ligand.



Explain why the H—O—H bond angle in the water ligand is 107° rather than 104.5°.

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.... [3]

[Total: 7]

For Examiner's Use

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

There are trends in the physical and chemical properties of the oxides of the elements of period 3.

Using only the oxides of the elements magnesium, aluminium and sulphur,

- describe and explain the trends in

  chemical formula

  structure and bonding

  action of water

- explain the trend in the melting points shown in the table.

oxide	magnesium oxide	aluminium oxide	sulphur dioxide
melting point / °C	2826	2072	–10

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For Examiner's Use

.... [12]

Quality of Written Communication [1]

[Total: 13]

END OF QUESTION PAPER