OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

CHEMISTRY 2815/01

Trends and Patterns

Friday **23 JANUARY 2004** 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	15	
2	7	
3	9	
4	14	
TOTAL	45	

This question paper consists of 11 printed pages and 1 blank page.

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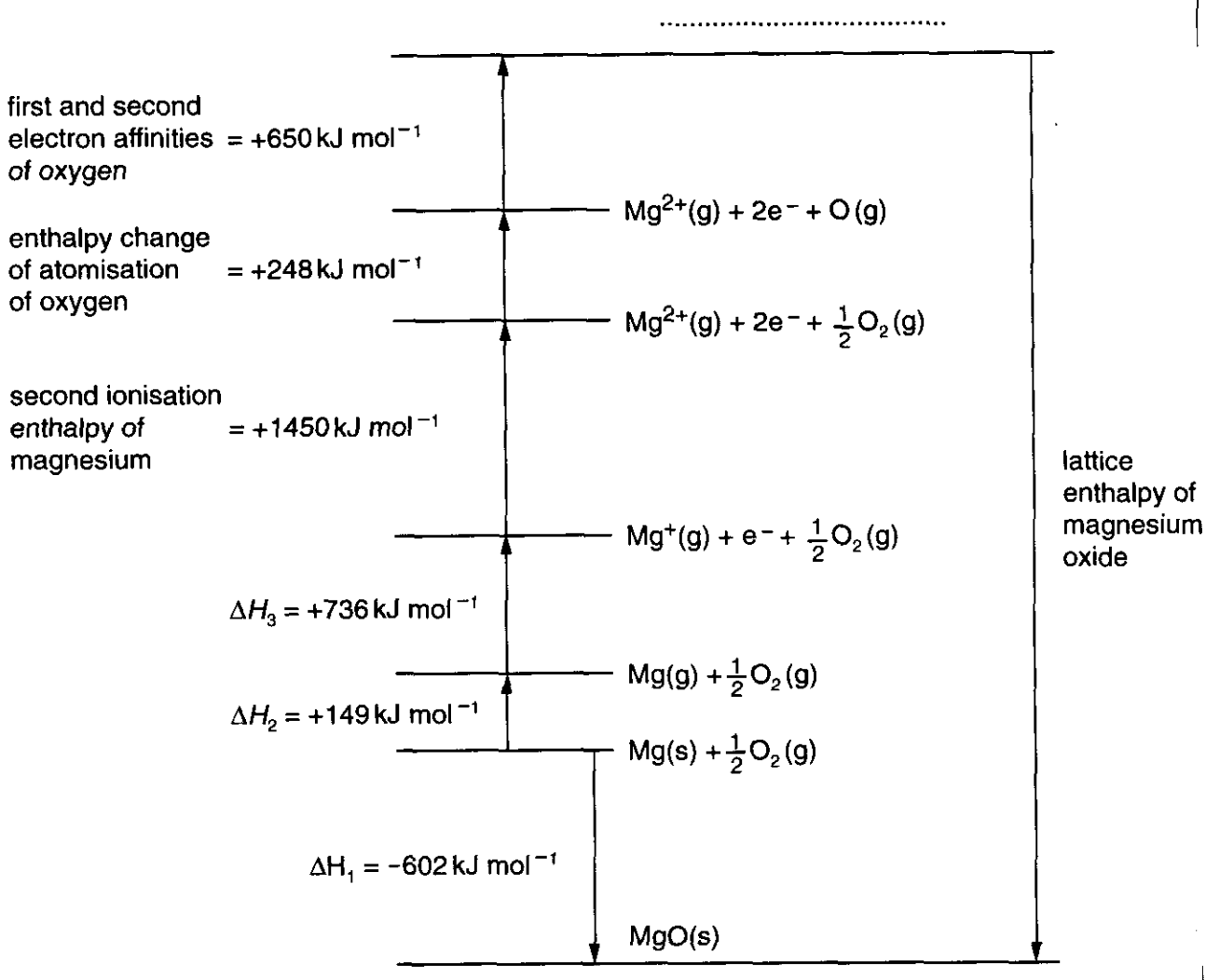
For Examiner's Use

Answer **all** the questions.

1 The Born-Haber cycle below can be used to calculate the lattice enthalpy for magnesium oxide.



(a) (i) Write down the name for each of the following enthalpy changes.

ΔH_1 .....

ΔH_2 .....

ΔH_3 .....[3]

(ii) Write down the missing formulae on the dotted line at the **top** of the Born-Haber cycle. Include state symbols. [1]

For Examiner's Use

(iii) The equations representing the first and second electron affinities for oxygen are shown below.

$$O(g) + e^- \longrightarrow O^-(g) \qquad \Delta H = -141\ kJ\ mol^{-1}$$
$$O^-(g) + e^- \longrightarrow O^{2-}(g) \qquad \Delta H = +791\ kJ\ mol^{-1}$$

Suggest why the enthalpy change for the second of these processes is positive.

.....

.....[1]

(b) (i) Use the Born-Haber cycle to calculate the lattice enthalpy of magnesium oxide.

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

(ii) Describe how, and explain why, the lattice enthalpy of magnesium oxide differs from that of barium oxide.

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.....[3]

(c) Give **one** reason why magnesium oxide is a good material to make the lining of a furnace.

.....[1]

[Turn over

(d) Magnesium carbonate and barium carbonate both decompose thermally.

(i) Write the equation for the decomposition of barium carbonate.

.....[1]

(ii) Describe and explain the difference between the decomposition temperature of barium carbonate and that of magnesium carbonate.

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.....[3]

[Total: 15]

2 Copper is a typical transition element.

- It forms coloured compounds.
- It forms complex ions.
- It has more than one oxidation state in its compounds.

(a) State **one** other typical property of a transition element.

.....[1]

(b) Dilute aqueous copper(II) sulphate is a blue solution containing $[Cu(H_2O)_6]^{2+}$ ions. A ligand substitution involving $[Cu(H_2O)_6]^{2+}$ is shown below.

$$\underset{\text{blue solution}}{[Cu(H_2O)_6]^{2+}} \xrightarrow{\text{reagent } \mathbf{X}} \underset{\text{yellow solution}}{[CuCl_4]^{2-}}$$

(i) Suggest a shape for the $[CuCl_4]^{2-}$ ion. Include the bond angles in your diagram.

[2]

(ii) State the **formula** of the ligand in $[CuCl_4]^{2-}$.

.....[1]

(iii) State the name or formula of reagent **X**.

.....[1]

(iv) Explain, with the aid of a balanced equation, what is meant by the term *ligand substitution*.

.....

.....

.....[2]

[Total: 7]

[Turn over

3 Aqueous hydrogen peroxide, H_2O_2, is used to sterilise contact lenses.
H_2O_2 decomposes to make oxygen and water as shown in the equation.

$$2H_2O_2(aq) \longrightarrow 2H_2O(l) + O_2(g)$$

(a) Decomposition of hydrogen peroxide is a redox reaction.
Use oxidation numbers to show that oxidation and reduction take place.

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.....[2]

(b) The concentration of an aqueous solution of hydrogen peroxide can be determined by titration. Aqueous potassium manganate(VII), $KMnO_4$, is titrated against a solution of hydrogen peroxide in the presence of acid.

The half-equation for the oxidation of H_2O_2 is as follows.

$$H_2O_2(aq) \longrightarrow O_2(g) + 2H^+(aq) + 2e^-$$

The half-equation for the reduction of acidified MnO_4^- is as follows.

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

(i) Construct the equation for the reaction between H_2O_2, MnO_4^- ions and H^+ ions.

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.....[2]

For Examiner's Use

(ii) A student takes a 25.0 cm^3 sample of aqueous hydrogen peroxide and places this into a conical flask and then adds sulphuric acid to acidify the hydrogen peroxide.

The student titrates this sample of acidified hydrogen peroxide against a solution containing 0.0200 mol dm^{-3} $MnO_4^-(aq)$ ions. For complete reaction with the acidified hydrogen peroxide, the student uses 17.5 cm^3 of this solution containing $MnO_4^-(aq)$ ions.

Calculate the concentration, in mol dm^{-3}, of the aqueous hydrogen peroxide.

2 mol MnO_4^- reacts with 5 mol H_2O_2.

concentration ..... mol dm^{-3} [3]

(c) Acidified hydrogen peroxide oxidises $Fe^{2+}(aq)$ to $Fe^{3+}(aq)$.

Describe a simple chemical test to show the presence of $Fe^{3+}(aq)$.

name of reagent used .....

observation .....

.....[2]

[Total: 9]

[Turn over

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

There are trends in the physical and chemical properties of the chlorides of the elements of Period 3.

Using the chlorides of the elements Na to Si **only**,

- 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.

chloride	sodium chloride	magnesium chloride	aluminium chloride	silicon(IV) chloride
melting point / °C	808	714	180	–70

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Quality of Written Communication [1]

[Total: 14]

END OF QUESTION PAPER

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