OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY

Trends and Patterns

2815/01

| Monday | **26 JUNE 2006** | 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 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	10	
2	7	
3	5	
4	13	
5	10	
TOTAL	45	

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

[Turn over

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2

Answer **all** the questions.

1 The table below shows the enthalpy changes needed to construct a Born-Haber cycle for sodium oxide, Na_2O.

process	enthalpy change / kJ mol^{-1}
first ionisation energy of sodium	+495
first electron affinity of oxygen	−141
second electron affinity of oxygen	+791
enthalpy change of formation for sodium oxide	−416
enthalpy change of atomisation for sodium	+109
enthalpy change of atomisation for oxygen	+247

(a) Use the table of enthalpy changes to complete the Born-Haber cycle by putting in the correct numerical values on the appropriate dotted line. [4]

$$2Na^+(g) + O^{2-}(g)$$

$$2Na^+(g) + O(g) + 2e^- \qquad \Delta H = \text{..........kJ}$$

$$\Delta H = \text{..........kJ}$$

$$\Delta H = \text{..........kJ}$$

$$2Na^+(g) + O^-(g) + e^-$$

$$2Na^+(g) + \tfrac{1}{2}O_2(g) + 2e^-$$

$$\Delta H = \text{..........kJ}$$

$$2Na(g) + \tfrac{1}{2}O_2(g)$$

$$\Delta H = \text{..........kJ}$$

lattice enthalpy of sodium oxide

$$2Na(s) + \tfrac{1}{2}O_2(g)$$

$$\Delta H = \text{..........kJ}$$

$$Na_2O(s)$$

3
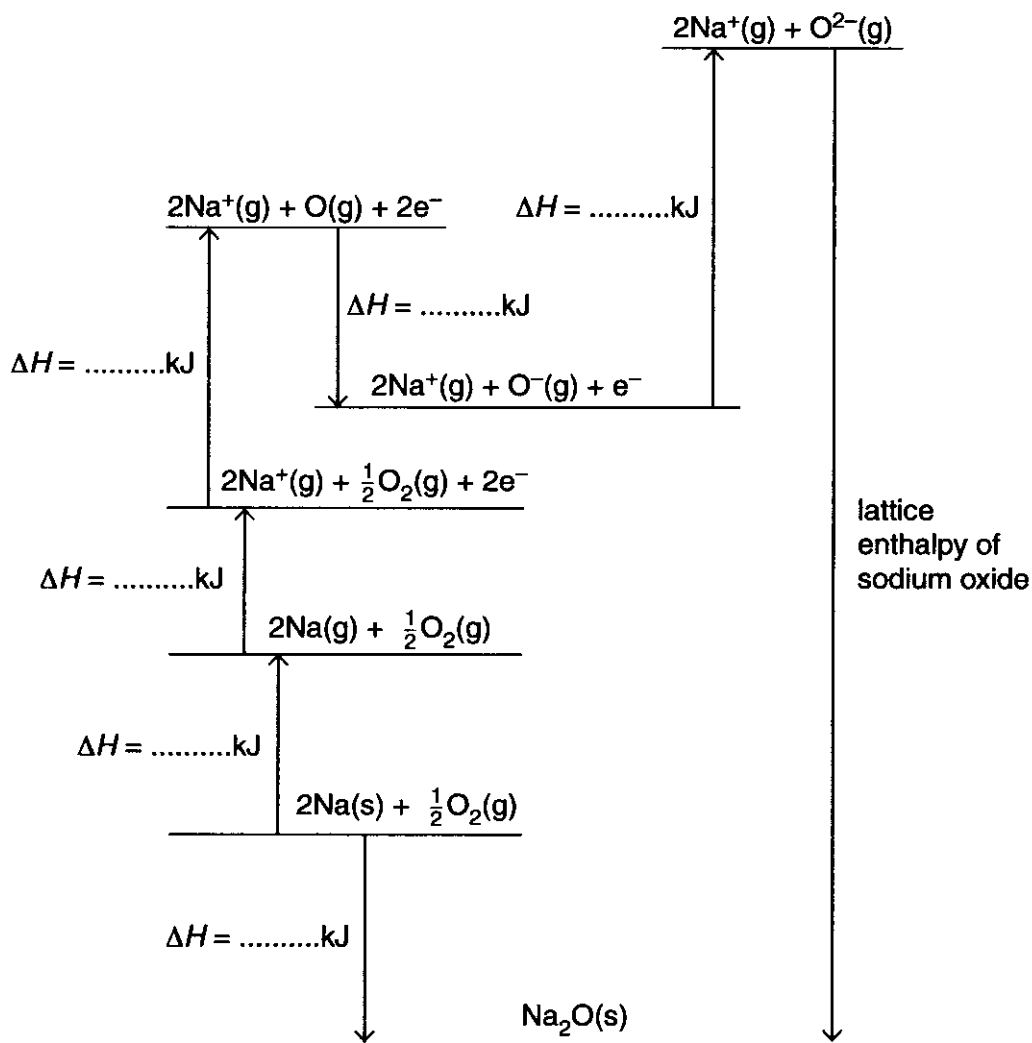
(b) Use the Born-Haber cycle to calculate the lattice enthalpy of sodium oxide.

lattice enthalpy =.....................................kJ mol^{-1} [2]

(c) Which one of the following compounds has the most exothermic lattice enthalpy?

- calcium bromide
- calcium chloride
- potassium bromide
- potassium chloride

Explain your answer in terms of the ions present.

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.... [4]

[Total: 10]

4

2 Copper and zinc are both d-block elements but only copper is a transition element. Copper forms compounds containing Cu^{2+} or Cu^+ ions but zinc only forms compounds containing Zn^{2+} ions.

(a) Use the electronic configurations of Cu^{2+} and Zn^{2+} to explain why copper is a transition element and zinc is not.

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.... [2]

(b) Suggest **two** differences between compounds containing Zn^{2+} and Cu^{2+} ions.

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.... [2]
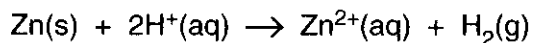
(c) Brass is an alloy of copper and zinc.

The percentage of copper and zinc in a sample of brass can be determined by reaction with hydrochloric acid. Only zinc reacts, as shown in the equation below.

$$Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$$

- A sample of brass powder of known mass is added to an excess of $1.00\,mol\,dm^{-3}$ hydrochloric acid.
- The mixture is heated gently and the hydrogen collected is measured once the reaction has finished.

A student analyses a 1.23 g sample of brass using the method described.
The student collects $76.0\,cm^3$ of hydrogen at room temperature and pressure.
1 mol of gas molecules occupies $24.0\,dm^3$ at room temperature and pressure.

Calculate the percentage by mass of copper in the sample of brass.
Give your answer to an appropriate number of significant figures.

answer.. % [3]

[Total: 7]

[Turn over

6

3 Artists between the 13th and the 19th Centuries used a green pigment called verdigris. The artists made the pigment by hanging copper foil over boiling vinegar.

(a) During the preparation of verdigris, copper atoms are oxidised to copper(II) ions.

(i) Write the oxidation half equation for the conversion of copper atoms into copper(II) ions.

....[1]

(ii) The reduction half equation that takes place is as follows.

$$O_2(g) + 4H^+(aq) + 4e^- \rightarrow 2H_2O(l)$$
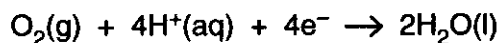
Construct the equation for the redox reaction between copper, oxygen and hydrogen ions.

[1]

(b) A sample of verdigris has the formula $[(CH_3COO)_2Cu]_2.Cu(OH)_2.xH_2O$.
Analysis of the sample shows that it contains 16.3% water by mass.
Calculate the value of **x** in the formula.

answer...[3]

[Total: 5]

7

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8

4   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 sodium oxide, Na_2O. Only draw the outer shell electrons.

[2]

(b) Magnesium oxide is a basic oxide which has a very high melting point.

(i) Explain why magnesium oxide has a very high melting point.

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.... [2]

(ii) A small mass of magnesium oxide is added to water. The mixture is stirred thoroughly and an aqueous solution is formed.
What is the name of the solution formed? Estimate its pH value.

.... [1]

(iii) Give the ionic equation, including state symbols, for the reaction between solid magnesium oxide and hydrochloric acid.

.... [2]

(c) Write an equation to show the formation of aluminium oxide from its elements.

.... [1]

(d) Silicon(IV) oxide has a giant molecular structure that is similar to that of diamond. Suggest **two** physical properties of silicon(IV) oxide.

1. ....

2. .... [2]

(e) Chlorine(VII) oxide, Cl_2O_7, has a simple molecular structure. Suggest one **chemical** property of Cl_2O_7.

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.... [1]

(f) Compare the reactions of sodium and magnesium with cold water. Identify the products formed in each case.

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.... [2]

[Total: 13]

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

Iron and its compounds take part in several different types of reaction including ligand substitution, precipitation and redox.

For each type of reaction

- give an example, taken from the chemistry of iron or its compounds
- state what you would see
- write a balanced equation for your example.

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Quality of Written Communication [1]

[Total : 10]

END OF QUESTION PAPER

12

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