THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

CHEMISTRY

Trends and Patterns

2815/01

Candidates answer on the question paper

OCR Supplied Materials:
- *Data Sheet for Chemistry* (inserted)

Other Materials Required:
- Scientific calculator

Thursday 18 June 2009
Morning

Duration: 1 hour

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* C U P / T 7 6 1 2 6 *

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **45**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.
- This document consists of **12** pages. Any blank pages are indicated.

FOR EXAMINER'S USE		
Qu.	**Max.**	**Mark**
1	**10**	
2	**9**	
3	**14**	
4	**12**	
TOTAL	**45**	

SP SHW 00132 12/07 T76126/2

Answer **all** the questions.

1 The lattice enthalpy of an ionic compound can be determined using a Born-Haber cycle.

(a) Complete the following table which shows some of the enthalpy changes needed to calculate the lattice enthalpy of barium oxide.

name of enthalpy change	process
.....	$Ba(s) \rightarrow Ba(g)$
first ionisation energy of barium	.....
.....	$O^-(g) + e^- \rightarrow O^{2-}(g)$
enthalpy change of formation of barium oxide	.....

[4]

(b) Suggest why the lattice enthalpy of an ionic solid cannot be measured directly.

.....

..... **[1]**

(c) The lattice enthalpy of barium oxide is more exothermic than that of barium carbonate.

Explain why.

.....

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.....

..... **[2]**

(d) Positive ions can polarise negative ions. Arrange the following ions into **increasing** order of polarising ability. Explain your answer.

Al^{3+} Mg^{2+} Na^{+} Rb^{+}

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.....

.....

..... **[3]**

[Total: 10]

2 Sodium oxide, Na_2O, is a white solid. Sulphur dioxide, SO_2, is a colourless gas. Silicon(IV) oxide, SiO_2, is a white solid.

(a) (i) What is the structure and bonding of sodium oxide?

..... **[1]**

(ii) Draw a '*dot-and-cross*' diagram for sodium oxide. You only need to draw the outer shell electrons.

[2]

(iii) Sodium oxide reacts with water. This is an example of an acid-base reaction.

Write an equation for the reaction and use it to explain why water behaves as an acid in this reaction.

.....

.....

.....

..... **[2]**

(b) (i) Sulphur dioxide reacts with water to form an acidic solution.

What is the formula of the acid formed in this reaction?

..... **[1]**

(ii) Sulphur dioxide is a gas at room temperature but silicon(IV) oxide has a very high melting point. Explain why in terms of structure and bonding.

.....

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..... **[3]**

[Total: 9]

3 **(a)** Hydrogen peroxide, H_2O_2, is sold as an aqueous solution.

The concentration of $H_2O_2(aq)$ can be determined by its reaction with acidified manganate(VII) ions.

- **Stage 1** – A 25.0 cm^3 sample of $H_2O_2(aq)$ is added to a 250 cm^3 graduated flask.
- **Stage 2** – Sufficient distilled water is added to the graduated flask to make 250 cm^3 of diluted $H_2O_2(aq)$.
- **Stage 3** – A 10.0 cm^3 sample of diluted $H_2O_2(aq)$ is added to a conical flask.
- **Stage 4** – The diluted sample has 25.0 cm^3 of 1 mol dm^{-3} sulphuric acid added to it.
- **Stage 5** – The contents of the flask are titrated against 0.0200 mol dm^{-3} MnO_4^-.

In **stage 5**, the equation for the reaction between $H_2O_2(aq)$ and acidified MnO_4^- is shown below.

$$5H_2O_2(aq) + 6H^+(aq) + 2MnO_4^-(aq) \rightarrow 2Mn^{2+}(aq) + 5O_2(g) + 8H_2O(l)$$

In **stage 5**, the titre was 28.55 cm^3.

Calculate the concentration, in g dm^{-3}, of the **undiluted** H_2O_2.

concentration of undiluted $H_2O_2(aq)$ = ... g dm^{-3} **[4]**

(b) Aqueous iron(II) ions, Fe^{2+}, can be oxidised by hydrogen peroxide, H_2O_2, under acidic conditions.

The reduction half-equation is as follows.

$$H_2O_2(aq) + 2H^+(aq) + 2e^- \rightarrow 2H_2O(l)$$

Construct the equation for the oxidation of $Fe^{2+}(aq)$ to $Fe^{3+}(aq)$ by hydrogen peroxide under acidic conditions.

.....

.....

..... **[2]**

(c) Describe, with the aid of an ionic equation, how aqueous sodium hydroxide can be used to confirm the presence of $Fe^{3+}(aq)$ ions.

.....

.....

..... **[2]**

(d) An unusual oxide of potassium is potassium superoxide, KO_2. It contains the mole ratio of one potassium ion to one superoxide ion. It is used in submarines to provide an emergency supply of oxygen and to remove carbon dioxide from the air.

$$4KO_2 + 2H_2O \longrightarrow 4KOH + 3O_2$$

$$2KOH + CO_2 \longrightarrow K_2CO_3 + H_2O$$

In KO_2, one of the oxygen atoms has an oxidation state of –1 and the other an oxidation state of 0.

(i) What is the charge on the superoxide ion?

..... **[1]**

(ii) The reaction between potassium superoxide and water involves both oxidation and reduction.

Use oxidation numbers to explain why.

.....

.....

..... **[2]**

(iii) What volume of carbon dioxide, measured at room temperature and pressure, can be removed from air using 1.00 kg of potassium superoxide?

One mole of gas molecules at room temperature and pressure occupies 24.0 dm^3.

volume of carbon dioxide = ... dm^3 **[3]**

[Total: 14]

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

One of the typical properties of transition elements is that they form complex ions.

- State three **other** typical properties of the compounds or ions of a transition element.
- Describe the bonding and shape of a complex ion containing **iron**. Include relevant bond angles in your answer.
- Describe, with the aid of an equation, ligand substitution using an example taken from the chemistry of **iron** or **copper**. Include experimental observations in your answer.

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.... **[11]**

Quality of Written Communication **[1]**

[Total: 12]

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