THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

CHEMISTRY

Trends and Patterns

2815/01

Candidates answer on the question paper
A calculator may be used for this paper

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

Other Materials Required:
- Scientific calculator

Friday 23 January 2009
Morning

Duration: 1 hour

2815501

CUP/T76203

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	**12**	
3	**6**	
4	**17**	
TOTAL	**45**	

SP SHW 00132 12/07 T76203/2

Answer **all** the questions.

1 Copper is a transition element. It forms compounds in which the oxidation number of copper is +1 or +2.

(a) Complete the electronic configuration of the copper(II) ion, Cu^{2+}.

$1s^2\ 2s^2\ 2p^6$..... **[1]**

(b) Transition elements form coloured complex ions. Choose an example of a coloured complex ion in which copper has the +2 oxidation state.

(i) Write the formula of your chosen coloured copper(II) complex ion.

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

(ii) What is the colour of your chosen complex ion?

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

(iii) Name and describe the bonding between the ligand and the metal ion within your chosen complex ion.

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

(c) Aqueous sodium hydroxide is added to aqueous copper(II) sulphate.

(i) Describe what you would see.

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

(ii) Write an ionic equation for the reaction taking place.

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

(d) A compound containing a copper complex ion was analysed. A sample was found to contain 0.938 g of potassium, 0.508 g of copper, 0.384 g of carbon and 0.448 g of nitrogen.

(i) Calculate the empirical formula of the compound.

[2]

(ii) Suggest the formula for the copper complex ion.

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

[Total: 10]

2 This question is about chlorides.

(a) Magnesium chloride has a high melting point.

(i) Draw a '*dot-and-cross*' diagram for magnesium chloride. You only need to draw the outer shell electrons.

[2]

(ii) Explain, in terms of structure and bonding, why magnesium chloride has a high melting point.

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

(b) Write an equation to show the formation of silicon(IV) chloride from its elements.

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

(c) Gaseous phosphorus(V) chloride exists as simple molecules with the formula PCl_5.

Draw a '*dot-and-cross*' diagram for PCl_5. You only need to draw the outer shell electrons.

[2]

(d) Phosphorus(V) chloride reacts with water.

(i) Write an equation for this reaction.

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

(ii) What is the name of this type of reaction?

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

(e) Anhydrous iron(III) chloride has the formula Fe_2Cl_6. It reacts with water to give a highly acidic solution.

What does this suggest about the bonding in Fe_2Cl_6?

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

(f) Aqueous iron(III) chloride contains aqueous iron(III) ions.

(i) Describe what you would see when aqueous thiocyanate ions are added to aqueous iron(III) chloride.

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

(ii) What is the name of this type of reaction?

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

[Total: 12]

3 This question is about redox reactions of some compounds of transition elements.

(a) Chromium(III) ions can be oxidised by hydrogen peroxide under alkaline conditions.

The relevant half-equations are as follows.

$$H_2O_2(aq) + 2e^- \rightarrow 2\ OH^-(aq)$$

$$Cr^{3+}(aq) + 8\ OH^-(aq) \rightarrow CrO_4^{2-}(aq) + 4H_2O(l) + 3e^-$$

Construct the equation for the oxidation of Cr^{3+} by H_2O_2 under alkaline conditions.

.....

.....

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

(b) Hydrated iron(II) ammonium sulphate has the formula $Fe(NH_4)_2(SO_4)_2.\boldsymbol{x}H_2O$.

The value of $\boldsymbol{x}$ in $Fe(NH_4)_2(SO_4)_2.\boldsymbol{x}H_2O$ can be determined by its reaction with acidified manganate(VII) ions.

- **Stage 1** – A sample of hydrated iron(II) ammonium sulphate of known mass is added to a conical flask.
- **Stage 2** – The sample has 25 cm^3 of 1 mol dm^{-3} sulphuric acid added to it.
- **Stage 3** – The contents of the flask are titrated against 0.0200 mol dm^{-3} MnO_4^-.

In **stage 2**, the hydrated crystals dissolve.

$$Fe(NH_4)_2(SO_4)_2.\boldsymbol{x}H_2O(s) + (aq) \longrightarrow Fe^{2+}(aq) + 2NH_4^+(aq) + 2SO_4^{2-}(aq) + \boldsymbol{x}H_2O(l)$$

In **stage 3**, the equation for the reaction between Fe^{2+} and acidified MnO_4^- is shown below.

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

In **stage 1**, a student used 0.907 g of $Fe(NH_4)_2(SO_4)_2.\boldsymbol{x}H_2O$.

In **stage 3**, the titre was 23.15 cm^3.

Calculate the relative formula mass of $Fe(NH_4)_2(SO_4)_2.\boldsymbol{x}H_2O$. Hence determine the value of $\boldsymbol{x}$.

relative formula mass = ...

$\boldsymbol{x}$ = ... **[4]**

[Total: 6]

4 This question is about lattice enthalpy and the decomposition of metal carbonates.

(a) Magnesium carbonate thermally decomposes as shown in the equation.

$$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$$

(i) Explain why magnesium carbonate decomposes at a much lower temperature than barium carbonate.

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

(ii) It takes an extremely high temperature to decompose sodium carbonate.

Suggest why.

.....

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

(b) In this question, one mark is available for the quality of your spelling, punctuation and grammar.

Lattice enthalpy is a measure of ionic bond strength.

- Distinguish, with the aid of equations, between the terms *lattice enthalpy* of sodium oxide and *enthalpy change of formation* of sodium oxide, Na_2O.

- Draw a labelled Born-Haber cycle. Include the names of all relevant enthalpy changes.

  Describe how the lattice enthalpy of sodium oxide can be calculated.

- Arrange the following compounds in order of their lattice enthalpies with the most exothermic first. Explain your answer.

  magnesium oxide **potassium bromide** **sodium chloride**

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[12]

Quality of Written Communication **[1]**

[Total: 17]

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