



**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**



Candidate Forename		Candidate Surname	
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Centre Number						Candidate Number				
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**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	
<b>TOTAL</b>	<b>45</b>	

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,  $\text{Cu}^{2+}$ .

$1s^2 2s^2 2p^6$  ..... [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.

.....  
.....  
.....  
..... [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.

.....  
 .....  
 .....  
 ..... [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  $\text{Fe}_2\text{Cl}_6$ . It reacts with water to give a highly acidic solution.

What does this suggest about the bonding in  $\text{Fe}_2\text{Cl}_6$ ?

..... [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?

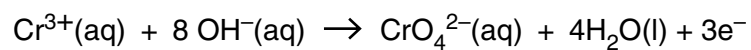
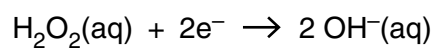
..... [1]

**[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.



Construct the equation for the oxidation of  $\text{Cr}^{3+}$  by  $\text{H}_2\text{O}_2$  under alkaline conditions.

.....

.....

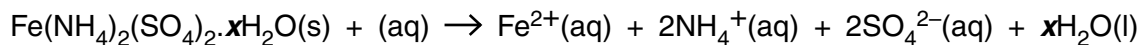
..... [2]

(b) Hydrated iron(II) ammonium sulphate has the formula  $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot x\text{H}_2\text{O}$ .

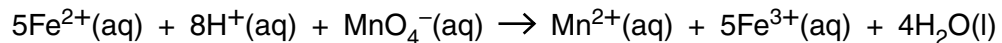
The value of  $x$  in  $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot x\text{H}_2\text{O}$  can be determined by its reaction with acidified manganate(VII) ions.

- **Stage 1** – A sample of hydrated iron(II) ammonium sulphate of known mass is added to a conical flask.
- **Stage 2** – The sample has  $25 \text{ cm}^3$  of  $1 \text{ mol dm}^{-3}$  sulphuric acid added to it.
- **Stage 3** – The contents of the flask are titrated against  $0.0200 \text{ mol dm}^{-3} \text{ MnO}_4^-$ .

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



In **stage 3**, the equation for the reaction between  $\text{Fe}^{2+}$  and acidified  $\text{MnO}_4^-$  is shown below.



In **stage 1**, a student used  $0.907 \text{ g}$  of  $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot x\text{H}_2\text{O}$ .

In **stage 3**, the titre was  $23.15 \text{ cm}^3$ .

Calculate the relative formula mass of  $\text{Fe}(\text{NH}_4)_2(\text{SO}_4)_2 \cdot x\text{H}_2\text{O}$ . Hence determine the value of  $x$ .

relative formula mass = .....

$x = \dots\dots\dots$  [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.



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

.....  
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.....  
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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<sub>2</sub>O.
- 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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