OCR

RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY   **2815/01**

Trends and Patterns

| Wednesday | **30 JANUARY 2002** | 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 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		
Question Number	Mark	Mark
1	10	
2	11	
3	9	
4	15	
TOTAL	45	

This question paper consists of 8 printed pages.

[Turn over

2

Answer **all** questions.

1 Enthalpy changes of formation can be calculated using Born-Haber cycles.

(a) Construct a labelled Born-Haber cycle for magnesium chloride, $MgCl_2$, using the information below.

enthalpy change	energy/kJ mol^{-1}
atomisation of magnesium	+148
atomisation of chlorine	+122
1st ionisation energy of magnesium	+738
2nd ionisation energy of magnesium	+1451
1st electron affinity of chlorine	−349
lattice enthalpy of magnesium chloride	−2526
formation of magnesium chloride	?

[5]

(b) Use the Born-Haber cycle to calculate a value for the enthalpy change of formation of magnesium chloride.

[2]

(c) State and explain which compound has the **most exothermic** lattice enthalpy; $MgCl_2$, $MgBr_2$ or MgI_2.

....

....

....

....[3]

[Total : 10]

[Turn over

4

2   Iron in compounds commonly exists as Fe^{2+} and Fe^{3+}.

(a)   Complete the electronic configuration of the Fe^{3+} **ion**.

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

(b)   (i)   State **one** reason why transition metals are good catalysts.

....

....[1]

(ii)   State **one** example of iron or a compound of iron being used as a catalyst in industry.

....[1]

(c)   Complete the following notes taken during a laboratory experiment.

Aqueous thiocyanate ions were added to aqueous iron(III) ions.
The solution changed colour

from .... *to* ....

Equation: ....[4]

(d)   Aqueous manganate(VII) ions were titrated against 25.0 cm³ of 0.0500 mol dm⁻³ Fe(II) ions in acid solution.

$$5Fe^{2+}(aq) + MnO_4^-(aq) + 8H^+(aq) \rightarrow Mn^{2+}(aq) + 5Fe^{3+}(aq) + 4H_2O(l)$$
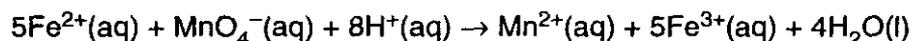
The volume of aqueous manganate(VII) ions required to reach the end point was 12.3 cm³.

(i)   State the colour change observed at the end point.

from .... to...[1]

(ii)   Calculate the concentration of the aqueous manganate(VII) ions used in the titration.

Answer...................mol dm⁻³   [3]

[Total : 11]

5

3   The compounds of magnesium are widely used and widely studied.

(a)   State **one** reason why magnesium oxide is used to make high-temperature ceramic materials.

....[1]

(b)   Magnesium oxide reacts with hydrochloric acid to form magnesium chloride.

Write an equation, including state symbols, for this reaction.

....[2]

(c)   Predict the approximate pH of the solution formed when the following compounds are added to water.

magnesium oxide   pH is ....

magnesium chloride   pH is..   [2]

(d)   State the bonding and structure in magnesium chloride.

bonding ....

structure ....[2]

(e)   Explain why different temperatures are needed to decompose magnesium carbonate and calcium carbonate.

decomposition reaction	decomposition temperature/°C
$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$	540
$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$	900

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....[2]

[Total : 9]

[Turn over

4 *(In this question, 1 mark is available for the quality of written communication.)*

Copper forms complex ions.

(a) The absorption spectrum of a complex ion in aqueous solution is shown below.
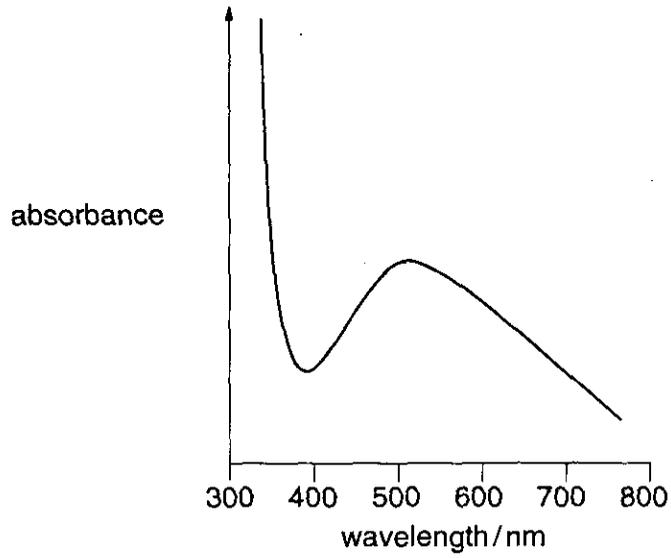
Predict the colour of the complex ion and explain your answer.

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....[2]

7

(b) Using complex ions of copper as examples, explain what is meant by the terms *complex ion* and *ligand*.

Explain what is meant by *ligand substitution*, giving two examples that are accompanied by a colour change and including equations in your answer.

Describe, using suitable examples, two different shapes of complex ions.   [13]

[Total : 15]

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