

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**
**Advanced GCE**
**CHEMISTRY**
**2815/06**

Transition Elements

Tuesday

**24 JUNE 2003**

Morning

50 minutes

Candidates answer on the question paper

Additional materials:

*Data sheet for Chemistry*

Scientific calculator

Candidate Name

Centre Number

 Candidate  
Number

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**TIME** 50 minutes

**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 provided 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		
Qu.	Max.	Mark
1	15	
2	11	
3	10	
4	9	
<b>TOTAL</b>	<b>45</b>	

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**This question paper consists of 8 printed pages.**

Answer **all** the questions.

1 Copper is an element that has many uses, both as a metal and in its compounds.

(a) By reference to a suitably labelled diagram, describe how you would measure the standard electrode potential of the  $\text{Cu}^{2+}/\text{Cu}$  electrode.

.....  
.....  
.....  
.....  
.....[6]

(b) Complete the electronic structures of

a Cu atom  $1s^22s^22p^6$  .....

a  $\text{Cu}^+$  ion  $1s^22s^22p^6$  .....

a  $\text{Cu}^{2+}$  ion  $1s^22s^22p^6$  .....

[3]



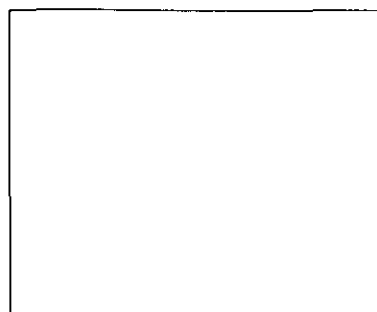
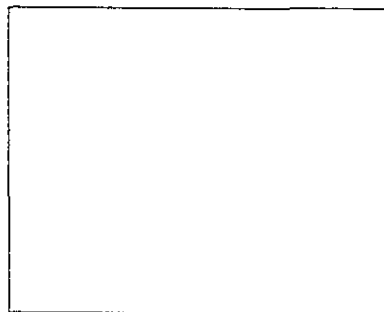
2 Cobalt ions can form complexes with many ligands.

(a) A complex of cobalt with the ligand  $X^-$  has the formula  $[CoX_4]^-$ .

(i) What is the oxidation state of cobalt in this complex? ..... [1]

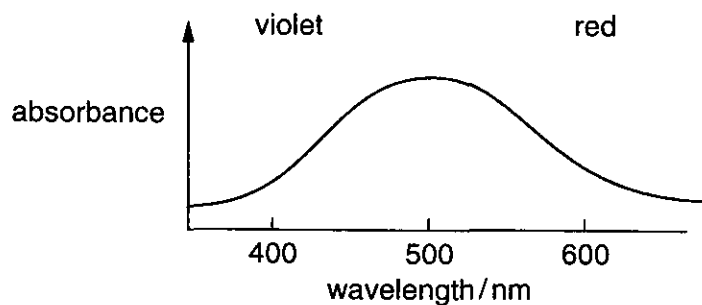
(ii) Some complex compounds with four ligands have one shape, other complexes with four ligands have a completely different shape.

Draw diagrams to show the two possible shapes for complexes with four-fold co-ordination.



[2]

(iii) The absorption spectrum for the complex  $[CoX_4]^-$  is shown below.



Suggest the colour of this complex. Explain your answer.

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

(b) The compound 1,2-diaminoethane,  $\text{H}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{NH}_2$ , is a bidentate ligand.

(i) Explain the meaning of the term *ligand*.

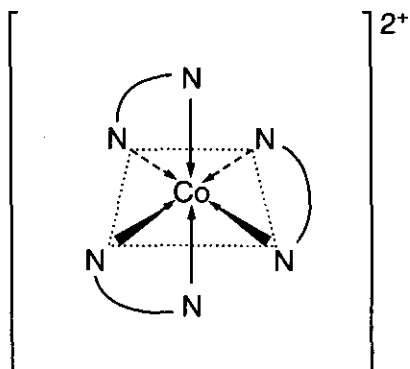
.....  
 .....[2]

(ii) Suggest the meaning of the term *bidentate*.

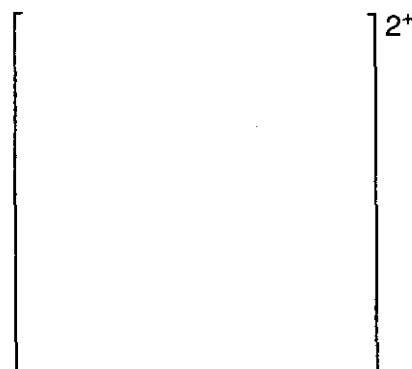
.....  
 .....[1]

(c) Cobalt(II) ions form a complex with the ligand 1,2-diaminoethane. The structure of an isomer of this complex is shown below (**structure A**).

 is used to represent 1,2-diaminoethane.



**structure A**



**structure B**

(i) In the space above (labelled **structure B**), draw the structure of another isomer of this complex. [1]

(ii) Name this type of isomerism. Explain why the complex shows this type of isomerism.

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

[Total: 11]

- 3 Some standard electrode (redox) potentials involving copper and its ions are given in the table below.

electrode reaction	$E^\ominus/V$
$\text{Cu}^+ + \text{e}^- \rightleftharpoons \text{Cu}$	+ 0.52
$\text{Cu}^{2+} + 2\text{e}^- \rightleftharpoons \text{Cu}$	+ 0.34
$\text{Cu}^{2+} + \text{e}^- \rightleftharpoons \text{Cu}^+$	+ 0.15

- (a) Use these data to explain why the reaction below is likely to occur.



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

- (b) This type of reaction can be called *disproportionation*. Explain the meaning of this term.

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

- (c) Some copper(I) compounds are stable. Suggest a condition under which copper(I) compounds are stable.

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

(d) When aqueous potassium iodide is added to aqueous copper(II) sulphate, a white solid and a yellow/brown solution are formed.

(i) Complete and balance the following equation for the reaction between copper(II) ions and iodide ions.



(ii) Including starting materials, use your answer to (i) to explain the observations above.

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

(e) Apart from its use to make pigments, give one use of copper. State the property which makes it suitable for this use.

use .....

property .....

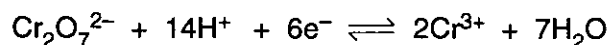
[1]

[Total: 10]

- 4 Compounds of chromium and manganese exist in a wide variety of oxidation states and these compounds can be used in redox reactions.

- (a) Under certain conditions dichromate(VI) ions,  $\text{Cr}_2\text{O}_7^{2-}$ , can oxidise manganese(II) ions,  $\text{Mn}^{2+}$ .

In this reaction, dichromate(VI) ions are reduced to chromium(III) ions according to the equation below.



In an experiment, it was found that  $20.0\text{ cm}^3$  of  $0.100\text{ mol dm}^{-3}$  potassium dichromate(VI) were needed to oxidise  $30.0\text{ cm}^3$  of  $0.200\text{ mol dm}^{-3}$  manganese(II) sulphate.

- (i) Calculate the amount of  $\text{Cr}_2\text{O}_7^{2-}$  used in the reaction.

..... mol [1]

- (ii) Calculate the amount of  $\text{Mn}^{2+}$  used in the reaction.

..... mol [1]

- (iii) Deduce the number of moles of  $\text{Mn}^{2+}$  that are oxidised by one mole of  $\text{Cr}_2\text{O}_7^{2-}$ .

[1]

- (iv) Deduce the oxidation state of manganese, after the manganese(II) sulphate has been oxidised. Show your reasoning.

[2]

- (b) A student added aqueous sodium hydroxide to aqueous potassium dichromate(VI) and noticed that the colour changed from orange to yellow. He thought that this was due to a change in the oxidation state of the chromium.  
Comment on the validity of this conclusion.

.....  
 .....  
 .....  
 .....  
 ..... [4]

[Total: 9]