OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced GCE

CHEMISTRY 2815/06

Transition Elements

Wednesday **29 JANUARY 2003** Afternoon 50 minutes

Candidates answer on the question paper.
Additional materials:
Data Sheet for Chemistry
Scientific calculator

Candidate Name	Centre Number	Candidate Number

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 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	10	
2	11	
3	7	
4	10	
5	7	
TOTAL	45	

This question paper consists of 8 printed pages.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 **(a)** A student wished to analyse the iron(II) content of a tablet given to pregnant women. He decided to oxidise the iron(II) with acidified potassium dichromate(VI).

The standard electrode potentials for the reactions involved are given below.

$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O \qquad E^\ominus = +1.33\,V$

$Fe^{3+} + e^- \rightleftharpoons Fe^{2+} \qquad E^\ominus = +0.77\,V$

(i) Define the term *standard electrode potential.*

.....

.....

.....

..... [3]

(ii) Explain, using the data given, why acidified dichromate(VI), $Cr_2O_7^{2-}$, is able to oxidise iron(II), Fe^{2+}.

.....

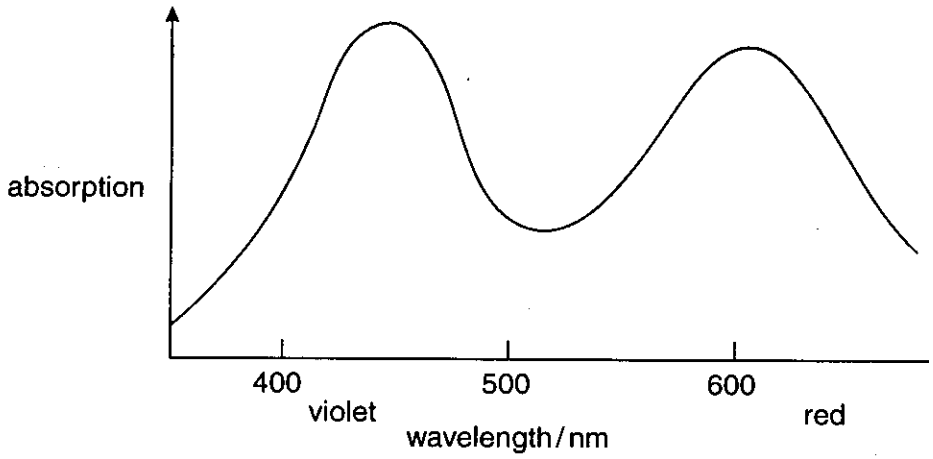
..... [1]

(iii) Construct the equation for this oxidation.

[2]

(b) Aqueous chromium(III) contains the complex ion $[Cr(H_2O)_6]^{3+}$.

The absorption spectrum of an aqueous solution of chromium(III) is shown below.



Suggest the colour of the solution. Explain your answer.

.....

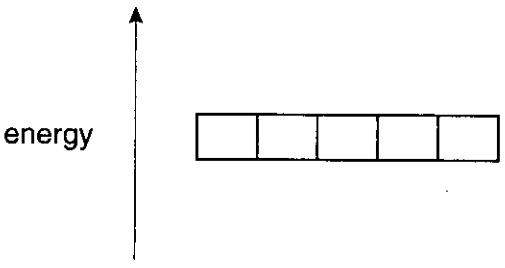
.....

..... [2]

(c) In a Cr^{3+} ion, all five 3d-orbitals have the same energy.

Complete the diagram below to show the splitting of the d-orbital energy levels when the octahedral complex ion, $[Cr(H_2O)_6]^{3+}$, is formed.

Note: you are **not** required to show the arrangement of electrons in the orbitals.



Cr^{3+} ion octahedral complex

[2]

[Total: 10]

2 Brass is a copper-containing alloy which is widely used for decorative purposes.

(a) What is the other main metal present in brass?

..... [1]

(b) A sample of brass was analysed to find the percentage copper that it contained.

- 0.500 g of brass was used
- the copper in the brass was converted into Cu^{2+} ions

  $Cu \longrightarrow Cu^{2+} + 2e^-$
- the Cu^{2+} ions were reacted with I^- ions to make I_2

  $Cu^{2+} + 2I^- \longrightarrow \frac{1}{2}I_2 + CuI$
- the I_2 was titrated with thiosulphate ions, $S_2O_3^{2-}$, using starch indicator

  $I_2 + 2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + 2I^-$
- 22.3 cm^3 of 0.200 mol dm^{-3} thiosulphate were needed for the titration.

(i) Calculate the amount of thiosulphate used in the titration.

..... mol [1]

(ii) Deduce the amount of I_2 that was titrated.

..... mol [1]

(iii) Deduce the amount of copper present in the sample of brass.

..... mol [1]

(iv) Calculate the percentage of copper present in the sample of brass.

[2]

(c) A student carried out the titration but forgot to add the starch indicator.

(i) What colour change would the student see at the end point **without** starch indicator?

from ..... to ..... [2]

(ii) Why is the colour change at the end point easier to see if starch is used?

.....

..... [1]

(d) Name another common alloy of copper and give a use for this alloy.

name .....

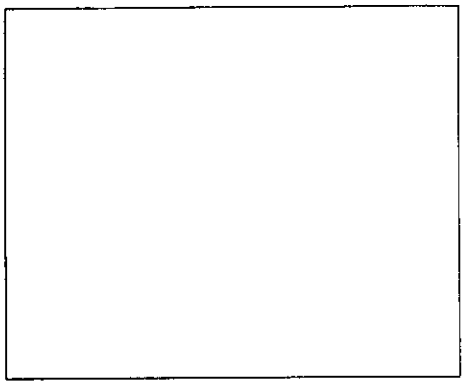
use ..... [2]

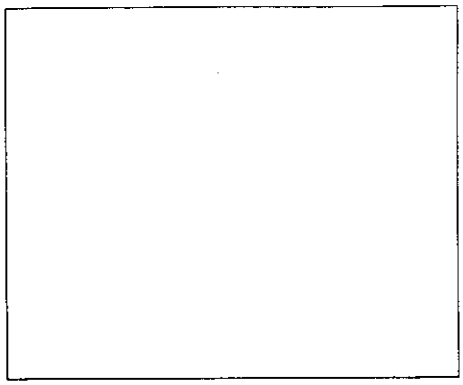
[Total: 11]

3 **(a)** A complex ion contains one Fe^{3+} ion, four molecules of ammonia and two chloride ions.

(i) What is the formula of this complex ion? ..... [1]

(ii) This complex shows *cis-trans* isomerism. Draw diagrams to show the structures of the *cis* and *trans* isomers.





[3]

(iii) What is the co-ordination number of this complex ion?

..... [1]

(b) Describe the role of *cis*-platin as an important therapeutic drug.

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..... [2]

[Total: 7]

4 Vanadium is a hard metal that is resistant to corrosion. It forms stable compounds with a wide range of oxidation states.

(a) What is the oxidation state of vanadium in the compound NH_4VO_3?

..... [1]

(b) Zinc powder is added to an acidified solution of NH_4VO_3.

Use the following data to describe and explain what you would see in the sequence of reactions that take place. Your answer should consider **all** of the electrode reactions below.

electrode reaction	$E^{\ominus}$ / V
$V^{2+} + 2e^- \rightleftharpoons V$	−1.20
$V^{3+} + e^- \rightleftharpoons V^{2+}$	−0.26
$VO^{2+} + 2H^+ + e^- \rightleftharpoons V^{3+} + H_2O$	+0.34
$VO_3^- + 4H^+ + e^- \rightleftharpoons VO^{2+} + 2H_2O$	+1.00
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	−0.76

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..... [7]

(c) Describe and explain the chemistry of vanadium(V) oxide in the Contact process.

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..... [2]

[Total: 10]

[Turn over

5 In this question, one mark will be awarded for the quality of written communication.

Cobalt is a transition element and therefore forms complex ions with different oxidation states. Many of these complex ions have characteristic colours.

By reference to suitable complex ions, describe the two most common oxidation states of cobalt. Include, where relevant, the stability and colours of the complex ions you describe.

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Quality of Written Communication [1]

[Total: 7]