OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced GCE

CHEMISTRY 2815/06

Transition Elements

Tuesday **28 JUNE 2005** Morning 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 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	12	
2	11	
3	10	
4	12	
TOTAL	45	

This question paper consists of 10 printed pages and 2 blank pages.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 Chlorine gas may be prepared in the laboratory by reacting hydrochloric acid with potassium manganate(VII). The following standard electrode potentials relate to this reaction.

$$\tfrac{1}{2}Cl_2 + e^- \rightleftharpoons Cl^- \qquad E^\ominus = +1.36\,V$$

$$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O \qquad E^\ominus = +1.52\,V$$

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

.....

.....

.....

..... [3]

(b) Determine the standard cell potential for a cell constructed from these two redox systems.

[1]

(c) Use the half-equations above to:

(i) construct an ionic equation for the reaction between hydrochloric acid and potassium manganate(VII);

.....

.....

..... [2]

(ii) determine the oxidation numbers of chlorine and manganese before and after the reaction has taken place;

.....

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..... [2]

(iii) state what is oxidised and what is reduced in this reaction.

.....

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..... [2]

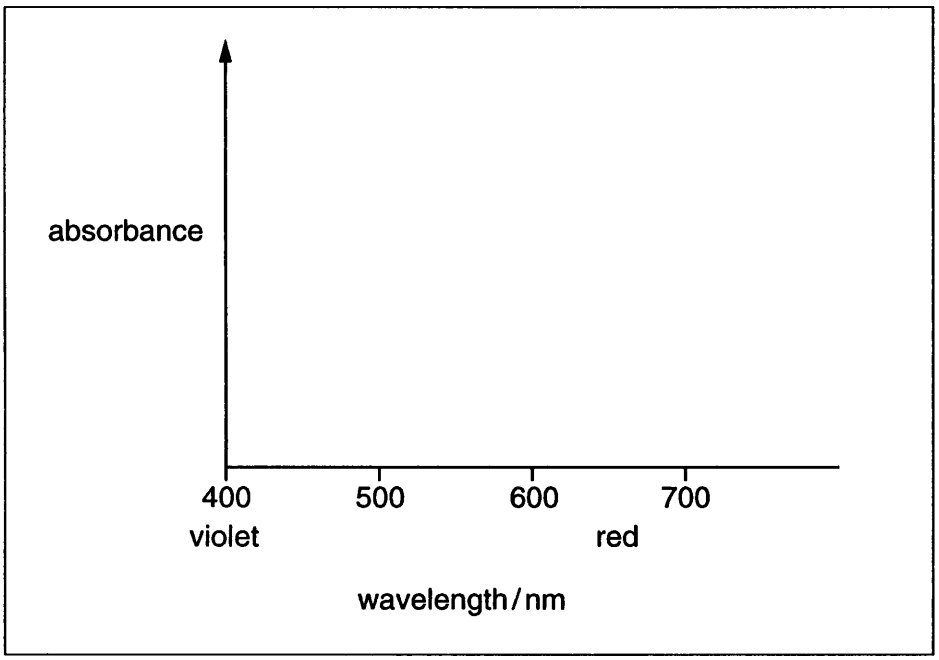
(d) If potassium manganate(VII) and very dilute hydrochloric acid are mixed, there is no visible reaction. Suggest why there is no visible reaction in this case.

.....

..... [1]

(e) A very dilute solution of potassium manganate(VII), which is purple in colour, was placed in a visible spectrometer.

In the box below, sketch the visible spectrum you would expect to see.



[1]

[Total: 12]

2 Brass is a widely used alloy of copper. It is possible to analyse a sample of brass by initially dissolving it in concentrated nitric acid.

(a) **(i)** What other metal is present in brass?

..... [1]

(ii) Give **one** common use for brass and state the property of brass which makes it ideal for that purpose.

.....

..... [1]

(b) During the analysis of brass, 1.65 g of the alloy was reacted with concentrated nitric acid. The resulting solution was neutralised, transferred to a volumetric flask and made up to 250 cm^3 using distilled water.

An excess of aqueous potassium iodide was added to a 25.0 cm^3 portion of the solution from the volumetric flask and the liberated iodine was titrated with 0.100 mol dm^{-3} sodium thiosulphate. 20.0 cm^3 of aqueous sodium thiosulphate were required to remove the iodine.

(i) What could be used to neutralise the excess nitric acid?

..... [1]

(ii) What indicator is used in the titration of iodine with sodium thiosulphate?

..... [1]

(iii) When is this indicator added to the titration mixture?

..... [1]

(c) The reactions taking place in this titration may be summarised as follows.

$$2Cu^{2+} + 4I^- \longrightarrow 2CuI + I_2$$

$$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$$

(i) Calculate the amount, in moles, of sodium thiosulphate in 20.0 cm^3 of solution.

answer ..... mol [1]

(ii) For every one mole of Cu^{2+} ions present in solution, deduce the amount, in moles, of $S_2O_3^{2-}$ ions needed for the titration.

answer ..... mol [1]

(iii) What is the amount, in moles, of Cu^{2+} ions present in 25.00 cm^3 of solution?

answer ..... mol [1]

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

answer ..... % Cu [3]

[Total: 11]

3 The Co^{2+} ion can form complexes with two different co-ordination numbers.

(a) What is meant by the *co-ordination number* of a complex ion?

.....

..... [1]

(b) The following equilibrium is readily established.

$$[Co(H_2O)_6]^{2+} + 4Cl^- \rightleftharpoons [CoCl_4]^{2-} + 6H_2O$$

(i) In the boxes below, draw the shape of each complex ion.

$[Co(H_2O)_6]^{2+}$	$[CoCl_4]^{2-}$

[2]

(ii) What colour change would you expect to see when an excess of Cl^- is added to $[Co(H_2O)_6]^{2+}$?

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

(iii) Describe how you would move the position of this equilibrium to the left.

..... [1]

(c) Cobalt also forms complex ions with an oxidation state of +3. The following standard electrode potentials refer to cobalt(III) complexes.

$$[Co(H_2O)_6]^{3+} + e^- \rightleftharpoons [Co(H_2O)_6]^{2+} \qquad E^{\ominus} = +1.82\,V$$

$$[Co(NH_3)_6]^{3+} + e^- \rightleftharpoons [Co(NH_3)_6]^{2+} \qquad E^{\ominus} = +0.11\,V$$

Which of the four complexes above is the strongest reducing agent? Explain your answer.

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.....

.....

..... [3]

(d) Why does ammonia form a more stable cobalt(III) complex than water?

.....

..... [1]

[Total: 10]

4 In this question, one mark is available for the quality of use and organisation of scientific terms.

(a) Stereoisomerism is very common in transition metal complexes. Some complexes have found an important use in the treatment of cancer.

(i) Name a transition metal complex used in the treatment of cancer.

..... [1]

(ii) Describe how this complex helps in the treatment of cancer.

.....

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..... [2]

(b) Describe the types of stereoisomerism found in transition metal complexes.

Use suitable examples to illustrate your answer.

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.....[8]

Quality of Written Communication [1]

[Total: 12]

END OF QUESTION PAPER