

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**

**Advanced GCE**

**CHEMISTRY**

**2815/06**

Transition Elements

Friday

**23 JANUARY 2004**

Afternoon

50 minutes

Candidates answer on the question paper.

Additional materials:

*Data Sheet for Chemistry*

Scientific calculator

Candidate  
Number

Candidate Name

Centre 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	7	
2	10	
3	9	
4	9	
5	10	
<b>TOTAL</b>	<b>45</b>	

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

Answer **all** the questions.

- 1 Transition metals and their compounds are useful in a variety of industrial and commercial situations.

- (a) For **three** different transition metals, state an important use of the metal or one of its compounds.

	name of metal or compound	use	
1	.....	.....	
2	.....	.....	
3	.....	.....	[3]

- (b) The copper compound  $\text{Cu}_2\text{SO}_4$  disproportionates.

Use this copper compound to explain the meaning of the term *disproportionate*. Include an equation and relevant oxidation states in your explanation.

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.....[4]

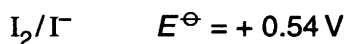
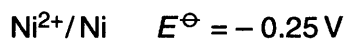
[Total: 7]

2 A cell can be constructed between a  $\text{Ni}^{2+}/\text{Ni}$  half-cell and an  $\text{I}_2/\text{I}^-$  half-cell.

(a) Draw a labelled diagram of this cell operating under standard conditions.

[5]

(b) The standard electrode potentials for the half-cells in this cell are given below.



(i) What is the standard cell potential of this cell?

..... V [1]

(ii) Write equations for the reactions that occur in each half-cell.

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

(iii) Write the overall equation for the reaction that occurs in the cell.

.....[1]

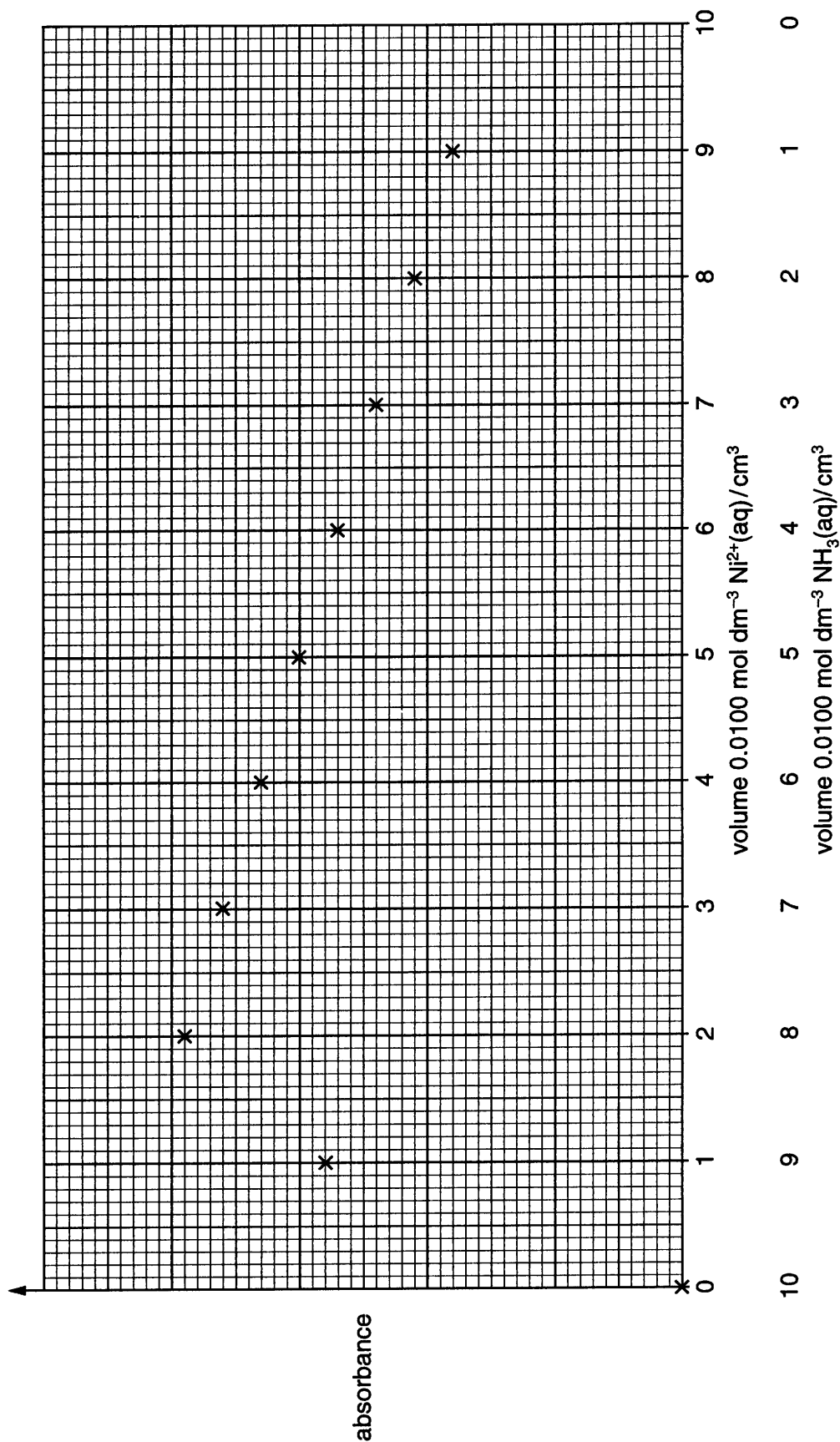
(iv) State, and explain, the direction of flow of electrons in the external circuit.

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

[Total: 10]

- 3 A student carried out an experiment to determine the formula of the complex ion formed between  $\text{Ni}^{2+}(\text{aq})$  and  $\text{NH}_3(\text{aq})$  using colorimetry.

He obtained the results plotted on the axes below.



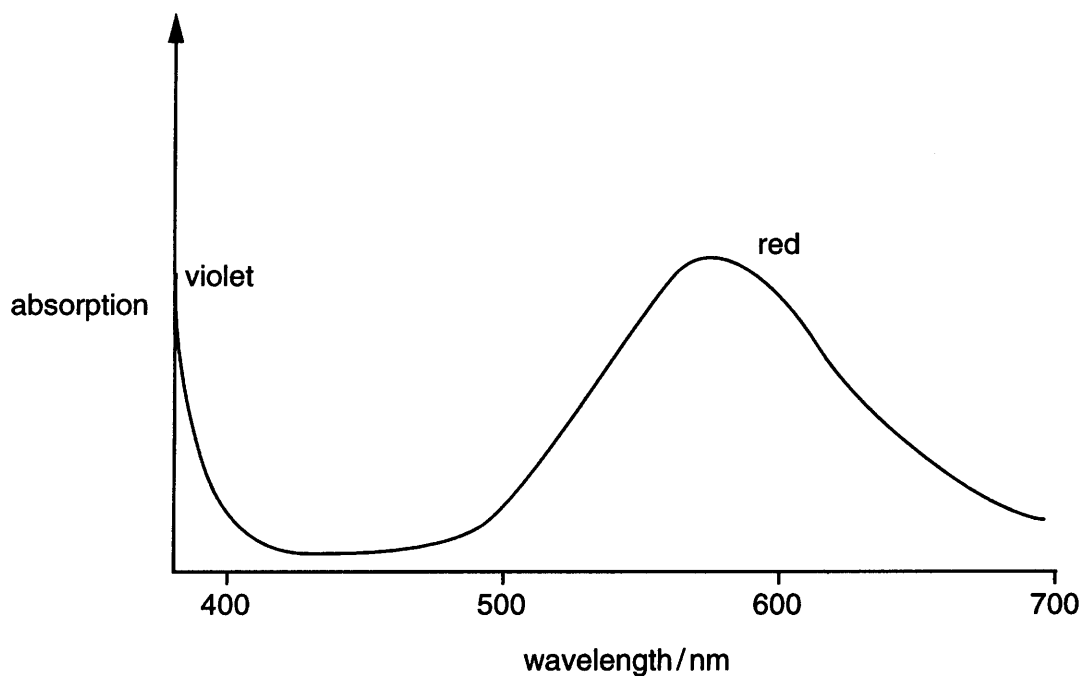
- (a) Outline the experimental procedure used by the student to obtain these results.

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

- (b) Complete the graph and hence determine the formula of the complex ion. Show how you worked out your answer.

[4]

- (c) The visible spectrum for this complex ion is shown below.



Suggest, with a reason, the colour of this complex ion.

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

[Total: 9]

4 Titanium(IV) oxide,  $\text{TiO}_2$ , can be used as a white pigment in horseradish sauce. However, many compounds of transition elements are coloured.

(a) Complete the electronic structures of a

Ti atom  $1s^22s^22p^6$  .....

$\text{Ti}^{4+}$  ion  $1s^22s^22p^6$  ..... [2]

(b) In this question, one mark is available for the quality of written communication.

Explain why compounds of transition elements are usually coloured.

Explain why titanium(IV) oxide is **not** coloured.

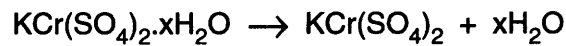
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.....[6]

Quality of Written Communication [1]

[Total: 9]

5 Chrome alum is used in dyeing and in tanning leather.

- (a) On heating chrome alum gently, it loses its water of crystallisation. The equation for this is given below.



**chrome alum**

It was found that when 1.73 g of chrome alum was heated, 0.75 g of water was lost.

Show that the value of  $x$  in the formula  $\text{KCr}(\text{SO}_4)_2 \cdot x\text{H}_2\text{O}$  is 12.

[3]

- (b) Chrome alum contains the complex ion  $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$ .

(i) Draw a diagram of this complex ion showing its shape and bond angle clearly.

[2]

- (ii) What name is given to this shape of complex ion?

.....[1]

(c) Another complex ion of chromium contains one chromium(III) ion, four molecules of water and two chloride ions. This complex shows *cis-trans* isomerism.

(i) Write the formula of this complex ion.

.....[1]

(ii) Draw labelled diagrams to show the *cis* and *trans* isomers of this complex ion.

[3]

[Total: 10]

**END OF QUESTION PAPER**