

**ADVANCED GCE  
CHEMISTRY**

Transition Elements

**THURSDAY 24 JANUARY 2008**

**2815/06**

Afternoon

Time: 50 minutes

Candidates answer on the question paper.

**Additional materials:** Scientific calculator  
*Data Sheet for Chemistry* (Inserted)



Candidate  
Forename

Candidate  
Surname

Centre  
Number

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Candidate  
Number

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**INSTRUCTIONS TO CANDIDATES**

- Write your name in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Do **not** write outside the box bordering each page.
- Write your answer to each question in the space provided.

**INFORMATION FOR CANDIDATES**

- The number of marks for each question is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is **45**.
- You will be awarded marks for the quality of written communication where this is indicated in the question.
- You may use a scientific calculator.
- A copy of the *Data Sheet for Chemistry* is provided as an insert with this question paper.
- You are advised to show all the steps in any calculations.

**FOR EXAMINER'S USE**

Qu.	Max.	Mark
1	11	
2	10	
3	13	
4	11	
<b>TOTAL</b>	<b>45</b>	

This document consists of **10** printed pages, **2** blank pages and a *Data Sheet for Chemistry*.

Answer **all** the questions.

- 1 Cobalt forms a number of complex ions. One such complex ion is  $[\text{CoCl}_2(\text{en})_2]^+$  where en is ethane-1,2-diamine,  $\text{H}_2\text{N}-\text{CH}_2-\text{CH}_2-\text{NH}_2$ .

(a) What is the oxidation number of cobalt in  $[\text{CoCl}_2(\text{en})_2]^+$ ?

..... [1]

(b) Ethane-1,2-diamine is a bidentate ligand.

What is meant by the term *bidentate ligand*?

.....

.....

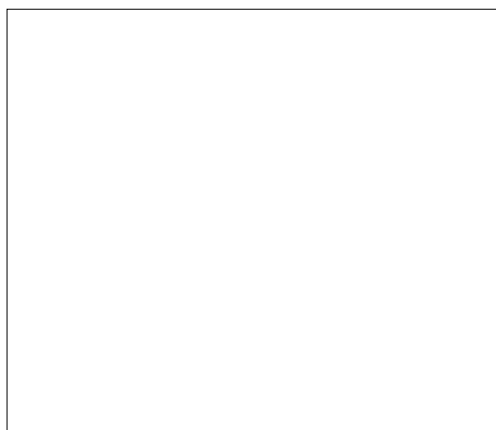
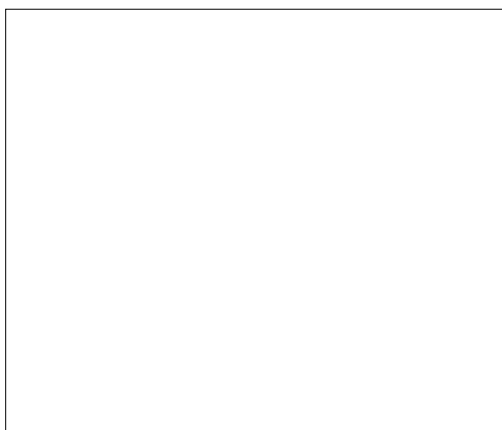
..... [2]

(c) The  $[\text{CoCl}_2(\text{en})_2]^+$  complex ion shows two different types of stereoisomerism.

Name the different types of stereoisomerism and draw diagrams to show the structure of these isomers.

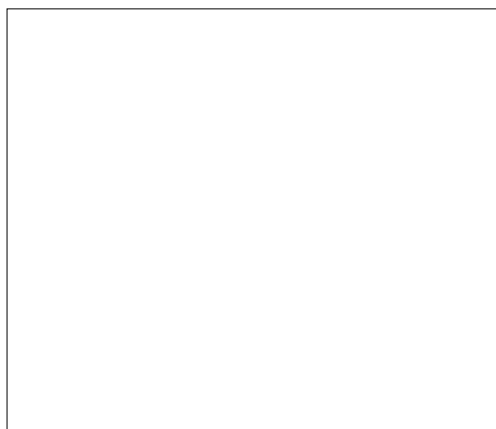
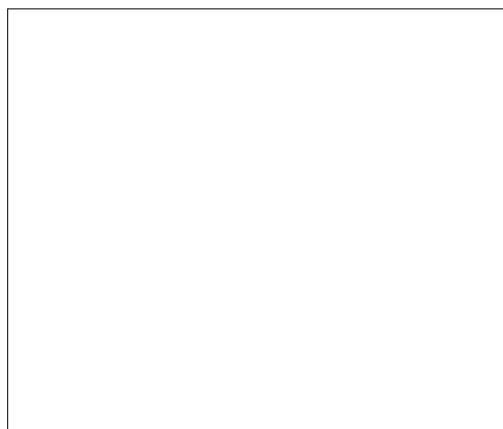
name of first type of stereoisomerism .....

structure of stereoisomers



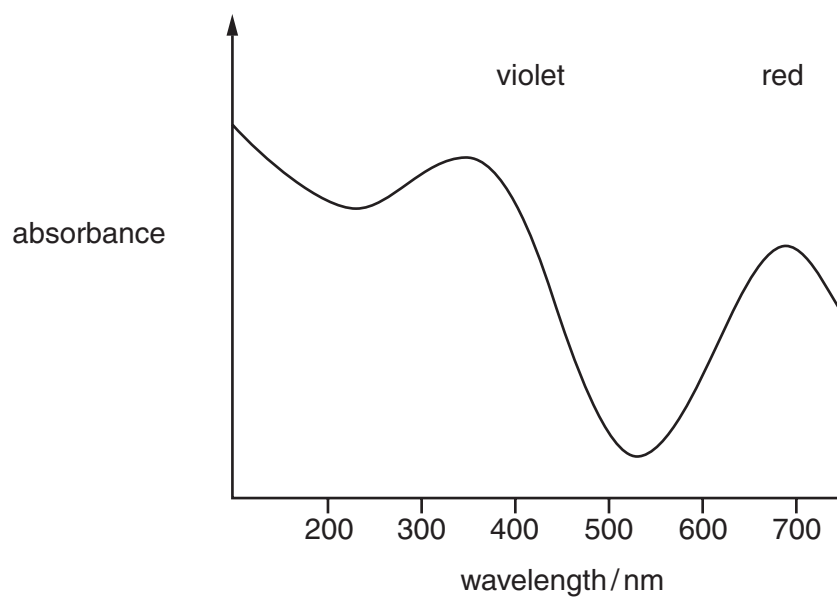
name of second type of stereoisomerism .....

structure of stereoisomers



[6]

(d) The ultraviolet-visible spectrum of one of the isomers of  $[\text{CoCl}_2(\text{en})_2]^+$  is shown below.



What colour is this isomer? Explain your reasoning.

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

[Total: 11]

2 Stainless steel is an alloy typically containing iron and chromium.

(a) Explain how the presence of chromium helps to prevent the rusting of iron.

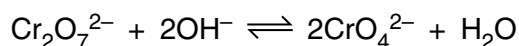
.....  
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..... [2]

(b) In its compounds chromium mainly exists in two oxidation states, +3 and +6.

State the colour of an aqueous solution of chromium with an oxidation state of +3.

..... [1]

(c) In the  $\text{Cr}_2\text{O}_7^{2-}$  ion, chromium has an oxidation state of +6. The  $\text{Cr}_2\text{O}_7^{2-}$  ion takes part in the following equilibrium



(i) What colour change occurs during the reaction from left to right?

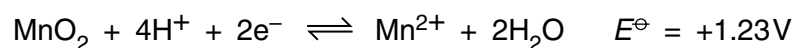
from ..... to ..... [1]

(ii) On addition of an acid the equilibrium position moves from right to left.

Explain this observation.

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

(d) You are provided with the following redox systems.



(i) Construct an equation for the oxidation of  $\text{Mn}^{2+}$  by  $\text{Cr}_2\text{O}_7^{2-}$  in acid conditions.

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

(ii) Show that this reaction is feasible.

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

(iii) Explain why there may **not** be a reaction when acidified  $\text{Cr}_2\text{O}_7^{2-}(\text{aq})$  is added to  $\text{Mn}^{2+}(\text{aq})$ .

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

[Total: 10]

- 3 The standard electrode potential,  $E^\ominus$ , of  $\text{S}_2\text{O}_8^{2-} + 2\text{e}^- \rightleftharpoons 2\text{SO}_4^{2-}$  is +2.01 V.

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

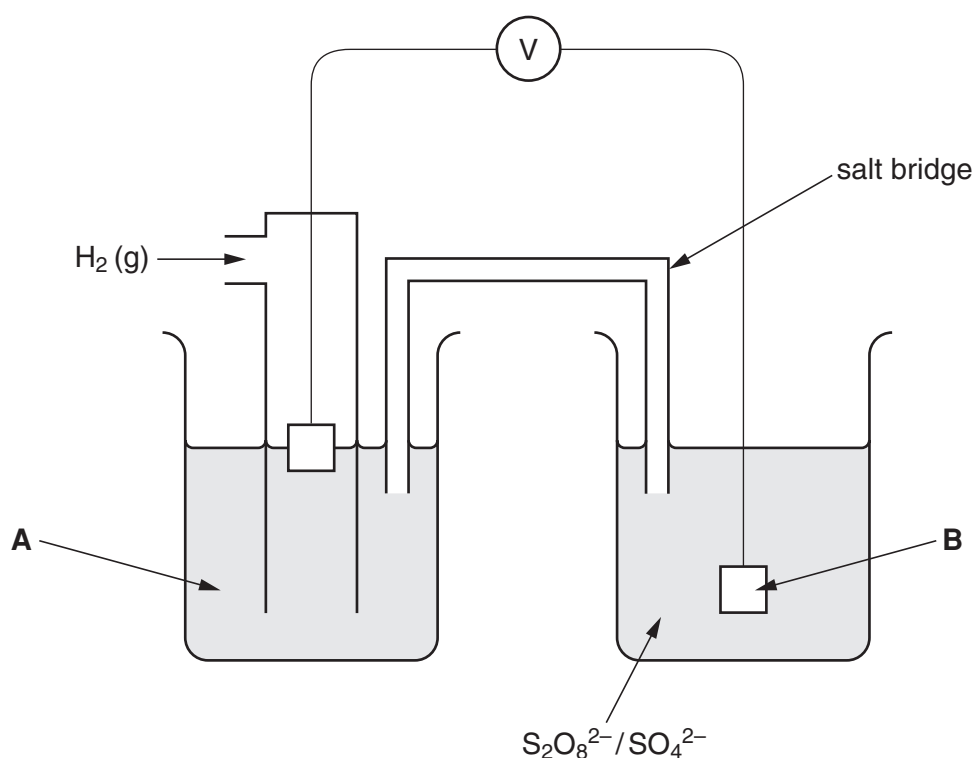
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..... [3]

- (b) The standard electrode potential of  $\text{S}_2\text{O}_8^{2-} + 2\text{e}^- \rightleftharpoons 2\text{SO}_4^{2-}$  may be measured using the following apparatus.



- (i) What could be used for:

solution **A** ..... [1]

solid **B** ..... [1]

- (ii) The voltmeter is replaced by a lamp.

On the diagram, show the direction of electron flow when the cell is used to light the lamp. [1]

- (iii) Construct an equation to show the reaction taking place when the cell is used to light a lamp.

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

- (c) The solution of  $\text{S}_2\text{O}_8^{2-}/\text{SO}_4^{2-}$  has a concentration of  $1.00\text{mol dm}^{-3}$  with respect to  $\text{S}_2\text{O}_8^{2-}$  and  $\text{SO}_4^{2-}$ .

Calculate the masses needed to make up exactly  $100\text{cm}^3$  of this solution, starting with solid  $\text{Na}_2\text{S}_2\text{O}_8$  and  $\text{Na}_2\text{SO}_4$ .

mass of  $\text{Na}_2\text{S}_2\text{O}_8 = \dots\dots\dots$  g; mass of  $\text{Na}_2\text{SO}_4 = \dots\dots\dots$  g [3]

- (d) A student made up the solution of  $\text{S}_2\text{O}_8^{2-}/\text{SO}_4^{2-}$  at  $1.00\text{mol dm}^{-3}$  with respect to  $\text{S}_2\text{O}_8^{2-}$  but  $0.100\text{mol dm}^{-3}$  with respect to  $\text{SO}_4^{2-}$ .

Suggest the effect this would have on the value of  $E^\ominus$ . Explain your answer.

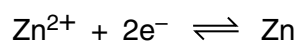
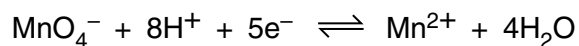
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 .....  
 .....  
 ..... [2]

[Total: 13]

- 4 In this question, one mark is available for the quality of spelling, punctuation and grammar.

Discuss the chemistry of vanadium and its compounds by considering the following:

- the oxidation states, colours and formulae of its aqueous ions
- redox behaviour, with one example of a vanadium ion being reduced by zinc and another with a vanadium ion being oxidised by acidified  $\text{MnO}_4^-$  ions



- catalytic properties

Your answer should contain balanced chemical equations.

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.....[10]

Quality of Written Communication [1]

[Total: 11]

**END OF QUESTION PAPER**

**10**  
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11  
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