



ADVANCED GCE
CHEMISTRY
 Transition Elements

2815/06

Candidates answer on the question paper

OCR Supplied Materials:

- *Data Sheet for Chemistry* (inserted)

Other Materials Required:

- Scientific calculator

Thursday 18 June 2009
Morning

Duration: 50 minutes



Candidate Forename		Candidate Surname	
--------------------	--	-------------------	--

Centre Number						Candidate Number				
---------------	--	--	--	--	--	------------------	--	--	--	--

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use 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.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.

INFORMATION FOR CANDIDATES

- The number of marks 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.
- This document consists of **12** pages. Any blank pages are indicated.

FOR EXAMINER'S USE

Qu.	Max.	Mark
1	7	
2	8	
3	10	
4	8	
5	12	
TOTAL	45	

Answer **all** the questions.

- 1** Vanadium exists in a number of different oxidation states, each with a typical colour.

(a) Complete the following table.

ion	$\text{VO}^{2+}(\text{aq})$	$\text{V}^{3+}(\text{aq})$	
colour	blue		yellow
oxidation state		+3	+5

[3]

- (b)** $\text{V}^{3+}(\text{aq})$ ions may be reduced to $\text{V}^{2+}(\text{aq})$ ions by metallic zinc.

(i) Suggest an equation for the reaction.

..... [1]

(ii) What is the colour of the $\text{V}^{2+}(\text{aq})$ ion?

..... [1]

- (c)** Vanadium and its compounds show good catalytic properties.

Name a vanadium compound used as a catalyst and state the name of the process in which it is used.

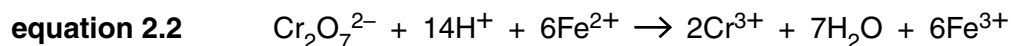
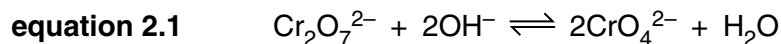
Write an equation for the reaction taking place in your named process.

.....

 [2]

[Total: 7]

- 2 The following reactions involve the dichromate(VI) ion, $\text{Cr}_2\text{O}_7^{2-}$.



- (a) (i) What colour change occurs when the equilibrium position in **equation 2.1** shifts from left to right?

from to [1]

- (ii) What could be added to the equilibrium mixture in **equation 2.1** to make the position of equilibrium shift from right to left?

..... [1]

- (iii) Show, using oxidation numbers, that the forward reaction in **equation 2.1** is **not** a redox reaction.

.....
 [1]

- (b) The reaction in **equation 2.2** may be used to determine the purity of iron wire.

- 1.20 g of iron wire were reacted with an excess of 2mol dm^{-3} sulphuric acid.
- The solution was transferred to a volumetric flask and the volume made up to 250cm^3 .
- 25.0cm^3 of this solution required 23.20cm^3 of 0.0150mol dm^{-3} $\text{Cr}_2\text{O}_7^{2-}$ solution to completely react.

Determine the % purity of the iron wire.

purity of iron wire = % [5]

[Total: 8]

3 Some standard electrode potentials are shown below.

	E^\ominus / V
$\frac{1}{2}\text{Br}_2 + \text{e}^- \rightleftharpoons \text{Br}^-$	+1.07
$\text{Cr}_2\text{O}_7^{2-} + 14\text{H}^+ + 6\text{e}^- \rightleftharpoons 2\text{Cr}^{3+} + 7\text{H}_2\text{O}$	+1.33
$\frac{1}{2}\text{Cl}_2 + \text{e}^- \rightleftharpoons \text{Cl}^-$	+1.36
$\text{BrO}_3^- + 6\text{H}^+ + 5\text{e}^- \rightleftharpoons \frac{1}{2}\text{Br}_2 + 3\text{H}_2\text{O}$	+1.52

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

.....

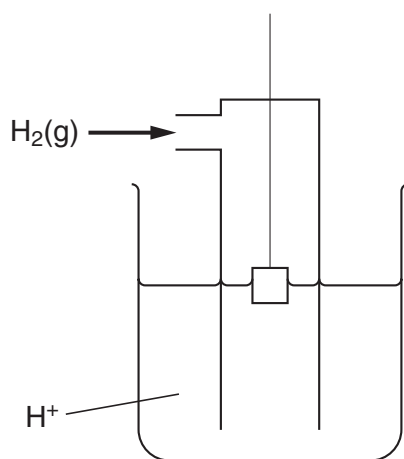
 [2]

(ii) State the conditions used to measure standard electrode potential.

.....

 [1]

(b) Complete the diagram to show how the standard electrode potential for the $\frac{1}{2}\text{Cl}_2 + \text{e}^- \rightleftharpoons \text{Cl}^-$ half-cell, could be measured.



[3]

(c) In acid solution, colourless BrO_3^- ions oxidise Br^- ions to Br_2 .

- (i) Use the standard electrode potential data opposite to construct an equation for this reaction.

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

- (ii) Describe what you would see when BrO_3^- reacts with Br^- .

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

(d) Acidified $\text{Cr}_2\text{O}_7^{2-}$ ions will oxidise Br^- to Br_2 but will not oxidise Cl^- ions to Cl_2 . Explain why.

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

[Total: 10]

4 (a) Titanium(IV) oxide, TiO_2 , is used as a pigment in paint.

(i) What is the electron configuration of the Ti^{4+} ion in TiO_2 ?

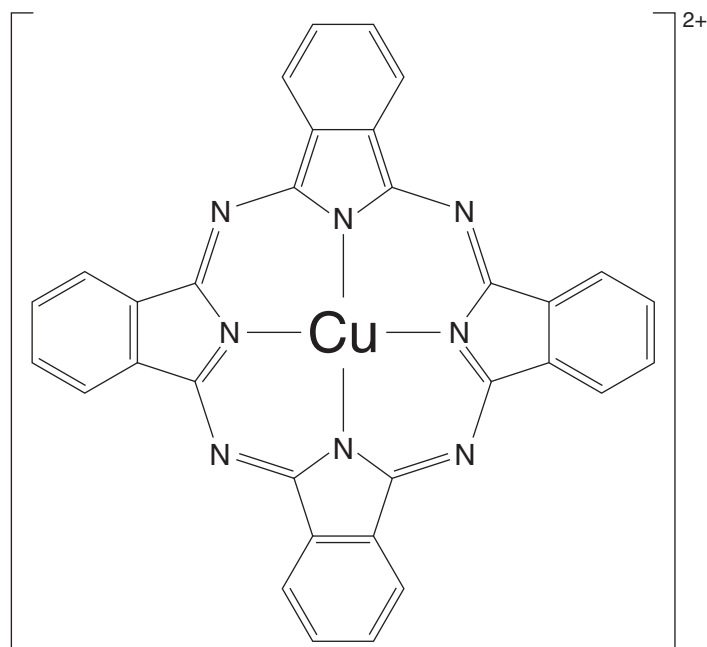
$1s^2 2s^2$ [1]

(ii) What is the colour of TiO_2 ? Explain your answer using the electron configuration in (i).

.....

 [2]

(b) Monastral Blue is an example of a copper complex, in which the phthalocyanine ligand is complexed with a Cu^{2+} ion.



(i) What type of bonding exists between the Cu^{2+} ion and the phthalocyanine ligand?

..... [1]

- (ii) The Cu^{2+} ion has the electron configuration $[\text{Ar}]3d^9$. Explain why this configuration leads to the copper complex being coloured.

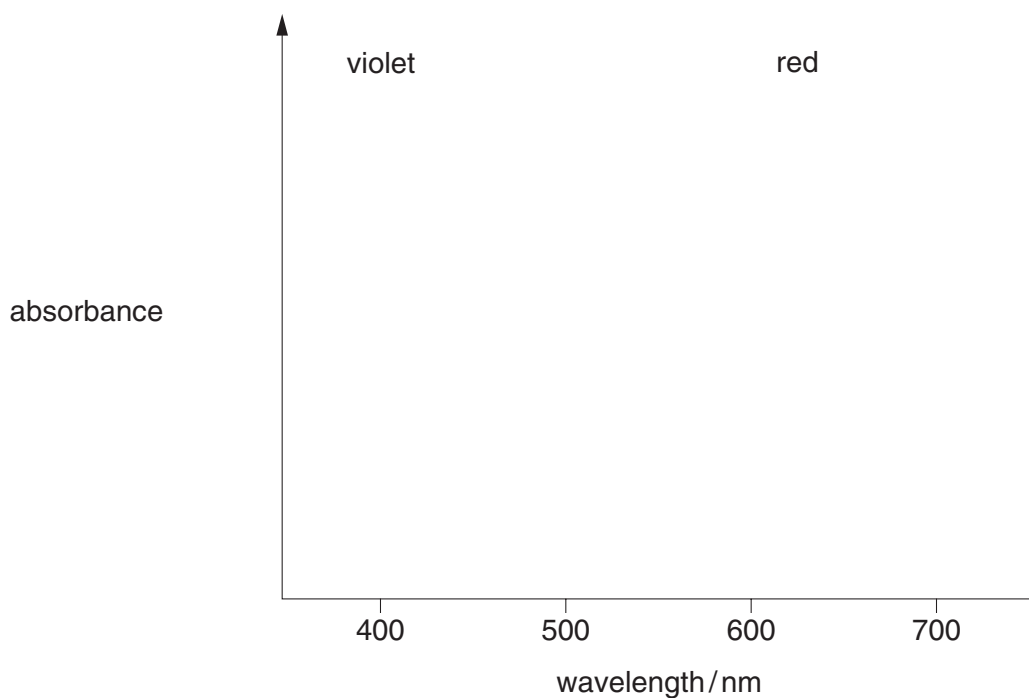
.....

.....

.....

..... [3]

- (c) It is possible to produce a visible spectrum for Monastral Blue. Sketch a diagram of the visible spectrum for Monastral Blue on the axes below.



[1]

[Total: 8]

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

Transition metals and their ions form complexes which may show stereoisomerism.

- What is meant by *stereoisomerism*?
- Using suitable examples, describe with the aid of diagrams the different types of stereoisomerism shown by complex ions.
- Some transition metal complexes are used in medicine. Describe and explain one such use.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[11]

[Total: 12]

© OCR 2009

10
BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

11
BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

PLEASE DO NOT WRITE ON THIS PAGE



Copyright Information

OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations, is given to all schools that receive assessment material and is freely available to download from our public website (www.ocr.org.uk) after the live examination series.

If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.

For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1PB.

OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.