

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS**

**Advanced GCE**

**CHEMISTRY**

**2815/01**

Trends and Patterns

Tuesday

**25 JUNE 2002**

Morning

1 hour

Candidates answer on the question paper.

Additional materials:

Data sheet for Chemistry

Scientific calculator

Candidate Name	Centre Number	Candidate Number										
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**TIME** 1 hour

**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		
Question Number	Mark	Mark
1	11	
2	5	
3	13	
4	5	
5	11	
<b>TOTAL</b>	<b>45</b>	

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

Answer **all** questions.

- 1 (a) (i) Explain what is meant by the term *transition element*.

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

- (ii) Complete the electronic configuration of the vanadium atom.

$1s^22s^22p^6$ .....[1]

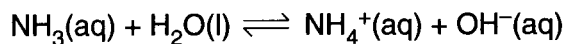
- (b) Aqueous transition metal ions can react with aqueous hydroxide ions.

- (i) Complete the table below.

metal ion	formula and state symbol of the product of the reaction with $\text{OH}^-(\text{aq})$	colour of product
$\text{Fe}^{2+}(\text{aq})$		
$\text{Fe}^{3+}(\text{aq})$		

[5]

- (ii) Aqueous ammonia reacts with water in the following way.



When aqueous ammonia is added dropwise to aqueous copper(II) ions, a very pale blue precipitate is observed which disappears in excess ammonia to give a deep blue solution.

Write equations to show the formation from aqueous copper(II) ions of  
 the pale blue precipitate,

.....

the deep blue solution.

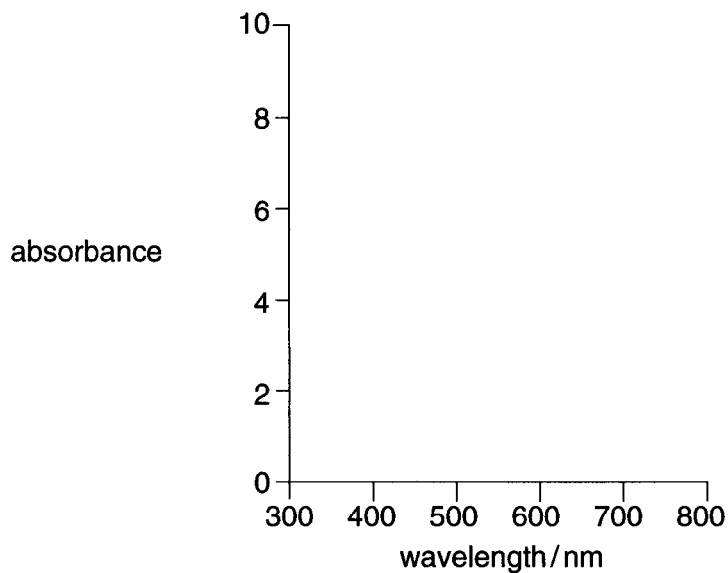
.....[4]

[Total : 11]

2 The transition metal compound **X** is analysed.

(a) The aqueous solution of **X** is yellow.

Sketch on the axes below the absorption spectrum you would predict for **X** in aqueous solution.



[1]

(b) Explain the shape of your sketch.

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

(c) Calculate the empirical formula of **X** which has the following composition by mass: K, 32.0%; Cr, 21.3%; F, 46.7%.

[2]

(d) Suggest the identity of the **ligand** in **X**.

.....[1]

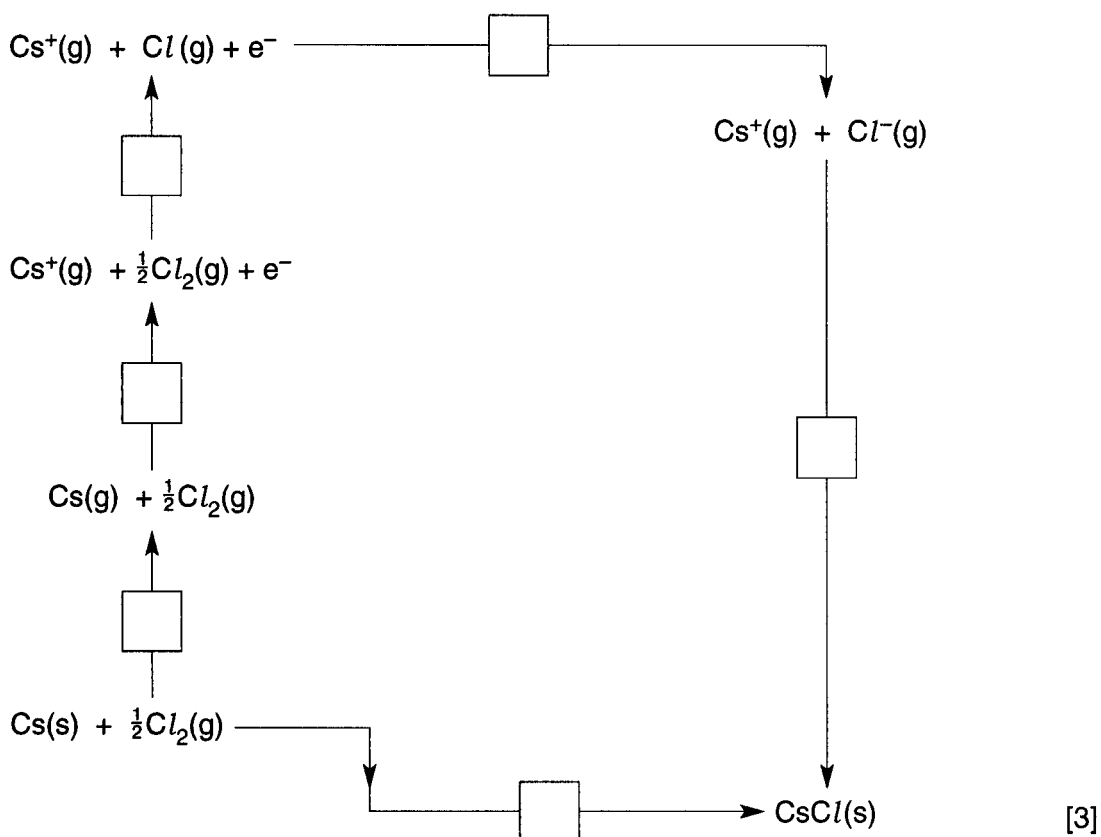
[Total : 5]

- 3 The lattice enthalpy of caesium chloride,  $\text{CsCl}$ , can be calculated using a Born-Haber cycle.

The table below shows the enthalpy changes and corresponding data for this cycle.

enthalpy change		energy/ $\text{kJ mol}^{-1}$
lattice enthalpy of $\text{CsCl}$	<b>A</b>	?
atomisation of caesium	<b>B</b>	+76
atomisation of chlorine	<b>C</b>	+122
1st ionisation energy of caesium	<b>D</b>	+376
1st electron affinity of chlorine	<b>E</b>	-349
formation of $\text{CsCl}$	<b>F</b>	-443

- (a) On the cycle below, put the letter for each enthalpy change in the appropriate box.



- (b) Calculate the lattice enthalpy of caesium chloride.

Answer ..... $\text{kJ mol}^{-1}$  [2]

- (c) The lattice enthalpy of sodium chloride is **more exothermic** than the lattice enthalpy of caesium chloride.

State and explain the relative strengths of the ionic bonding in sodium chloride and caesium chloride.

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

- (d) What would you expect to observe when solid caesium chloride is added to water?

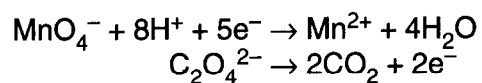
.....  
.....  
.....[2]

- (e) Describe how you would distinguish between aqueous caesium chloride and aqueous caesium iodide using a simple laboratory test. State the observations you would make.

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

[Total : 13]

- 4 The manganate(VII) ion,  $\text{MnO}_4^-$ , is a strong oxidising agent frequently used in laboratory analysis. It reacts with the ethanedioate ion,  $\text{C}_2\text{O}_4^{2-}$ , in hot acidic solution to form  $\text{CO}_2$  and  $\text{Mn}^{2+}$  ions.



- (a) Construct the full ionic equation for this reaction.

[2]

- (b) Calculate the volume of  $0.0200 \text{ mol dm}^{-3}$  potassium manganate(VII) required to react with  $25.0 \text{ cm}^3$  of  $0.0400 \text{ mol dm}^{-3}$  sodium ethanedioate.

[3]

[Total : 5]





Question	Expected Answers	Marks
3 (a)	<i>correctly labelled</i> atomisation of chlorine + atomisation of caesium	1
	1 <sup>st</sup> ionisation energy + 1 <sup>st</sup> electron affinity	1
	formation of CsCl + LE	1
(b)	-443 = + 76 + (+122) + (+376) + (-349) + LE	1
	LE = -668 kJ mol <sup>-1</sup> ( allow ecf here if 1 mistake only in step 1 )	1
(c)	Na <sup>+</sup> smaller than Cs <sup>+</sup> ( don't accept sodium smaller first time)	1
	Na <sup>+</sup> has a larger charge density	1
	attracts the anion/Cl <sup>-</sup> more strongly/ sodium chloride has the stronger bonding	1
(d)	dissolves / no reaction <i>do not accept "nothing"</i>	1
	colourless / neutral / pH 7	1
(e)	add aqueous AgNO <sub>3</sub>	1
	chloride gives a white ppt	1
	iodide gives a yellow ppt	1
	Alternative answer	
	Pass chlorine/use NaOCl & HCl	
	No change with CsCl	
	Iodine displaced/brown solution with CsI	

[Total: 13]

Question	Expected Answers	Marks
4 (a)	$2\text{MnO}_4^- + 16\text{H}^+ + 5\text{C}_2\text{O}_4^{2-} \rightarrow 2\text{Mn}^{2+} + 8\text{H}_2\text{O} + 10\text{CO}_2$	2
	<i>1 mark for correct species, 1 mark for correct balancing including electrons if present</i>	
(b)	amount of $\text{C}_2\text{O}_4^{2-} = (25.0/1000) \times 0.0400 = 0.001 \text{ mol}$	1
	amount of $\text{MnO}_4^-$ required = $0.001 \times (2/5) = 0.0004 \text{ mol}$	1
	vol of $\text{MnO}_4^-$ required = $0.0004/0.0200 \times 1000 = 20 \text{ cm}^3 / 0.02 \text{ dm}^3$	1
	( Allow ecf on parts 2 & 3 )	

[Total 5]

Question	Expected Answers	Marks
5 (a)	$2\text{Al} + \frac{3}{2}\text{O}_2 \rightarrow \text{Al}_2\text{O}_3$	1
	$2\text{P} + 3\text{Cl}_2 \rightarrow 2\text{PCl}_3$ / $2\text{P} + 5\text{Cl}_2 \rightarrow 2\text{PCl}_5$ / $\text{P}_4 + 6\text{Cl}_2 \rightarrow 4\text{PCl}_3$ / $\text{P}_4 + 10\text{Cl}_2 \rightarrow 4\text{PCl}_5$	1
	correct oxidation numbers in 2 equations	2
	show oxidation or reduction by increase/decrease in oxidation numbers	1
	Credit electron transfer if used for $\text{Al}_2\text{O}_3$	
	QWC for good organisation?	1
(b)	$\text{Al}_2\text{O}_3$ does not react / does not dissolve	1
	$\text{PCl}_5$ exothermic reaction/vigorous reaction	1
	White fumes/steamy fumes/misty fumes	1
	HCl produced/acidic solution produced	1
	$\text{PCl}_5 + 4\text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_4 + 5\text{HCl}$ / $\text{PCl}_3 + 3\text{H}_2\text{O} \rightarrow \text{H}_3\text{PO}_3 + 3\text{HCl}$ / $\text{PCl}_5 + \text{H}_2\text{O} \rightarrow \text{POCl}_3 + 2\text{HCl}$	1
	not a redox reaction	1
	<i>N.B. max 5 marks</i>	

[Total: 11]