OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE **2815/01**

CHEMISTRY

Trends and Patterns

THURSDAY 19 JUNE 2008 Morning

Time: 1 hour

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

*C U P / T 4 5 7 1 2 *

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

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.
- 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	**13**	
2	**8**	
3	**13**	
4	**11**	
TOTAL	**45**	

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

[Turn over

Answer **all** the questions.

1 Oxy salts such as carbonates, nitrates and sulphates can thermally decompose.

(a) Describe and explain how the decomposition temperature of barium carbonate compares with that of strontium carbonate.

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..... [3]

(b) Magnesium nitrate, $Mg(NO_3)_2$, thermally decomposes to form magnesium oxide, oxygen and nitrogen dioxide.

(i) Write the equation for this decomposition.

..... [1]

(ii) Explain why the lattice enthalpy of magnesium oxide is much more exothermic than that of magnesium nitrate.

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..... [2]

(c) Anhydrous iron(II) sulphate thermally decomposes as shown in the equation below.

$$2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$$

(i) Use oxidation numbers to show that this reaction involves both oxidation and reduction.

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..... [2]

(ii) The table below shows some enthalpy changes of formation, ΔH_f.

substance	ΔH_f / kJ mol^{-1}
$FeSO_4(s)$	–929
$Fe_2O_3(s)$	–826
$SO_2(g)$	–297
$SO_3(g)$	–396

Use the data in the table to calculate the enthalpy change of reaction, ΔH_r, for the decomposition of 2 mol of iron(II) sulphate.

$$2FeSO_4(s) \longrightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$$

ΔH_r = ... kJ mol^{-1} [2]

(iii) An impure sample of hydrated iron(II) sulphate, $FeSO_4.7H_2O$, is heated strongly until it reaches constant mass.

A sample of 2.784 g of impure $FeSO_4.7H_2O$ gives 92.5 cm^3 of sulphur dioxide measured at room temperature and pressure.

Calculate the percentage purity of the $FeSO_4.7H_2O$.

Quote your answer to an appropriate number of significant figures.

Assume that the impurities in the sample do not thermally decompose.

One mole of gas molecules at room temperature and pressure occupies 24.0 dm^3.

% purity = ... [3]

[Total: 13]

2 This question is about molybdenum and iron.

Molybdenum steel is extremely hard.
Molybdenum is made by heating molybdenum(VI) oxide, MoO_3, with aluminium powder.

(a) Construct an equation to show the reduction of molybdenum(VI) oxide to molybdenum metal by aluminium.

..... [1]

(b) Molybdenum has the electronic configuration $[Kr]4d^5 5s^1$ where [Kr] represents the electronic configuration for krypton.

Complete the electronic configuration for Mo^{3+} and use it to explain why molybdenum is a transition element.

[Kr] .....

explanation ..... [1]

(c) Molybdenum(IV) oxide, MoO_2, can be oxidised by dichromate(VI) ions, $Cr_2O_7^{2-}$, under acidic conditions.

The relevant half-equations are as follows.

$$MoO_2(s) + 2H_2O(l) \longrightarrow MoO_4^{2-}(aq) + 4H^+(aq) + 2e^-$$

$$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \longrightarrow 2Cr^{3+}(aq) + 7H_2O(l)$$

Construct the equation for the oxidation of MoO_2 by $Cr_2O_7^{2-}$ ions under acidic conditions.

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..... [2]

(d) Iron can form the ferrate(VI) ion, FeO_4^{2-}.

(i) What is the formula for potassium ferrate(VI)?

..... [1]

(ii) Aqueous ferrate(VI) ions can be made by the oxidation of iron(III) oxide by chlorine in alkaline conditions.

$$Fe_2O_3 + 3Cl_2 + 10\,OH^- \longrightarrow 2FeO_4^{2-} + 6Cl^- + 5H_2O$$

A 1.00 g sample of Fe_2O_3 is added to 10.0 cm^3 of 4.00 mol dm^{-3} KOH.

Which reagent, Fe_2O_3 or KOH, is in excess? Explain your answer.

[3]

[Total: 8]

3 This question is about oxides and chlorides.

(a) Complete the following table about some of the enthalpy changes needed to determine the lattice enthalpy of calcium oxide.

Include the state symbols in equations for any process.

enthalpy change	process
enthalpy change of formation of calcium oxide	$Ca(s) + \frac{1}{2}O_2(g) \rightarrow CaO(s)$
second ionisation energy of calcium	
	$\frac{1}{2}O_2(g) \rightarrow O(g)$
	$O^-(g) + e^- \rightarrow O^{2-}(g)$
enthalpy change of atomisation of calcium	

[4]

(b) Explain, in terms of structure and bonding, why aluminium oxide has a much higher melting point than aluminium chloride.

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..... [3]

(c) Compare the action of water on aluminium oxide with that of water on aluminium chloride.

Include experimental observations where relevant.

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..... [3]

(d) Solid phosphorus(V) chloride has electrostatic interactions between PCl_4^+ and PCl_6^- ions.

(i) Draw a '*dot-and-cross*' diagram for PCl_4^+.

You only need to draw the outer shell electrons of both chlorine and phosphorus.

[1]

(ii) Predict, with a reason, the shape of the PCl_4^+ ion.

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..... [2]

[Total: 13]

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

Transition elements form complex ions that have characteristic colours.

Describe, using complex ions containing **copper**,

- the bonding within a complex ion
- the shape of a complex ion clearly indicating relevant bond angles
- ligand substitution illustrating any reaction with an equation
- the colours of two different complex ions.

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Quality of Written Communication [1]

[Total: 11]

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