Centre No.						Paper Reference							Surname	Initial(s)
Candidate No.						6	2	5	6	/	0	1	Signature	

Paper Reference(s)

6256/01

Edexcel GCE

Chemistry (Nuffield)

Advanced Level

Unit Test 6 (Synoptic)

Thursday 18 June 2009 – Morning

Time: 2 hours

Examiner's use only

Team Leader's use only

Question Number	Leave Blank
1	
2	
3	
4	
Total	

Materials required for examination
Nil

Items included with question papers
Nil

Candidates may use a calculator

Centre to provide
Nuffield *Students' Book* (fourth edition)
Nuffield Advanced Science *Book of Data*

Instructions to Candidates

In the boxes above, write your centre number, candidate number, your surname, initial(s) and your signature.
Check that you have the correct question paper. The paper reference is shown above.
Answer **ALL** the questions. Write your answers in the spaces provided in this question paper.
Do not use pencil. Use blue or black ink.
Final answers to calculations should be given to an appropriate number of significant figures.

Information for Candidates

The marks for individual questions and the parts of questions are shown in round brackets: e.g. **(2)**.
The total mark for this paper is 60. There are 16 pages in this question paper. Any blank pages are indicated.

Advice to Candidates

You may use the Nuffield *Students' Book* and the *Book of Data* in answering this paper.
The time allowed to answer this paper means that you do not have time to look up all the information you may wish to refer to in your answers. You should plan to restrict your use of the *Students' Book* to relevant passages of background reading or for confirmation of data or equations.
You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, taking account of your use of grammar, punctuation and spelling.
Your Quality of Written Communication will be assessed in this paper. To gain full marks you must explain your ideas clearly using equations and diagrams where appropriate. You are advised to show all the steps in any calculations.

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Leave blank

Answer ALL the questions. Write your answers in the spaces provided.

1. A sample of 0.149 g of impure iron was dissolved in hydrochloric acid to form a solution of Fe^{2+} ions. All the resultant solution was titrated with 0.0200 mol dm^{-3} acidified sodium dichromate(VI) solution, $Na_2Cr_2O_7(aq)$. The $Fe^{2+}(aq)$ was oxidised to $Fe^{3+}(aq)$ and the $Cr_2O_7^{2-}(aq)$ was reduced to $Cr^{3+}(aq)$. The end-point of the titration was 19.8 cm^3.

(a) (i) Balance this equation for the reaction between $Fe^{2+}(aq)$ and acidified sodium dichromate(VI) solution.

.....$Fe^{2+}(aq)$ + $Cr_2O_7^{2-}(aq)$ + ...$H^+(aq)$ → .....$Fe^{3+}(aq)$ + ...$Cr^{3+}(aq)$ + ...$H_2O(l)$

(2)

(ii) Calculate the % purity of the sample of iron.

(3)

Leave blank

(iii) Explain why using the more powerful oxidising agent potassium manganate(VII) to titrate the Fe^{2+} ions would be likely to lead to an inaccurate result. Use items 85 and 88 from table 6.1 in your *Book of Data* to justify your answer.

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(2)

(b) Iron(III) ions form a complex with cyanide ions, CN^-, with the formula $[Fe(CN)_6]^{3-}$.

(i) What shape would you expect the complex to be?

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(1)

(ii) Draw a 'dot and cross' diagram of the cyanide ion.

(1)

(iii) What type of ligand is CN^-? Describe how it attaches to the iron in the complex.

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(2)

Leave blank

(c) Under appropriate conditions $[Fe(CN)_6]^{3-}$ can be converted to the complex $[Fe(edta)H_2O]^-$. The equation for the reaction is

$$[Fe(CN)_6]^{3-}(aq) + H_2O(l) + edta^{4-}(aq) \rightleftharpoons [Fe(edta)H_2O]^-(aq) + 6CN^-(aq)$$

(i) Suggest what is unusual about the complex $[Fe(edta)H_2O]^-$.

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(1)

(ii) Which of the two iron complexes would be likely to have the greater stability constant? Justify your answer by considering the entropy changes that occur in the reaction.

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(2)

Leave blank

(d) Solutions of $Fe^{2+}(aq)$ can oxidise in air.

(i) Use item 67 from Table 6.1 in your *Book of Data* and the standard electrode potential below to write a cell diagram for the reaction.

$[O_2(g) + 4H^+(aq)], 2H_2O(l) \,|\, Pt \qquad E^{\ominus} = +1.23\ V$

(1)

(ii) Calculate $E^{\ominus}_{cell}$. Use your answer to predict the extent of the reaction.

(2)

(iii) Write a balanced equation for the cell reaction. State symbols are **not** required.

(2)

(e) Iron is used to catalyse the reaction between nitrogen and hydrogen gases in the Haber process. Explain how the iron speeds up the reaction and describe ONE factor that may have been considered when choosing iron as a catalyst in preference to other transition metals.

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(2)

Q1

(Total 21 marks)

Leave blank

2. Substance **X** is a yellow oil found naturally in the bark of the *Cinnamomum* tree. The boiling point of **X** is 246 °C.

(a) Steam distillation is used to extract **X** from the bark.

(i) Explain why this procedure is used.

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(1)

(ii) Describe how to purify the mixture obtained from the steam distillation.

Diagrams or lists of apparatus used are **not** required.

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(3)

Leave blank

(b) **X** contains carbon, hydrogen and oxygen only. On complete combustion, 0.397 g of **X** forms 0.215 g of water and 650 cm^3 of carbon dioxide at 298 K and 1 atm. Use the combustion data to calculate the empirical formula.

[You may assume that 1 mole of any gas occupies 24 000 cm^3 at 298 K and 1 atm]

(4)

Leave blank

(c) The results of tests carried out on **X** are described below. In each case state what could be deduced about the structure of **X**.

(i) **X** decolorised bromine water.

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(1)

(ii) **X** formed an orange precipitate on addition of Brady's reagent.

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(1)

(iii) **X** formed a red precipitate when warmed with Benedict's solution.

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(1)

(iv) **X** burned with a very sooty flame.

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(1)

(v) The infra-red spectrum of **X** had absorptions at 750 cm^{-1} and 700 cm^{-1}.

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(1)

(d) The molecular formula of **X** is the same as its empirical formula. Use this information and your answers from (b) and (c) to suggest a structural formula for **X**.

(1)

Q2

(Total 14 marks)

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3. (a) (i) Draw a **labelled** diagram of the Born-Haber cycle for silver(I) oxide, including appropriate state symbols. Use the cycle to calculate the lattice energy of silver(I) oxide, giving your final answer to **four** significant figures.

(4)

Leave blank

(ii) Suggest why the theoretical value for the lattice energy of silver(I) oxide is similar to that calculated using the Born-Haber cycle.

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(2)

(b) (i) Give the electronic configuration of the silver(I) ion.

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(1)

(ii) Why are aqueous solutions of most compounds containing silver(I) ions colourless?

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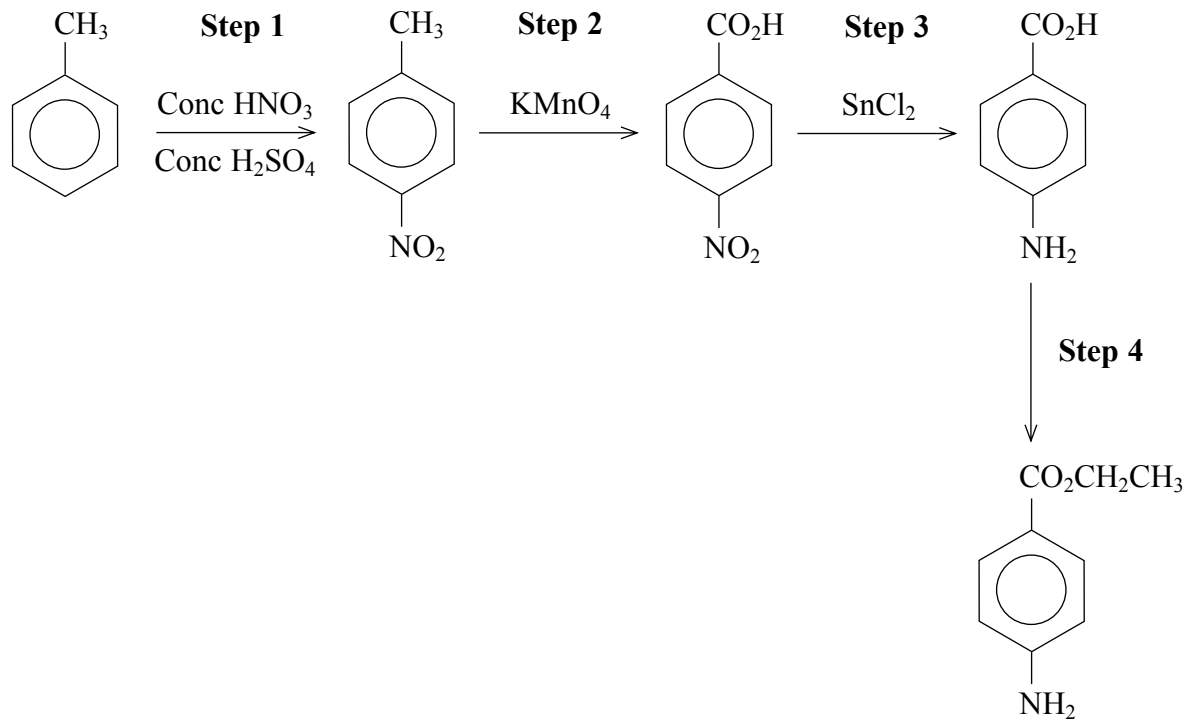
(1)

Q3

(Total 8 marks)

Leave blank

4. A proposed synthetic route for the local anaesthetic benzocaine is outlined below.



Benzocaine

(a) (i) What type of reaction and mechanism occurs in **step 1**? Suggest a possible by-product that could be formed in this step.

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(2)

(ii) Suggest why $SnCl_2$ was used as a reducing agent in **step 3**, rather than lithium tetrahydridoaluminate, $LiAlH_4$.

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(1)

Leave blank

(iii) Describe a chemical test you could carry out to confirm that **step 3** had produced the amine group. What result would you expect to **see**?

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(2)

(iv) State the reagents and conditions needed to complete **step 4**.

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(2)

(v) Suggest the structural formula of the product if benzocaine was reacted with chloroethane.

(1)

(b) Suggest the formulae of the ions responsible for peaks with mass/charge ratios of 120 and 73 in the mass spectrum of benzocaine.

(2)

Leave blank

(c) Use Table 3.4 in your *Book of Data* to identify which structural features of benzocaine produce chemical shifts (δ) of 7.8 and 1.5 in its nmr spectrum.

(2)

(d) Drops of a dilute solution of benzocaine can be used to tranquilize fish. Suggest what solvent you would use to make the solution. Justify your answer with reference to intermolecular forces.

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(3)

(e) $SnCl_2$, used in **step 3**, can be formed using the reaction below.

$$SnCl_4 \xrightarrow{100\,°C} SnCl_2 + Cl_2$$

(i) What type of reaction takes place?

.....

(1)

Leave blank

(ii) Despite the metallic nature of tin, $SnCl_4$ has a molecular structure. Suggest an equation for the reaction if $SnCl_4$ and water were mixed.

State symbols are **not** required.

(1)

Q4

(Total 17 marks)

TOTAL FOR PAPER: 60 MARKS

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