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Class	Student Number	Name

CAMBRIDGE A LEVEL PROGRAMME

A2 TRIAL EXAMINATION AUGUST / SEPTEMBER 2012

(June 2011 Intake)

Tuesday **4 September 2012** **8.30 am – 10.30 am**

CHEMISTRY 9701/43

PAPER 43 Structured Questions **2 hours**

Candidates answer on the Question Paper.
Additional Materials: Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your name, class and student number in the spaces at the top of this page.
Write in dark blue or black pen.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions.

You may lose marks if you do not show your workings or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
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6	
7	
8	
9	
10	
Total	

This document consists of **19** printed pages

[Turn over

Section A

Answer **all** the questions in the spaces provided.

1 (a) Define the terms

(i) lattice energy

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.....

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(ii) standard enthalpy of hydration

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.....

[4]

(b) (i) Draw a labelled energy cycle that would enable the enthalpy change of solution, ΔH_{soln} of an ionic solid M^+X^- to be calculated from the lattice energy and enthalpy of hydration of the ions.

(ii) Express the enthalpy change of solution, ΔH_{soln} in terms of an equation.

.....

[4]

(c) Draw the energy cycle and use the following data together with further data from the Data Booklet to calculate a value for the lattice energy of sodium oxide.

Data:		
	enthalpy change of atomisation for Na	+107 kJ/mol
	first electron affinity of oxygen	-141 kJ/mol
	second electron affinity of oxygen	+798 kJ/mol
	enthalpy change of formation of $Na_2O(s)$	-414 kJ/mol

[3]

[Total : 11]

[Turn over

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

.....

..... [1]

(b) Chlorine gas and iron(II) ions react together in aqueous solution as follows.

$$Cl_2 + 2Fe^{2+} \rightarrow 2Cl^- + 2Fe^{3+}$$

(i) Draw a fully labelled diagram to show how two linked half-cells could be used to measure the standard cell potential for this reaction. On the diagram, indicate the flow of electrons in the external circuit.

(ii) Use the *Data Booklet* to calculate the $E^{\ominus}_{cell}$ for this reaction.

[5]

(c) Use data from the *Data Booklet* to construct a redox equation and calculate the standard cell potential, for the reaction between $Cl_2(g)$ and $SO_2(g)$

[2]

(d) Calculate the mass of copper deposited at the cathode during electrolysis when a current of 1.5A flows through an aqueous solution of copper(II) sulphate for 1 hour.

[2]

[Total: 10]

3. (a) The rate of reaction between compounds Q and R was studied at a fixed temperature. When the initial rate was measured at various initial concentrations of Q and R, the following results were obtained.

Experiment number	Initial [Q] / mol dm^{-3}	Initial [R] / mol dm^{-3}	Initial rate / mol dm^{-3} s^{-1}
1	0.010	0.010	1.0×10^{-6}
2	0.020	0.010	4.0×10^{-6}
3	0.030	0.020	9.0×10^{-6}
4	0.040	0.020	r

(i) Use the data in the table above to deduce the order with respect to each reactant.

Order with respect to Q

Order with respect to R

(ii) Use your results from part (i) to write the rate equation for the reaction.

(iii) State the units of the rate constant in the rate equation

(iv) Calculate the initial rate, r, for a mixture of Q and R in Experiment 4.

[5]

(b) What do you understand by **homogeneous catalysis**?

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..... [1]

(c) In aqueous solution, peroxodisulphate ions, $S_2O_8^{2-}$ can be reduced by iodide ions to sulphate (VI) ions.

(i) Write an equation for this reaction.

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(ii) This reaction is slow. It can be speeded up by adding a few drops of $Fe^{3+}(aq)$ ions. With the aid of suitable equations, suggest why $Fe^{3+}(aq)$ ions catalyse the reaction between peroxodisulphate ions and iodide ions.

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..... [4]

[Total : 10]

4. This question is about compounds of tin, lead and germanium.

(a) Oxides of tin and lead exist in two different oxidation states, +2 and +4. Give the formula of

(i) the most stable oxide of tin.....

(ii) the most stable oxide of lead .....

[2]

(b) Germanium, tin and lead form tetrachlorides.

(i) Describe and explain the difference in the thermal stability of these chlorides.

.....

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(ii) Write a balance equation for the reaction between germanium chloride and water.

.....

(iii)Draw a diagram to show the three dimensional structure of germanium chloride.

[4]

(c) Explain how the variation of melting point in group IV elements is related to the structure and bonding of the elements.

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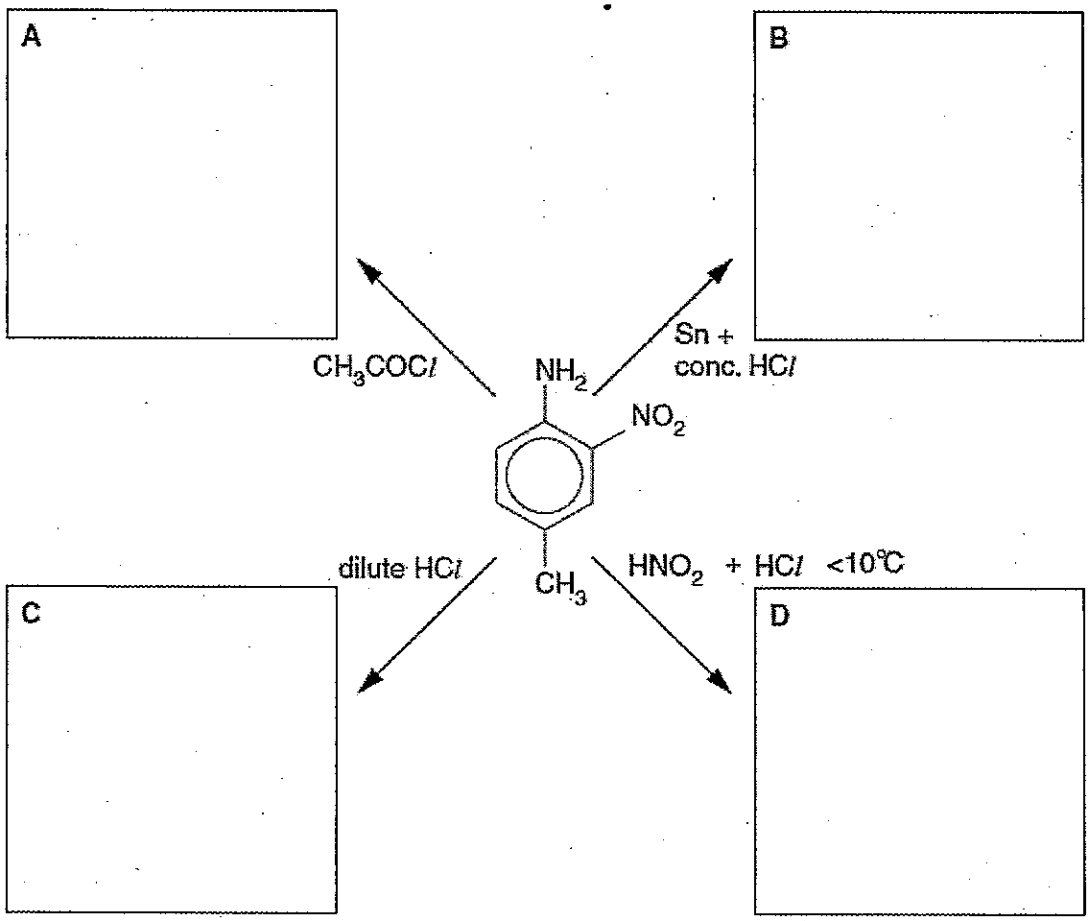
.....[3]

[Total : 9]

5 4-methyl-2-nitrophenylamine is used in the manufacture of pharmaceuticals and dyes.

(a) The diagram below shows some reactions of 4-methyl-2-nitrophenylamine.

Complete the diagram to show the structure of the organic product in each of the reactions.



[4]

(b) One of the products above can be converted into an azo dye.

(i) State how you would convert the product you have drawn in **D** above into an azo dye.

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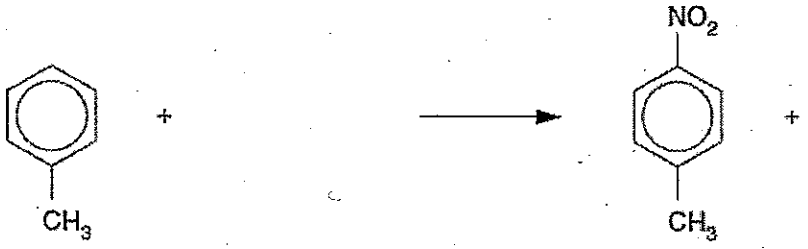
.....

(ii) Draw the structure of the azo dye that would be form in (i).

[4]

(c) 4-methyl-2-nitrophenylamine can be synthesis from methylbenzene. One stage involves the mononitration of methylbenzene using nitric acid in the presence of a concentrated sulphuric acid catalyst.

(i) Complete the overall equation for this reaction.



(ii) Write an equation to illustrate how the concentrated sulphuric acid catalyst is involved at the start of this reaction.

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(iii) Outline the mechanism for the substitution of the nitro group into methylbenzene, showing relevant curly arrows.

.....

[5]
[Total: 13]

6 Alanine, $CH_3CH(NH_2)COOH$, and valine, $(CH_3)_2CHCH(NH_2)COOH$, are both α-amino acids that occur naturally.

(a) Draw the zwitterion structure of valine.

[1]

(b) Draw the structure of the dipeptide that could be formed when one molecule of alanine reacts with one molecule of valine.

[2]

(c) State the type of reaction occurring.

.....[1]

(d) Phosphorus pentachloride, PCl_5, was added to alanine forming an acyl chloride. The acyl chloride was then reacted separately with methanol and with ammonia.

Draw the structure of the acyl chloride and the organic compounds formed from the acyl chloride.

Acyl chloride	Product with methanol	Product with ammonia

[3]

[Turn over

(e) Describe and explain how the acidities of $CHCl_2CO_2H$ and CH_2ClCO_2H compare to each other, and to the acidity of ethanoic acid.

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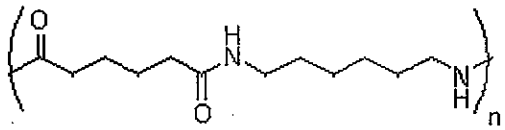
.....[3]

[Total: 10]

7 (a) The following diagram shows the repeat unit of nylon-6,6.



(i) What *type of polymerisation* made this nylon-6,6?

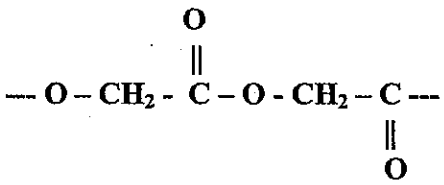
.....

(ii) Draw the structures of the two monomers that are used to make nylon-6,6.

[3]

(b) Poly(glycolic acid), PGA, is a polymer that is being developed as an inner coating for polyester bottles.

A short section of PGA is shown below.



(i) Compared with other synthetic polymers, PGA can be easily hydrolysed. State suitable reagents and conditions for the hydrolysis of PGA

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(ii) Draw the structure of the organic product formed from the complete hydrolysis of PGA by using the reagent stated in (i) above.

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(iii) Explain why scientists now think that polymers such as PGA are better for the environment than hydrocarbon-based polymers.

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[4]

[Total: 7]

[Turn over

Section B

Answer **all** the questions in the spaces provided

8 (a) A combination of mass spectrometry and NMR spectroscopy is often used to determine the structure of a simple organic compound. An organic compound **J** produced a mass spectrum in which the ratio of the M : M+1 peaks was 5.45 : 0.36 and which had an M+2 peak which was one-third the height of the M peak.

(i) Calculate how many carbon atoms are present in one molecule of **J**.

(ii) Deduce which element, other than carbon and hydrogen, is present in compound **J**.

.....

(iii)Explain how many atoms of this element are present in one molecule of **J**.

.....

.....

[5]

(b) The mass spectrum of 3-bromopropan-1-ol includes the following peaks.

(i) Identify the fragments (including isotopic composition where relevant) responsible for these 6 peaks.

Mass/charge ratio (m/e)	Fragments
31	
45	
93	
95	
107	
109	

(ii) At what mass number would you expect the molecular ion to occur?

.....

[5]

[Total : 10]

9 (a) NMR spectroscopy is a very important analytical technique for use with organic compounds. NMR spectroscopy uses the fact that under certain conditions, protons can exist in two different energy states.

Explain how these different energy states arise.

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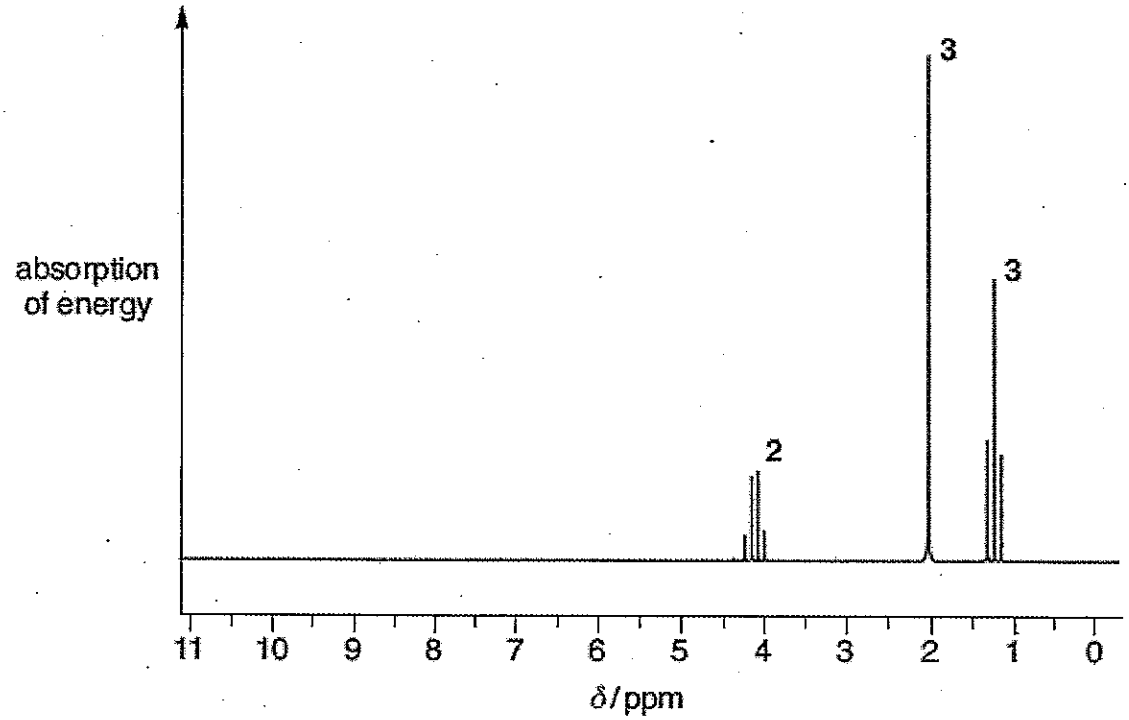
..... [2]

(b) An unknown compound **X** containing 54.5% carbon, 9.1% hydrogen and 36.4% oxygen was analysed by NMR spectroscopic method. The relative molecular mass of **X** is 88.

(i) Determine the empirical formula and the molecular formula of **X**. Show all your workings.

.....

(ii) The high resolution NMR spectrum of compound **X** is shown below.



Use the information above to identify compound **X** by deducing its structural formula. Account for the chemical shifts and splitting of each peak on the NMR spectrum.

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.....[8]

[Total:10]

[Turn over

10 The partition coefficient of butanoic acid between ether and water at room temperature is 3.0.

(a) Explain what this statement means.

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.....[1]

(b) State and explain how you would expect the partition coefficient of butanoic acid between hexane and water to compare with that between ether and water.

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.....[2]

(c) Give 2 reasons why ether is particular useful as a solvent for the extraction of an organic compound from aqueous solution.

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.....[2]

(d) Calculate the mass of butanoic acid which can be extracted from 100 cm^3 of an aqueous solution containing 4.0 g of butanoic acid by shaking with

(i) 100 cm^3 of ether in one portion.

(ii) two successive $50cm^3$ portions of ether.

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[4]

(e) Comment briefly on the results obtained in (d) (i) and (ii).

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.....[1]

[Total :10]