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Class	Student Number	Name

CAMBRIDGE A LEVEL PROGRAMME

A2 TRIAL EXAMINATION AUGUST/SEPTEMBER 2010

(June 2009 Intake)

Monday **30 August 2010** **8.30 am – 10.15 am**

CHEMISTRY 9701/43

PAPER 43 Structured Questions **1 hour 45 minutes**

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	
3	
4	
5	
6	
7	
8	
9	
10	
Total	

This document consists of **17** printed pages

[Turn over

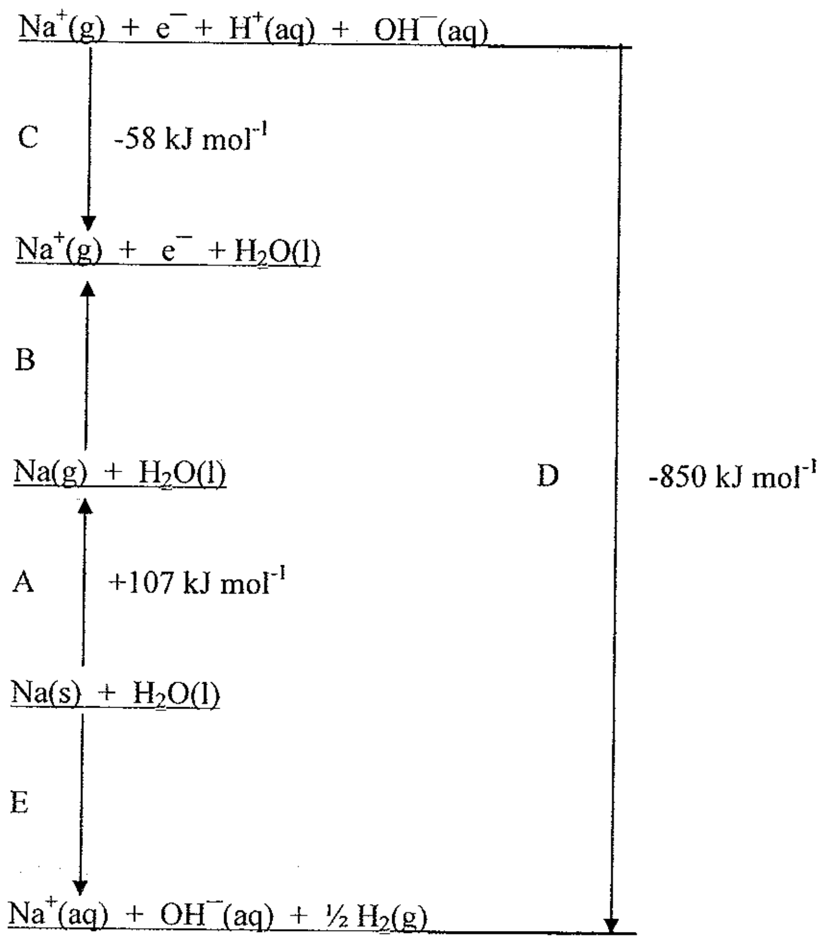
Section A

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

1. Sodium reacts with water to form aqueous sodium hydroxide.

$$Na(s) \ + \ H_2O(l) \ \rightarrow \ Na^+(aq) \ + \ OH^-(aq) \ + \ \tfrac{1}{2} H_2(g)$$

An energy cycle which starts from Na(s) and $H_2O(l)$ is sketched below. Some enthalpy changes are included.



(a) Name the enthalpy changes involved in steps :

A: ....

B: ....

C: ....

[3]

(b) Define *enthalpy change of neutralisation.*

....

....

....
[2]

(c) Calculate the enthalpy change for step **E**.

[2]
[Total: 7]

2. (a) State what is meant by a *buffer solution.*

....

....

....
[2]

(b) (i) Explain, using equations, how an aqueous mixture of ethanoic acid and sodium ethanoate can act as a buffer.

....

....

....

....

....

(ii) Write an expression for K_a, as applied to ethanoic acid.

(iii) What is meant by pK_a?

....

[Turn over

(iv) Use the relationship

$$pH = pK_a - \log_{10} \frac{[acid]}{[salt]}$$

to calculate the pH of a solution which is 0.40 mol dm^{-3} with respect to ethanoic acid and 0.20 mol dm^{-3} with respect to sodium ethanoate.
[K_a (ethanoic acid) = 1.80×10^{-5} mol dm^{-3}]

(v) Calculate the change in pH of 1.0 dm^3 of solution in **b(iv)** when 0.0050 mol of solid sodium hydroxide is added (assume no change in volume).

[8]

(c) Calculate the pH of solution when 0.050 mol of sodium hydroxide is added to 1.0 dm^3 of water.

[2]

(d) State a buffer system which helps to control the pH of blood.

....

[1]

[Total: 13]

3. At 700°C, nitrogen monoxide and hydrogen react as follows:

$$2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$$

The results of some investigations of the rate of this reaction are shown below.

Experiment number	*Initial concentration of NO / mol dm^{-3}*	*Initial concentration of H_2 / mol dm^{-3}*	*Initial rate of reaction / mol dm^{-3}s^{-1}*
1	0.0020	0.012	0.0033
2	0.0040	0.012	0.013
3	0.0060	0.012	0.030
4	0.012	0.0020	0.020
5	0.012	0.0040	0.040
6	0.012	0.0060	0.060

(a) Explain what is meant by *order of reaction.*

....

.... [1]

(b) (i) Use the above data to determine the order of the reaction with respect to :

1. **NO**

....

....

2. **H_2**

....

....

(ii) Write the rate equation for the reaction, including rate constant, k.

....

(iii) Determine a value for k, stating its units

[8]
[Total: 9]

4. (a) What do you understand by the term *standard electrode potential*?

....

....

....

[2]

(b) Draw labeled diagrams to show how you could measure the standard electrode potential of each of the following electrode systems.

1. $Cu^{2+}(aq) / Cu(s)$

2. $Fe^{3+}(aq) / Fe^{2+}(aq)$

[6]

(c) By making use of the data contained in the *Data Booklet*, predict whether the following pairs of reagents are likely to react when mixed in acidified aqueous solution. Calculate the E^{θ}_{cell} and write balanced equation for each reaction you predict will occur.

1. $I_2(aq)$ and $Cr^{2+}(aq)$

....

....

....

2. $H_2O_2(aq)$ and $MnO_4^-(aq)$

....

....

....

[6]

(d) Explain, with the aid of equations how copper (II) ion forms pale blue precipitate in aqueous ammonia and dissolves in excess of the solution to give deep blue solution.

....

....

....

....

[2]

(e) Transition metal ions form coloured compounds both in solid state and in solution. Explain.

....

....

....

....

[3]

[Total: 19]

[Turn over

5 (a) Lead(II) chloride and Lead(IV) chloride have melting points of 49°C and -15°C respectively. Explain in terms of structure and bonding.

....

....

....

....

[3]

(b) Going down Group IV there is a variation in the relative stabilities of the higher and lower oxidation states of the elements in their oxides. Illustrating your answers with balanced chemical equations, in each of the following cases suggest **one** piece of chemical evidence to show that

(i) CO is less stable than CO_2,

....

....

(ii) PbO is more stable than PbO_2.

....

....

[3]

(c) Tin(II) oxide reacts with both acids and alkalis.

Write suitable equations to show these two reactions of tin(II) oxide.

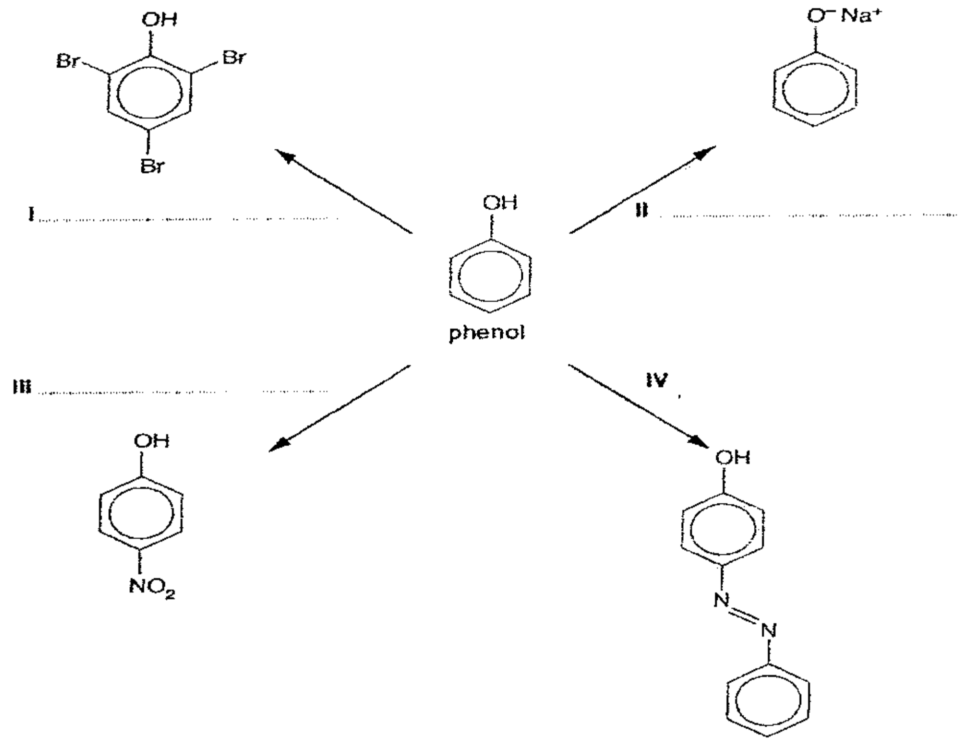
....

....

[2]

[Total: 8]

6. The diagram below shows some reactions of phenol.



(a) On the diagram above, identify suitable reagents that could be used to carry out reactions I, II and III. [3]

(b) State a use for the compound formed in reaction IV.

....

[1]

(c) Outline how you could carry out reaction IV in the laboratory starting from phenol and a suitable aromatic amine.

....

....

....

....

....

....

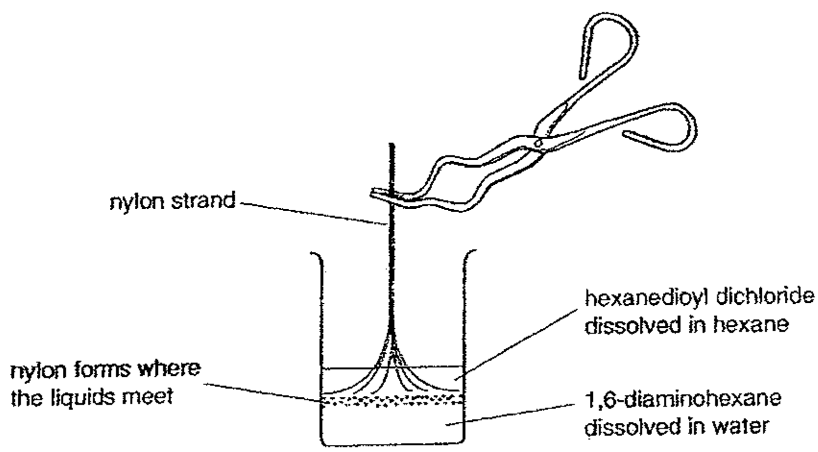
[4]

[Total: 8]

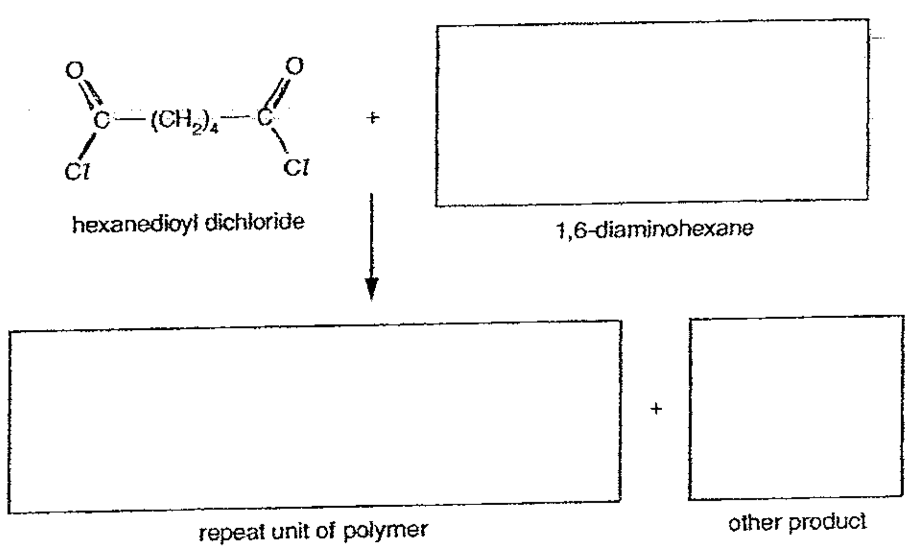
[Turn over

7. The 'Nylon Rope Trick' is a well known laboratory demonstration for the formation of a condensation polymer from its monomers.

Two solutions, one containing each monomer, are placed in a beaker as shown. In this reaction, the more reactive hexanedioyl dichloride is used instead of hexanedioic acid. The nylon forms where the two immiscible liquids join, and can be pulled out from between the layers in a continuous strand.



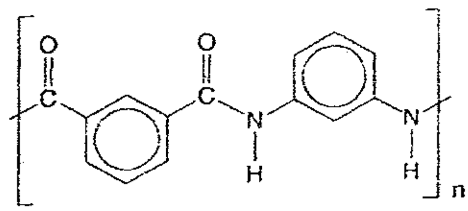
(a) Complete the equation below to show the formation of the nylon polymer from its monomers. Show a repeat unit for the polymer and the other product formed.



[3]

(b) Nylon is sometimes used for electrical insulation. However, if there is a risk of high temperatures then the polymer such as Nomex®, with a higher melting point is used.

The repeat unit of Nomex® is shown below.



(i) Draw the structures of the two monomers that could be used to form Nomex®

(ii) Suggest why the melting point of Nomex® is higher than that of nylon.

....

....

....

[3]

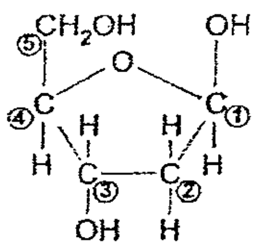
[Total: 6]

Section B – Applications of Chemistry

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

8. This question is about DNA.

(a) The sugar in DNA is deoxyribose.



In the DNA structure, identify which of the carbon atoms **1 – 5** are attached to:

(i) phosphate,

....

(ii) a base.

....

[2]

(b) (i) DNA is a condensation polymer.

What is meant by condensation and polymer in this context?

....

....

....

(ii) Describe, with the aid of a diagram, one type of interaction that holds the two strands of DNA together in a double helix.

....

....

....

[4]

(c) Briefly outline the process of DNA replication.

....

....

....

....

....

[4]

[Total: 10]

9. (a) Thin-layer chromatography, TLC can be used to separate the amino acids in a mixture.

(i) Identify the **mobile** and the **stationary** phases in TLC.

....

....

....

(ii) Explain how TLC separates the amino acids.

....

....

[4]

(b) The mixture of amino acids was analysed by two-way chromatography.

Describe how two-way chromatography is carried out and explain why it is more effective than one-way chromatography.

....

....

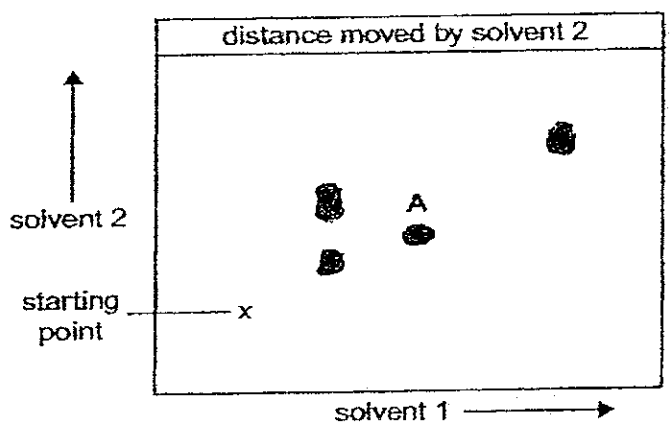
....

....

[3]

[Turn over

(c) The two-way chromatogram of the mixture of amino acids is shown below.



(i) How many different amino acid spots would have been separated by **solvent 1**?

....

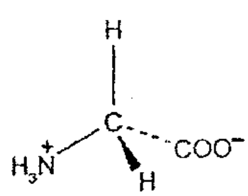
(ii) Estimate the R_f value of the amino acid **A** in **solvent 2**.

....

[2]

(d) Amino acids can also be separated by electrophoresis. The separation depends on the mass of, and charge on, the amino acid as well as the pH of the mixture.

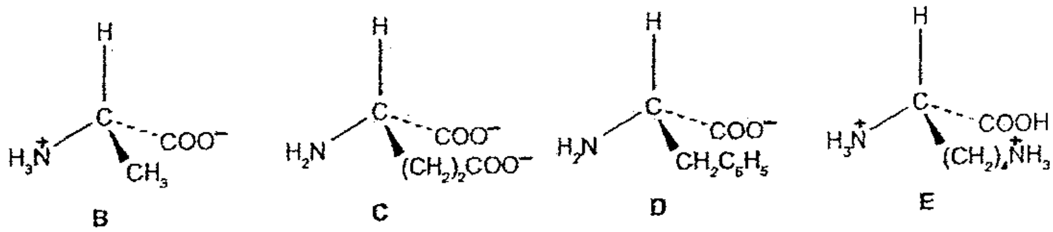
At a pH of 5.8 glycine forms a zwitterion.



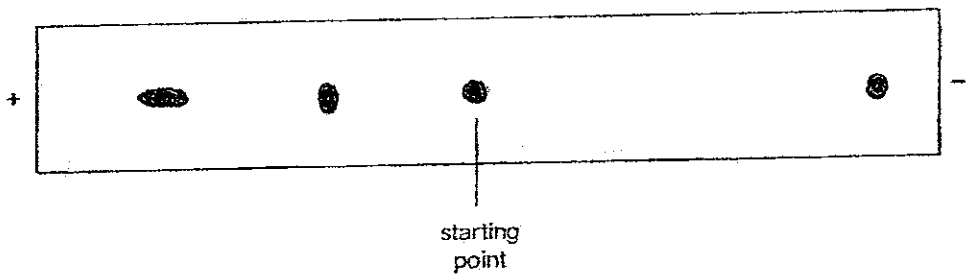
Draw the structure of glycine at pH 2.0.

[1]

(e) At a pH of 6.0 the four amino acids in a mixture exist in the forms B - E shown below.



The diagram below shows the result of the electrophoresis of the mixture of the four amino acids at pH 6.0.



Label on the diagram spots **B, C, D** and **E** appropriately. [3]

[Total: 13]

10. Read the passage below on production of ethanol for fuel, and then answer the questions.

Sugar cane is the world's largest source of fermentation ethanol Ethanol can be produced by converting the starch content of biomass feedstocks, such as sugar cane, into alcohol. Yeast is used to break down the complex sugars of starch into simpler sugars, which are fermented to form ethanol. A further advantage is that bagasse, the remains of the cane after the sugar is extracted, and the tops and leaves of the sugar cane can be used as a fuel for electricity production. An efficient ethanol distillery using sugar cane by-products can therefore be self-sufficient and also generate a surplus of electricity.

There is a second process that utilises biomass feedstocks to produce ethanol. The main carbohydrate constituent of these feedstocks is cellulose, which, like starch, is a sugar polymer that can be broken down by hydrolysis into simpler sugars. The new process uses enzymatic hydrolysis or acid hydrolysis of cellulose to produce simple sugars for fermentation

The use of bagasse as the cellulose source in the new process could allow off-season production of ethanol with very little new equipment. This process is relatively new and is not yet commercially available, but potentially can use a much wider variety of abundant, inexpensive feedstocks. Alcohol fuels have been developed in a number of African countries – Kenya, Malawi, South Africa and Zimbabwe – currently producing sugar, with others, including Mauritius, Swaziland and Zambia also having great potential.

Ethanol has different chemical properties from gasoline. Although one litre of ethanol has about two-thirds of the energy of a litre of gasoline, tuning the engine for ethanol can make up as much as half the difference. Furthermore, should there be a spill, ethanol can be dealt with more quickly and easily than gasoline.

Using ethanol even in low-level blends (e.g. E10 – which is 10% ethanol, 90% gasoline) can have environmental benefits. Tests show that E10 produces less carbon monoxide, sulphur dioxide and carbon dioxide than gasoline. Higher blends (E85 – 15% gasoline), or even neat ethanol burn with less of almost all these pollutants.

(a) Explain **two** ways in which *bagasse* can be used to reduce the cost of ethanol production.

1. ....

....

....

2. ....

....

....

[2]

(b) In addition to ethanol, what other product is formed in the fermentation of sugars by yeast?

....

[1]

(c) Suggest an equation to show the hydrolysis of cellulose in *bagasse* to form fermentable sugars with the molecular formula $C_6H_{12}O_6$.

[1]

(d) Using your knowledge of chemical bonding, suggest why a spill of ethanol is more easily dealt with than a spill of gasoline.

....

....

....

....

....

[3]

[Total: 7]