Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE
General Certificate of Education
Advanced

CYD-BWYLLGOR ADDYSG CYMRU
Tystysgrif Addysg Gyffredinol
Uwch

FOR EXAMINER'S USE ONLY		
Section	Question	Mark
A	1	
	2	
	3	
B	4	
	5	
TOTAL MARK		

334/01

CHEMISTRY CH4

P.M. MONDAY, 18 June 2007

(1 hour 40 minutes)

ADDITIONAL MATERIALS

In addition to this examination paper, you will need:
- a calculator;
- an 8 page answer book;
- a **Data Sheet** which contains a **Periodic Table** supplied by WJEC. Refer to it for any **relative atomic masses** you require.

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Section A Answer **all** questions in the spaces provided.
Section B Answer **both** questions in **Section B** in a separate answer book which should then be placed inside this question-and-answer book.

Candidates are advised to allocate their time appropriately, between **Section A (35 marks)** and **Section B (40 marks)**.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The maximum mark for this paper is 75.

Your answers must be relevant and must make full use of the information given to be awarded full marks for a question.

You are reminded that marking will take into account the Quality of Written Communication in all written answers.

No certificate will be awarded to a candidate detected in any unfair practice during the examination.

SECTION A

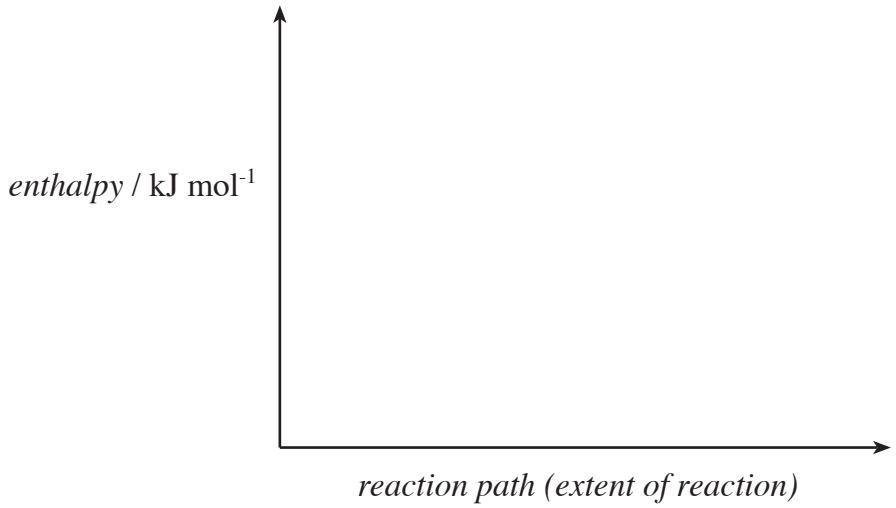
Answer **all** *the questions in the spaces provided.*

1. *(a)* Some car-body fillers contain phenylethene, $C_6H_5CH{=}CH_2$, which is polymerised by a 'hardener' containing benzoyl peroxide.

(i) Write the **empirical** formula for phenylethene. [1]

.....

(ii) Heat is given out to the surroundings when phenylethene undergoes addition polymerisation to give poly(phenylethene).
Using the axes below, draw a reaction profile for this polymerisation. [1]



(iii) Benzoyl peroxide decomposes to produce free radicals.

I. State what is meant by a ***free radical***. [1]

.....

II. Although benzoyl peroxide produces free radicals to initiate the polymerisation of phenylethene, other products can be formed in small quantities. These include benzenecarboxylic acid (benzoic acid) and phenyl benzenecarboxylate (phenyl benzoate), $C_6H_5COOC_6H_5$.
If you were given a sample that is either benzenecarboxylic acid or phenyl benzenecarboxylate, show how you would distinguish between them by the use of infrared spectroscopy and by a chemical test. A comment about each substance is necessary. Refer to the Data Sheet. [3]

Infrared spectroscopy .....

.....

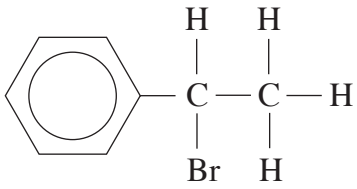
.....

Chemical test .....

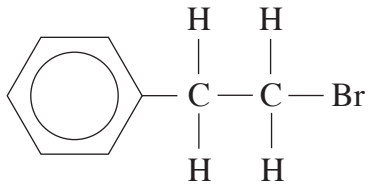
.....

.....

(b) (i) The reaction of phenylethene with hydrogen bromide can give the two products shown below.



1-bromo-1-phenylethane



1-bromo-2-phenylethane

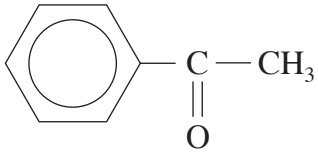
Only one of these compounds is optically active.

Identify the chiral centre in this compound by use of an asterisk (*) and state how an optical isomer of this compound could be distinguished from the other compound. Your answer should give the result with both compounds. [2]

.....

.....

(ii) 1-Bromo-1-phenylethane can be converted into phenylethanone, in a two-stage process.



phenylethanone

Give the reagent(s) used and the formula of the product formed at the end of the first stage. [3]

Stage 1 reagent(s) .....

Stage 1 product

Stage 2 reagent(s) .....

Total [11]

2. *(a)* Ethanol is a commercially important compound.

(i) Describe the industrial preparation of ethanol from ethene, giving the reagent(s) and any essential conditions. [2]

.....

.....

(ii) Ethanol has benefits to society but also has its disadvantages.
State **one** benefit of ethanol and **one** disadvantage. [2]

Benefit .....

.....

Disadvantage .....

.....

(iii) Ethanol is able to hydrogen bond with water and also with other ethanol molecules.
Explain how this hydrogen bonding occurs and describe **two** of the physical properties of ethanol, relating these to hydrogen bonding.
You may find a diagram helpful to illustrate your answer. [4]

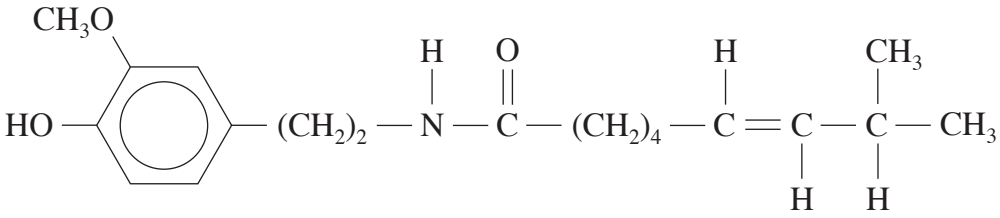
.....

.....

.....

.....

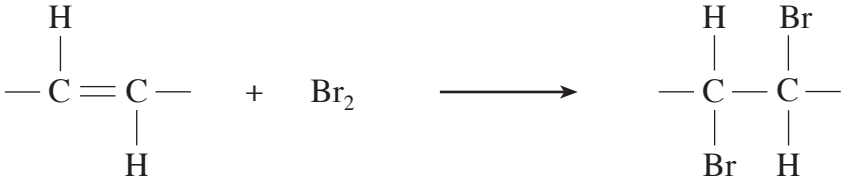
(b) One of the compounds responsible for the hot burning taste given by chilli peppers is capsaicin.



(i) State what would be **seen** if capsaicin is reacted with iron(III) chloride solution. [1]

.....

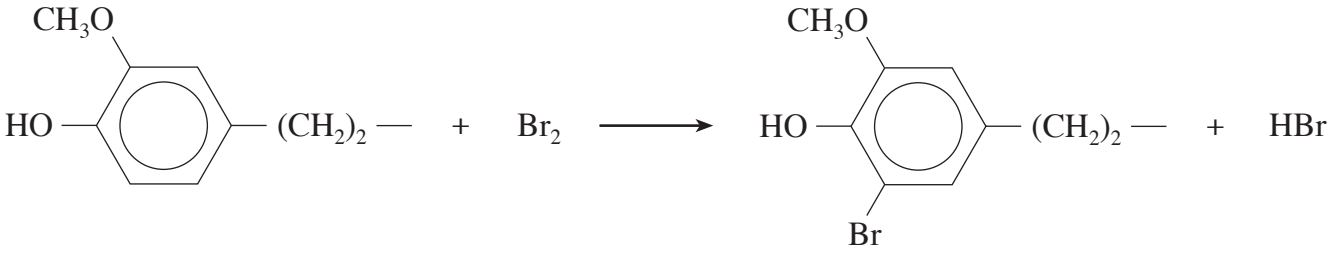
(ii) Capsaicin will react with bromine at the double bond position.



State the type of mechanism occurring in this process. [1]

.....

(iii) Bromine will also react with the aromatic group in capsaicin.



State the type of mechanism occurring in this process. [1]

.....

(c) (i) Capsaicin is a substituted amide.

Give the graphic formula of the simpler compound ethanamide. [1]

(ii) Describe how ethanamide is made from ethanoic acid. [2]

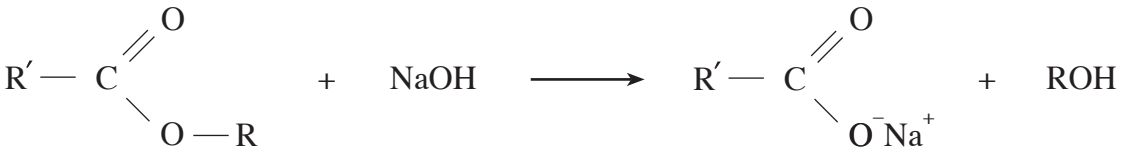
.....

.....

.....

Total [14]

3. *(a)* Esters are hydrolysed by aqueous sodium hydroxide.



One way to identify an ester is to hydrolyse it with an excess of aqueous sodium hydroxide and then to titrate the excess sodium hydroxide with an acid.

3·52 g of an ester **N** was added to an aqueous solution of sodium hydroxide containing a total of 0·0800 mole of sodium hydroxide.

The excess sodium hydroxide was exactly neutralised by 25·0 cm^3 of hydrochloric acid of concentration 1·60 mol dm^{-3}, according to the following equation.

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

(i) I. Calculate the number of moles of hydrochloric acid used in the reaction with the excess of sodium hydroxide.

.....

.....

II. State the number of moles of sodium hydroxide in excess.

.....

III. Calculate the number of moles of sodium hydroxide that have reacted with the ester.

.....

.....

IV. State the number of moles of ester present.

.....

[2]

(ii) Calculate the relative molecular mass of the ester. [1]

.....

.....

(iii) Give a graphic formula for the ester. [1]

(b) Complete the table below by giving the products formed when **butanone** reacts with the reagents listed and the reagent(s) needed to give the product shown. [3]

Reagent(s)	*Organic product (if any)*
$NaBH_4$	
acidified $K_2Cr_2O_7$	
	yellow antiseptic smelling solid

(c) A molecule of nonane, C_9H_{20}, is cracked to produce two molecules of ethene and one molecule of a third product, compound **T**.

(i) Find the molecular formula of compound **T**. [1]

.....

(ii) Compound **T** is a branched chain isomer. Give a graphic formula for compound **T** and name your chosen compound. [2]

.....

Total [10]

Section A Total [35]

SECTION B

Answer **both** *questions in the separate answer book provided.*

4. *(a)* The following information was obtained on analysis of an organic compound **X**.

- Compound **X** contained only carbon, hydrogen and oxygen
- The mass spectrum showed a molecular ion peak, M^+, at *mass/charge* 86
- Compound **X** contained two oxygen atoms in every molecule
- Compound **X** contained approximately 55.8% of carbon by mass
- The infrared spectrum showed a strong absorption at 1680 cm^{-1}
- Compound **X** had no reaction with Tollens' reagent
- The NMR spectrum consisted of a single signal at $\delta = 2{\cdot}2$ ppm

Use **all** the information provided to deduce a molecular **and** a graphic formula for compound **X**. [5]

(b) Read the short account below and then use the information to answer the question.

Preparation of compound **G**

Place into a boiling tube 1 cm^3 of benzenecarbaldehye (benzaldehyde), 5 drops of propanone, 5 cm^3 of ethanol and 2 cm^3 of aqueous sodium hydroxide.
Heat the mixture to boiling and continue boiling for 1 minute. Cool and shake.
Add 20 cm^3 of water. Shake and filter.
Wash the solid with water, recrystallise it from ethanol and dry.
Measure its melting temperature, which should be around 112 °C.

(i) Outline a safe method for heating the mixture to boiling. You may use a diagram if you wish. [1]

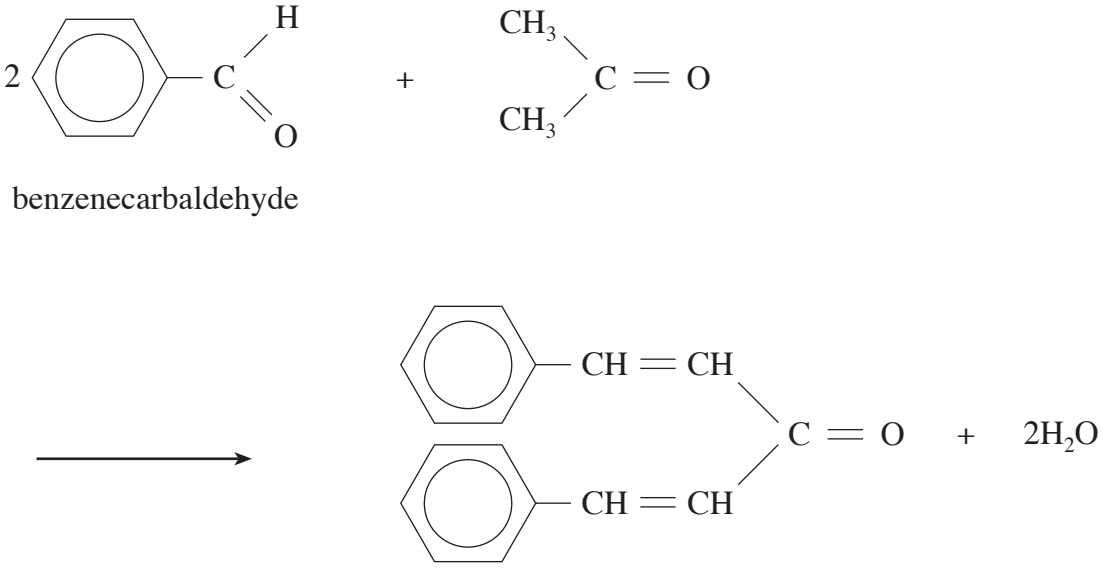
(ii) State why it is necessary to wash the product with water. [1]

(iii) Outline how you would recrystallise compound **G** from ethanol to obtain pure dry crystals. [3]

(c) Compound **G**, prepared in *(b)*, is produced as yellow crystals.

(i) Explain why compound **G** appears yellow in white light. [1]

(ii) The overall reaction to make compound **G** can be represented by the equation below.



benzenecarbaldehyde

compound **G**

In an experiment, 3·18 g of benzenecarbaldehyde reacted with an excess of propanone to give 2·82 g of compound **G**.
Calculate the percentage yield of compound **G** to **two** significant figures. [4]

(d) Compound **G** absorbs in the visible region of the electromagnetic spectrum but diphenylmethanone, $(C_6H_5)_2CO$, absorbs in the ultraviolet region.
Use the relationship between wavelength, frequency and energy to comment on the relative wavelengths of the energy absorbed in compound **G** and diphenylmethanone. [3]

(e) Give an example of the use of spectroscopic techniques in industry, medicine or environmental science.
You should state the technique employed and its application. [2]

Total [20]

Turn over for question 5.

5. *(a)* 1-Chlorobutane is obtained by reacting butane and chlorine together. The conditions required are the same as for the reaction of methane and chlorine.
Give the equation for this reaction and state any essential conditions. [2]

(b) 1-Chlorobutane is hydrolysed by aqueous sodium hydroxide in a similar way to 1-bromobutane.
Outline the mechanism for this reaction by using curly arrows and state the type of mechanism which occurs. [4]

(c) (i) Outline a two-stage method for making pentanoic acid starting from 1-chlorobutane. [4]

(ii) Outline how pentanoic acid could be converted into methyl pentanoate. [2]

For each stage you should state the reactants, products and any essential conditions.

(d) You are given the following named liquids in labelled bottles:

butylamine, butan-1-ol, pentan-3-one and butanoyl chloride.

Outline **one** chemical test in **each** case to confirm that each bottle is correctly labelled. [5]

(e) The mass spectrum of a compound of molecular formula C_2H_6O was recorded. The spectrum showed the expected molecular ion at *mass/charge* 46 and gave strong signals at *mass/charge* 15 and 31. It did not give a signal at *mass/charge* 29 or 45.
Use these results to deduce whether the compound is likely to be ethanol or methoxymethane, CH_3OCH_3.
You should consider both molecules in your answer. [3]

Total [20]

Total Section B [40]