Candidate Name	Centre Number	Candidate Number
		2

GCE A level

334/01

CHEMISTRY CH4

A.M. TUESDAY, 20 January 2009

1 hour 40 minutes

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

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.

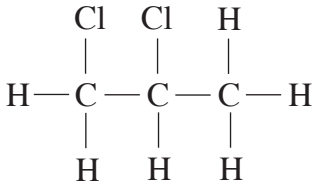
You are reminded that marking will take into account the Quality of Written Communication in all written answers.

SECTION A

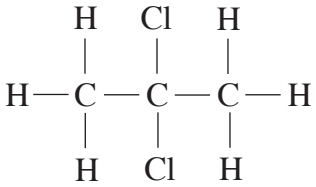
Answer **all** *the questions in the spaces provided.*

1. There are several structural isomers of dichloropropane.

(a) Two examples are shown below. In the space provided, draw the full graphical structure(s) of all other structural isomers of this compound. [2]



1,2 – dichloropropane



2,2 - dichloropropane

(b) (i) State which isomer given in *(a)* is formed by the addition reaction of chlorine to propene. [1]

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(ii) State which isomer in *(a)* exhibits optical isomerism, and identify the chiral centre with a star (*). [2]

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(iii) Explaining your reasoning, state which isomer in *(a)* gives only a single, unsplit, peak in its proton NMR spectrum. [1]

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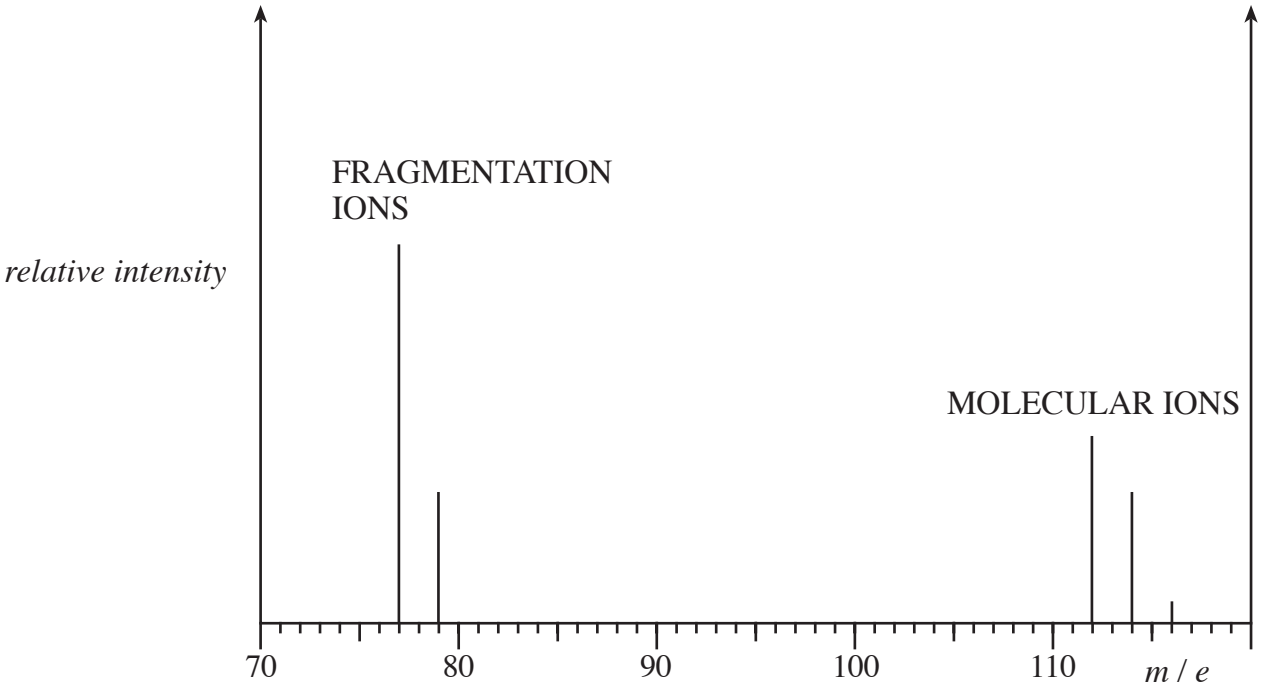
(c) All the dichloropropane isomers show identical mass spectrum peaks in the section of the spectrum shown in the diagram.



(i) Explain why **each** compound gives three different molecular ion peaks and give the species responsible for **each** of the three peaks. [2]

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(ii) Identify which covalent bond is broken in forming the fragmentation ion peaks shown, and explain why this covalent bond is the one broken. [2]

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(iii) The same covalent bond can also be split by homolytic fission. Explain how this could have an adverse effect on the environment. [2]

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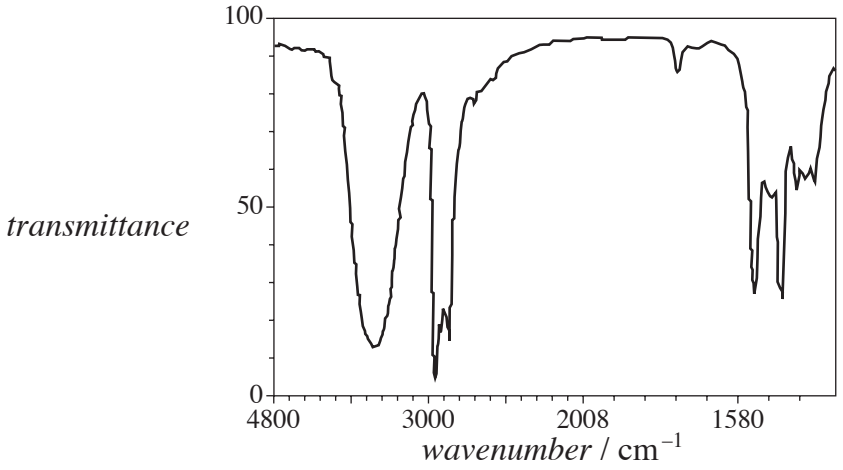
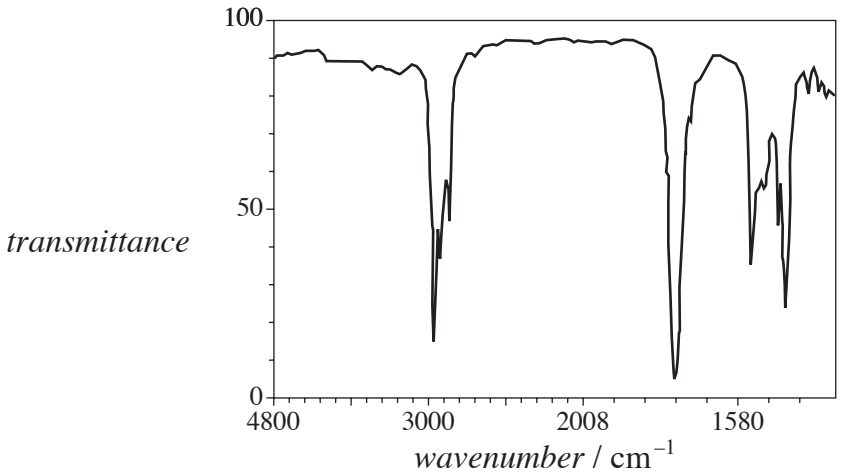
Total [12]

2. Compound **A**, a colourless liquid, has the molecular formula $C_5H_{12}O$. On warming with acidified potassium dichromate solution, compound **A** is oxidised to another colourless liquid, compound **B**.

(a) The IR spectra of compounds **A** and **B** are shown below.



IR spectrum of compound **A**



IR spectrum of compound **B**

Explain how the differences between the two IR spectra provide evidence that

- the conversion of compound **A** to **B** involves the oxidation of an alcohol;
- the product is an aldehyde or ketone and not a carboxylic acid. [2]

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(b) State one test, and the expected observations in each case, which could be used to determine whether **B** is an aldehyde or whether it is a ketone. [2]

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(c) Compounds **A** and **B** both give a positive ***triiodomethane (iodoform) test***. State the reagents used for the ***triiodomethane (iodoform) test***, the observations necessary for a positive result and the groups which the test shows to be present in each of **A** and **B**. [3]

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(d) Given the additional information that both **A** and **B** are branched chain compounds and **A** is optically active whereas **B** is not, identify compounds **A** and **B** either by structure or name. Show the chiral centre in **A**. [3]

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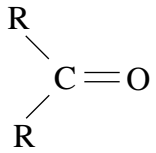
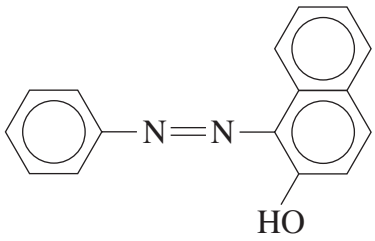
(e) Draw the mechanism for the addition reaction of a carbonyl compound, such as **B**, with hydrogen cyanide, HCN. For simplicity, you may represent the carbonyl compound as [3]

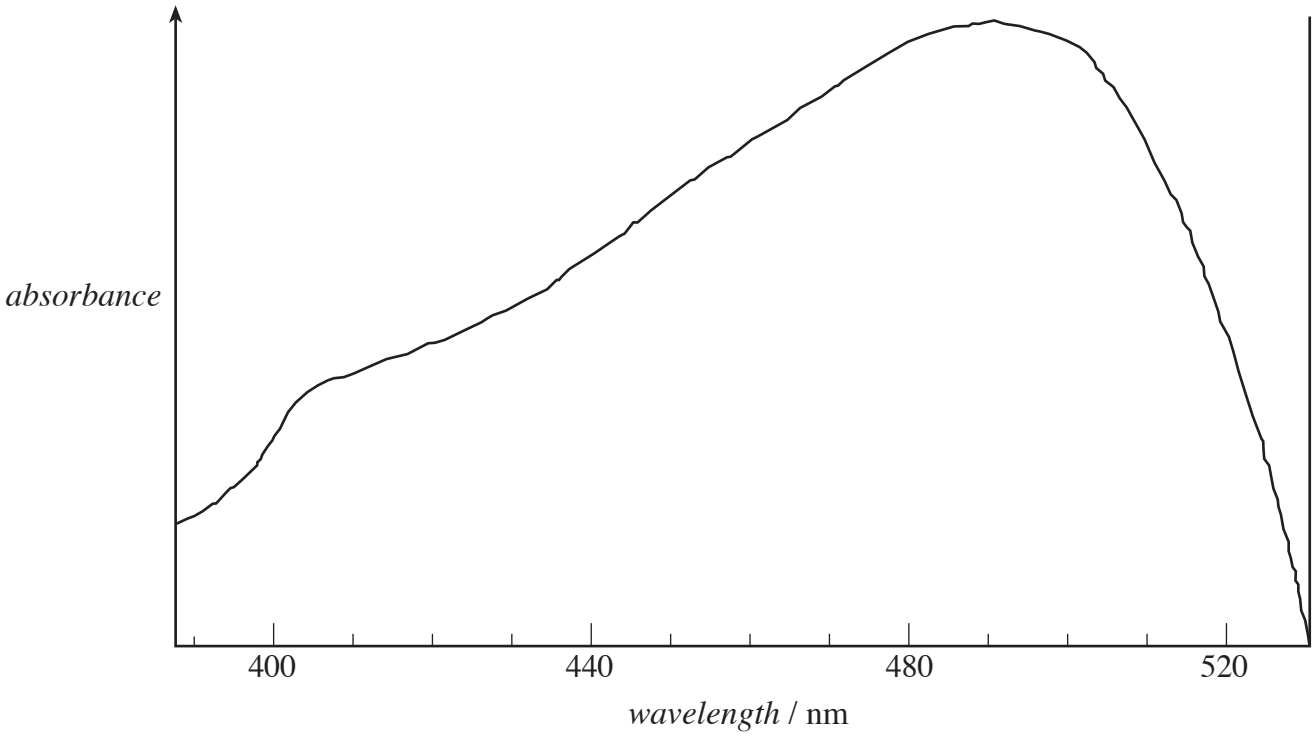


Total [13]

3. *(a)* 1-(phenylazo)naphthalen-2-ol has the structure shown below.



The following diagram shows the section of its visible absorption spectrum where it has the strongest absorption of light.



(i) Determine the wavelength at which 1-(phenylazo)naphthalen-2-ol has the strongest absorption of light. [1]

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(ii) Using your answer to (i) and given the following information for visible light, determine the colour of 1-(phenylazo)naphthalen-2-ol, explaining your reasoning.

Colour	*Wavelength range* / nm
violet	380 - 450
blue	450 - 495
green	495 - 570
yellow	570 - 590
orange	590 - 620
red	620 - 750

[2]

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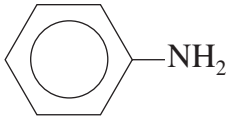
(iii) Identify the grouping responsible for 1-(phenylazo)naphthalen-2-ol absorbing light and hence being coloured. [1]

(b) Giving reagents and outlining practical details, describe how a solid sample of 1-(phenylazo)naphthalen-2-ol can be prepared starting from phenylamine.



phenylamine

[4]

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(c) Explain why phenylamine behaves as a base. [2]

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Total [10]

Section A Total [35]

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SECTION B

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

4. Malonic acid, $C_3H_4O_4$, can be formed from several naturally-occurring chemicals.

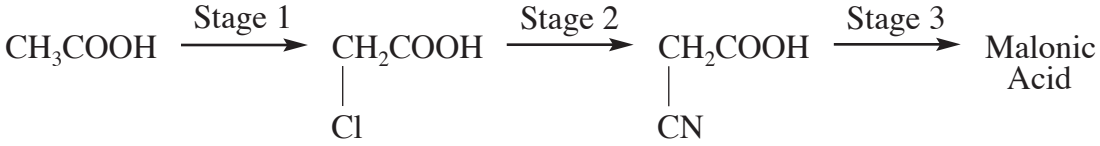
(a) (i) Giving reagent(s) and expected observation(s), outline one test which could be used to show that malonic acid is a carboxylic acid. [2]

(ii) 1·04 g malonic acid needed 16·0 cm^3 sodium hydroxide of concentration 1·25 mol dm^{-3} for complete reaction. Calculate the number of moles of sodium hydroxide which react with one mole of malonic acid. [2]

(iii) The proton NMR spectrum of malonic acid showed only two peaks, at 3·2 ppm and 11·5 ppm. The two peaks were both singlets (no splitting present) and of equal area.
Using **all** the information given in *(a)*, and showing your reasoning, draw the structure of malonic acid. [4]

(iv) State the systematic name for malonic acid. [1]

(b) Malonic acid was originally synthesized from ethanoic acid by the following reaction sequence.



State the reagent(s) and condition(s) necessary to carry out stage 1 and stage 2. [4]

(c) Decarboxylation of malonic acid gives a mixture of two organic products.

(i) State the reagent used for the decarboxylation of carboxylic acids. [1]

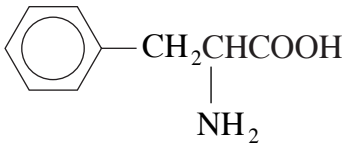
(ii) Name the two organic products possible from the decarboxylation of malonic acid. [2]

(d) Malonic acid is also formed by the oxidation of malonaldehyde, a suspected carcinogenic initiator and mutagen produced during the cooking of meats.
One step in the test for malonaldehyde in food involves reacting it with 2,4-dinitrophenylhydrazine (2,4-DNPH) to form an orange solid. For this reaction:

- state the group for which reaction with 2,4-DNPH is a test;
- classify the type of reaction occurring;
- outline how the orange solid can be separated and used to identify the original compound being tested. [4]

Total [20]

5. *(a)* Phenylalanine is an amino acid with the structure shown below.



phenylalanine

(i) One method of synthesizing phenylalanine involves a five-stage process starting from malonic acid, $C_3H_4O_4$, with a 35% yield.

I. Calculate the yield (in grams) of phenylalanine starting from 100 g of malonic acid. [3]

II. This method has been replaced by alternative processes involving fewer stages. Explain why reducing the number of stages in a synthesis usually leads to an increased yield of product. [1]

(ii) Phenylalanine is amphoteric. Explain the meaning of the term ***amphoteric*** and why phenylalanine exhibits amphoteric behaviour. [2]

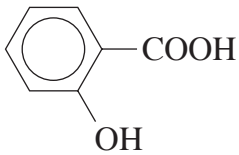
(iii) Phenylalanine reacts with excess lithium tetrahydridoaluminate(III), $LiAlH_4$.

I. Draw the structure of the organic compound produced. [1]

II. State the conditions under which the reaction is carried out. [1]

(iv) Phenylalanine can react to form a dipeptide. Draw the structure of the dipeptide formed from two molecules of phenylalanine and identify the peptide link in the molecule. [2]

(b) In some plants, infection causes the conversion of phenylalanine to salicylic acid (2-hydroxybenzenecarboxylic acid), thereby increasing resistance to attack.



2-hydroxybenzenecarboxylic acid

(i) State the reagent and conditions used industrially to convert salicylic acid into aspirin (ethanoyloxybenzenecarboxylic acid). [2]

(ii) Draw the structure of aspirin (ethanoyloxybenzenecarboxylic acid). [1]

Turn over for part *(c)*

(c) By treatment with sulphuric and nitric acids under appropriate conditions, either salicylic acid or aspirin can be converted into picric acid (2,4,6-trinitrophenol), $C_6H_3N_3O_7$, used in explosives and the first chemical to be used as an artificial dye.

(i) Draw the structure of picric acid (2,4,6-trinitrophenol). [1]

(ii) Give **one** test which can be used to show that picric acid contains a phenol group. [2]

(iii) Picric acid dissolves readily in sodium hydroxide solution. Draw the structure of the organic species formed in this solution. [1]

(iv) Picric acid (2,4,6-trinitrophenol) also reacts with ethanoyl chloride, CH_3COCl.

I. Draw the structure of the organic product.

II. Write a balanced equation for the reaction.

III. Name the class of compounds to which the organic product belongs. [3]

Total [20]

Section B Total [40]