

Candidate Name	Centre Number	Candidate Number

WELSH JOINT EDUCATION COMMITTEE  
General Certificate of Education  
Advanced

**WJEC**  
**CBAC**

CYD-BWYLLGOR ADDYSG CYMRU  
Tystysgrif Addysg Gyffredinol  
Uwch

334/01

**CHEMISTRY CH4**

A.M. TUESDAY, 23 January 2007

(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.

**ADVICE TO CANDIDATES**

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 used in your 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) But-2-ene,  $\text{CH}_3\text{CHCHCH}_3$ , exhibits geometrical isomerism. Draw structures to show the two possible isomers and explain why geometrical isomerism occurs in this case. [2]

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- (b) Describe a test which would show that but-2-ene contains a C=C double bond. Your answer should include reagent(s), condition(s) and expected observation(s). [2]

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- (c) (i) Name and draw the structure of the compound formed when but-2-ene reacts with hydrogen bromide gas. [2]

*Structure*

*Name* .....

- (ii) The compound formed in (c)(i) also has two isomers, due to a different type of stereoisomerism. Name this type of stereoisomerism and explain why it occurs in this particular compound. [2]

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- (iii) State **one** physical technique which can be used to distinguish between the two isomers in (c)(ii). [1]

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- (d) State **one** former large-scale use of halogenoalkanes and **one** problem associated with halogenoalkanes in the environment. [2]

*Use* .....

*Problem* .....

.....

Total [11]

2. (a) The table shows some of the electron energy levels for the hydrogen atom. The energies quoted are relative to the ground state ( $n = 1$ ) being defined as zero energy.

<i>Energy level</i>	<i>Energy / kJ mol<sup>-1</sup></i>
$n = \infty$	1312
$n = 7$	1285
$n = 6$	1275
$n = 5$	1259
$n = 4$	1230
$n = 3$	1166
$n = 2$	984
$n = 1$	0

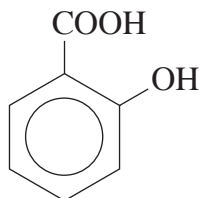
- (i) Each of the items in the following table involves an electron transition between two of the energy levels. Complete the table by inserting, in **each** case, the **two** energy levels involved in the transition and by calculating the energy change associated with the transition. [3]

	<i>Energy levels involved</i>	<i>Energy change /kJ mol<sup>-1</sup></i>
The first line in the Balmer series in the atomic hydrogen spectrum	$n =$ and $n =$	
The first line in the Lyman series in the atomic hydrogen spectrum	$n =$ and $n =$	
Ionisation of atomic hydrogen	$n =$ and $n =$	

- (ii) State which one of the transitions in 2(a)(i) corresponds to the energy of red light. [1]
- .....

- (iii) State which one of the transitions in 2(a)(i) corresponds to light of the longest wavelength. [1]
- .....

- (b) 2-Hydroxybenzenecarboxylic acid (salicylic acid) is prepared industrially from phenol,  $C_6H_5OH$ .



2-hydroxybenzenecarboxylic acid

- (i) If the yield for the industrial preparation is 79.0 %, calculate, to three significant figures, the mass of 2-hydroxybenzenecarboxylic acid (salicylic acid) produced from 1.00 kg of phenol. [3]

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- (ii) 2-Hydroxybenzenecarboxylic acid (salicylic acid) is used in the industrial preparation of aspirin. State the reagent(s) and conditions used to convert 2-hydroxybenzenecarboxylic acid (salicylic acid) to aspirin. [2]

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- (iii) Describe **one** chemical test, including reagent(s) and expected observation(s), which can be used to show the presence of a phenol group. [2]

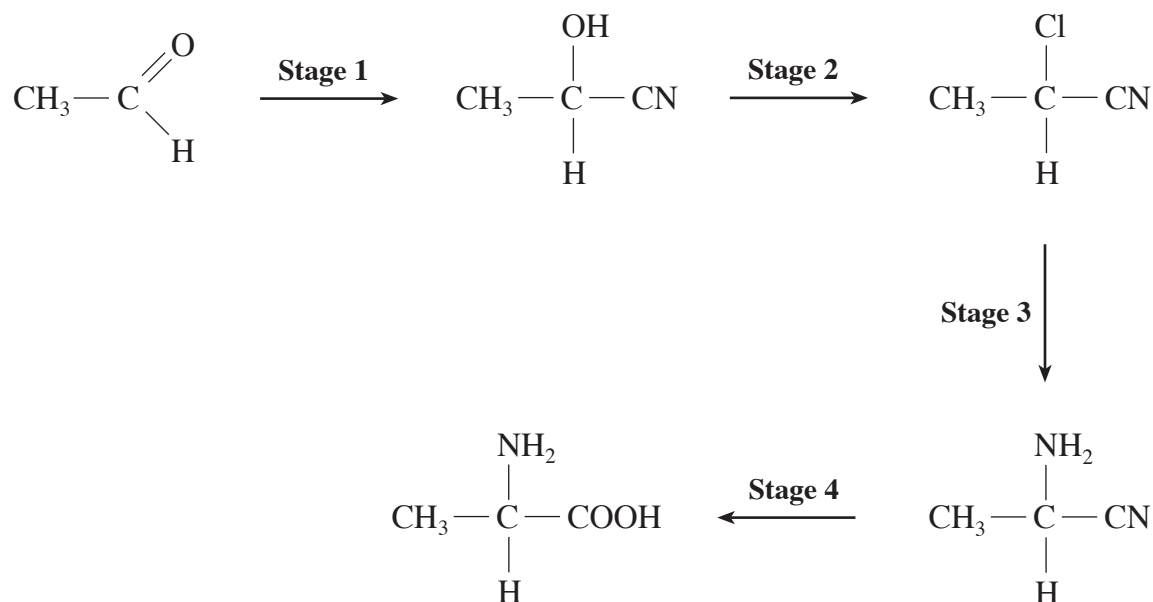
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Total [12]

3. The following sequence of reactions could be used to convert ethanal into alanine (2-aminopropanoic acid). It is an example of a general sequence that can be used to prepare  $\alpha$ -amino acids.



- (a) Classify the type of reaction which occurs in **Stage 1**. Draw the mechanism for the reaction of ethanal with HCN.

*Type of reaction* ..... [1]

*Mechanism* ..... [3]

- (b) Classify the type of reaction which occurs in **Stage 3** and name the reagent used for the conversion.

*Type of reaction* ..... [1]

*Reagent* ..... [1]

- (c) Classify the type of reaction which occurs in **Stage 4** and name the reagent used for the conversion.

*Type of reaction* ..... [1]

*Reagent* ..... [1]

- (d) (i) Alanine (2-aminopropanoic acid) is a white solid with a high melting point (315°C). Explain the bonding in this solid that accounts for the high melting point. [2]

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- (ii) Alanine (2-aminopropanoic acid) is *amphoteric*. Explain the meaning of this term and why the compound shows such behaviour. [2]

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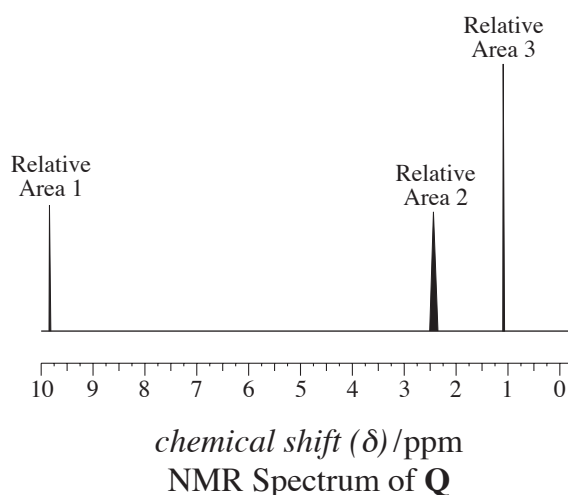
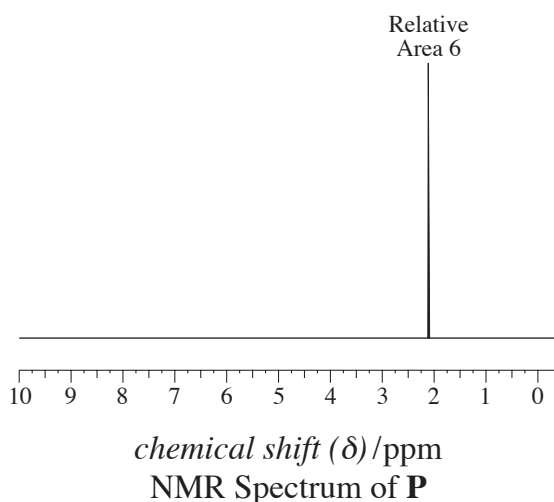
Total [12]

**Section A Total [35]**

## SECTION B

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

4. (a) The composition of a colourless organic liquid, **A**, is 59.9% carbon, 13.5% hydrogen and 26.6 % oxygen by mass.
- Calculate the empirical formula of **A**. [2]
  - Given that the mass spectrum of **A** shows a molecular ion peak at  $m/e$  60, determine the molecular formula of **A**. [1]
- (b) On oxidising **A** by warming with acidified potassium dichromate(VI) solution, a liquid, **B**, is produced.
- State the colour change which occurs during the oxidation reaction. [1]
  - The infra-red spectrum of **B** contains, amongst others, a broad intense peak at  $3000\text{ cm}^{-1}$  and a sharper peak at  $1720\text{ cm}^{-1}$ . Using the data sheet provided, and giving your reasons, identify the functional group present in **B**. [2]
  - Give **one** chemical test which could be used to confirm the identity of the functional group in **B**. Your answer should include all reagents, conditions and expected observations. [2]
  - Using your answers to (a) and (b), and giving your reasons, identify compounds **A** and **B**. [2]
- (c) When a mixture of **A** and **B** is refluxed with concentrated sulphuric acid, compound **C**,  $\text{C}_6\text{H}_{12}\text{O}_2$ , is formed. Draw the structure of **C** and name the functional group present. [2]
- (d) **P** and **Q** are structural isomers with molecular formula  $\text{C}_3\text{H}_6\text{O}$ .
- The NMR spectra of **P** and **Q** are shown below. The spectra are low resolution, so do not show the splitting due to neighbouring groups. Giving your reasons, use these spectra to identify **P** and **Q**. [4]

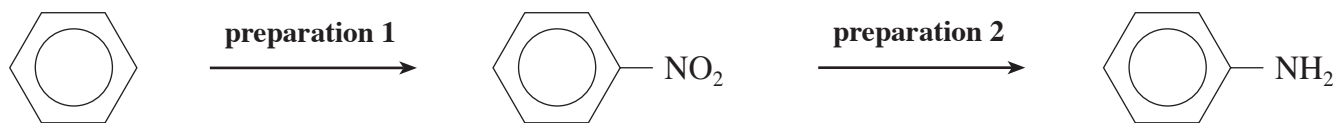




- (ii) Including details of reagents and expected observations in **each** case, explain how the triiodomethane (iodoform) test can be used to distinguish between **P** and **Q**. Identify the group present in this case for the triiodomethane (iodoform) test to give a positive result. [3]
- (iii) State which one of **P** and **Q** can be converted in a **single** reaction to compound **A**, and identify the reagent involved. [1]

Total [20]

5. (a) Outline the preparation of nitrobenzene,  $C_6H_5NO_2$ , from benzene and how nitrobenzene can then be converted into phenylamine,  $C_6H_5NH_2$ .



For **each** preparation your answer should include

- the type of reaction occurring
- the reagent(s) and the roles they play
- essential reaction conditions
- a technique to separate the product from the reaction mixture.

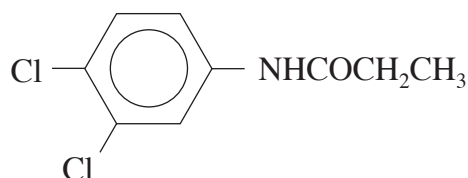
Full reaction mechanisms are **not** required. [5]

- (b) (i) Explain why phenylamine,  $C_6H_5NH_2$ , behaves as a base. [2]

- (ii) Give the formula of the organic ion formed when phenylamine dissolves in hydrochloric acid. [1]

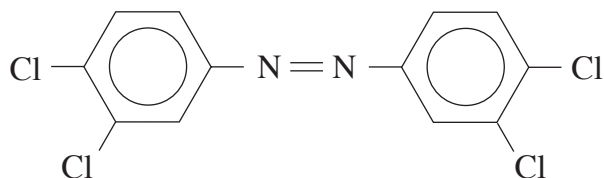
- (iii) Name a reagent used for the ethanoylation of phenylamine. Write a balanced equation for this reaction. [2]

- (c) Propanoylation, a corresponding reaction to ethanoylation in (b)(iii), is the final stage in the preparation of the herbicide *Propanil*, used to prevent unwanted deciduous plant growth in rice plantations.



- (i) Name the  $-NHCO-$  functional group present in *Propanil*. [1]
- (ii) *Propanil* does not persist in the environment because its  $-NHCO-$  group is quickly hydrolysed in soil. Draw the structures of the **two** molecules formed when one molecule of *Propanil* reacts with one molecule of water. [2]
- (iii) Explain why the  $C-Cl$  bonds in *Propanil* are resistant to hydrolysis. [1]

- (iv) In the presence of bacteria, the breakdown of *Propanil* can lead to the soil becoming coloured due to the formation of the following compound.



Explain why this compound is coloured, clearly identifying the group of atoms which is necessary to produce colour, and name the class of dyes of which this is an example. [3]

- (d) The  $\text{-NHCO-}$  group occurs in many important proteins and polymers in which **hydrogen bonding** involving this group has an important effect on properties. Explain the term **hydrogen bonding** and how it occurs between  $\text{-NHCO-}$  groups in proteins or polymers. [3]

Total [20]

**Section B Total [40]**