



GCE A Level

1094/01

CHEMISTRY – CH4

P.M. TUESDAY, 14 June 2016

1 hour 45 minutes plus your additional time allowance

Surname _____

Other Names _____

Centre Number _____

Candidate Number 2 _____

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
Section A		
1.	12	
2.	13	
3.	15	
Section B		
4.	20	
5.	20	
Total	80	

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

Use black ink, black ball-point pen or your usual method.

Write your name, centre number and candidate number in the spaces provided on the front cover.

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 (40 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 80.

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

The **QWC** label alongside particular part-questions indicates those where the Quality of Written Communication is assessed.

SECTION A

Answer ALL questions in the spaces provided.

1(a) A compound **P** of molecular formula $C_4H_{10}O$ was heated with acidified potassium dichromate(VI). The solution changed from orange to green and compound **Q**, of molecular formula C_4H_8O , was formed. Compound **Q** had no effect on Tollens' reagent.

- (i) Name the **TYPE** of reaction that occurred when compound **P** was heated with acidified potassium dichromate(VI). [1]

- (ii) State what information the lack of reaction with Tollens' reagent gives. [1]

1(a) (iii) When compound **P** was heated with concentrated sulfuric acid a mixture of three isomers formed. All these isomers decolourised bromine.

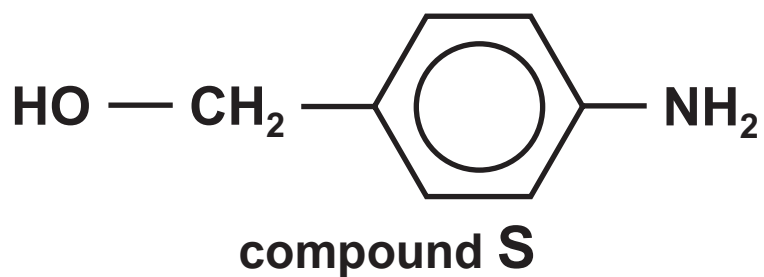
I. Name the TYPE of reaction that occurred when compound **P** was heated with concentrated sulfuric acid. [1]

II. Draw the structural formulae of the THREE isomers formed. [3]

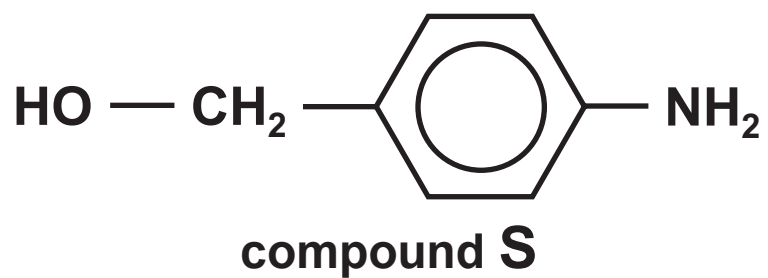
1(a) (iv) Draw the **SKELETAL** formula of compound **P**. [1]

1(b) Primary amines contain the functional group NH_2 . For each of the reactions below identify the organic product(s).

- (i) The reaction between compound **S** and cold nitric(III) (nitrous) acid. [1]



- 1(b) (ii) The reaction between compound **S** and ethanoyl chloride (CH_3COCl). [2]



- 1(b) (iii) The reaction between compound **T** and compound **U** (forming two dipeptides). Compound **T** and compound **U** are shown opposite. [2]

Total [12]

12

2. **Students in an A level chemistry group were discussing topics that they had studied. They decided that each of the following statements was incorrect.**

For each statement:

- **identify the error and explain why the statement is incorrect,**
- **discuss the chemical principles involved, naming the products of any reaction.**

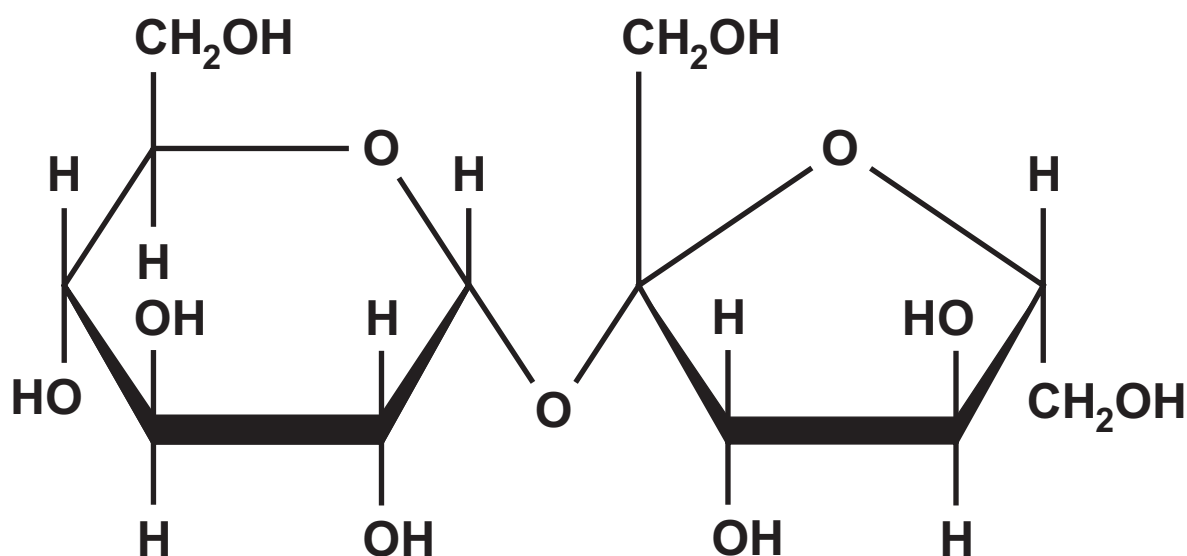
- (a) Ethanol and propanone can be distinguished from each other because only propanone forms a yellow solid when warmed with iodine and aqueous sodium hydroxide. [4] QWC [1]**

3. Read the following passage and then answer the questions in the spaces provided.

STEREOISOMERISM IN ORGANIC COMPOUNDS

- Stereoisomerism in organic compounds often involves the presence of a chiral centre but this is not always the reason for different isomers being possible. The existence of stereoisomers can be useful but it can have serious effects in biological systems.
- 5

Sucrose is a sugar with the formula below.



10 Sucrose can be hydrolysed to produce two simpler sugars – glucose and fructose. The hydrolysis of sucrose can be carried out by merely heating the sugar with water but it is much quicker if an enzyme or an acid is used as a catalyst. The extent to which hydrolysis has occurred

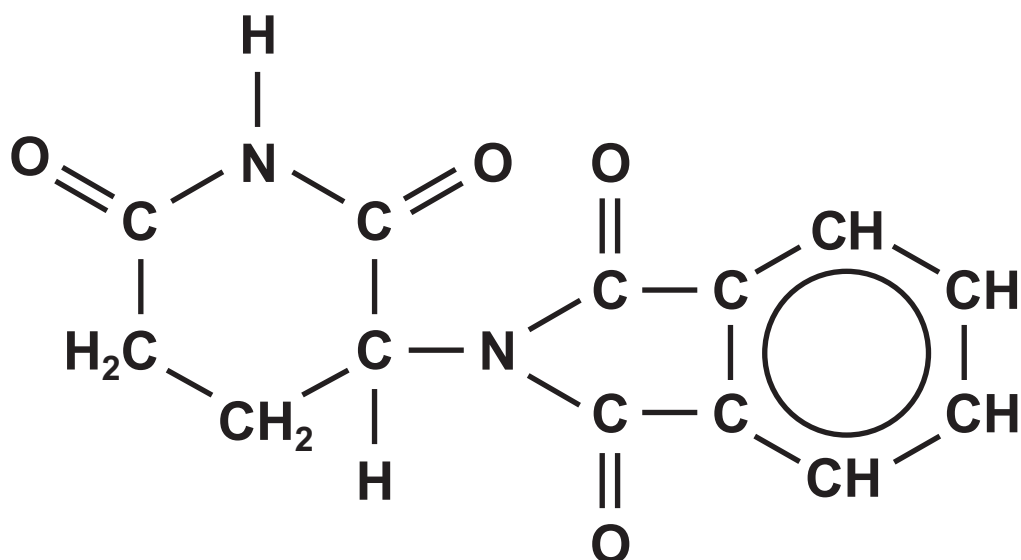
15 can be followed using the fact that sucrose does not contain an aldehyde group but glucose and fructose both exist in a form that includes this functional group.

20 The hydrolysis can also be monitored by using the fact that sucrose, glucose and fructose all exist in forms that are optically active. The table shows data for this optical activity.

Sugar	Angle of rotation for 1 mol dm ⁻³ solution
sucrose	+66.5°
glucose	+52.8°
fructose	-92.0°

25 The solution that is formed after the complete hydrolysis of sucrose is called invert sugar.

Thalidomide is a drug that has a wide range of valuable medical uses. Its formula is below.



- 30 This molecule contains a chiral centre and therefore has two optical isomers. One of the isomers is safe but the other one is dangerous to the foetus if taken by pregnant women. It is possible to prepare only the safe isomer but, in the body, a racemic mixture is produced.

- End of passage -

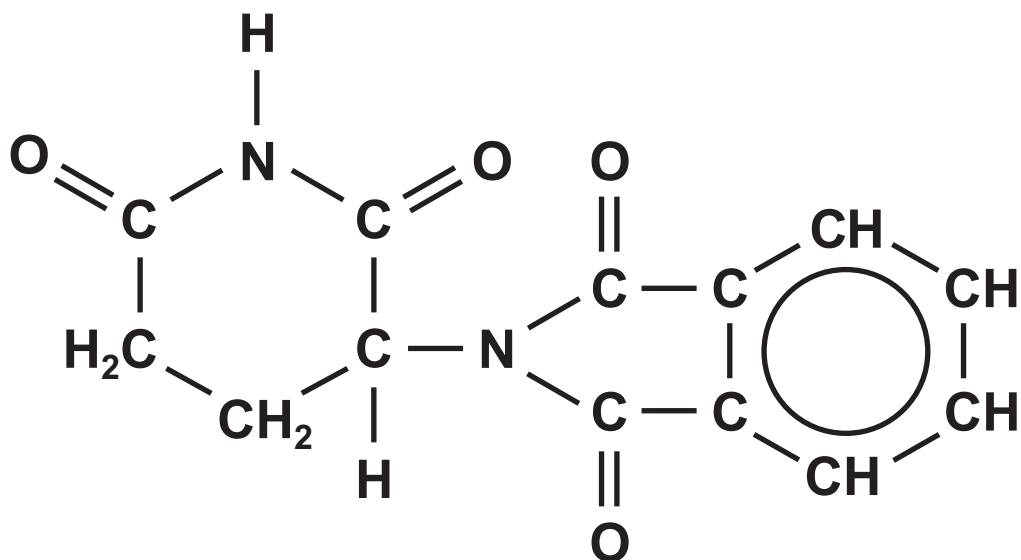
3(a) What is stereoisomerism? (line 1) [1]

(b) Suggest a chemical method by which an analytical chemist could identify that sucrose has been hydrolysed. (line 14) [2]

3(c) (i) Explain what is meant by OPTICAL ACTIVITY and the significance of the sign in the table of data. (lines 21-22) [2]

(ii) Use the data to explain why a rotation of -39.2° is seen when the hydrolysis of sucrose is complete. [2]

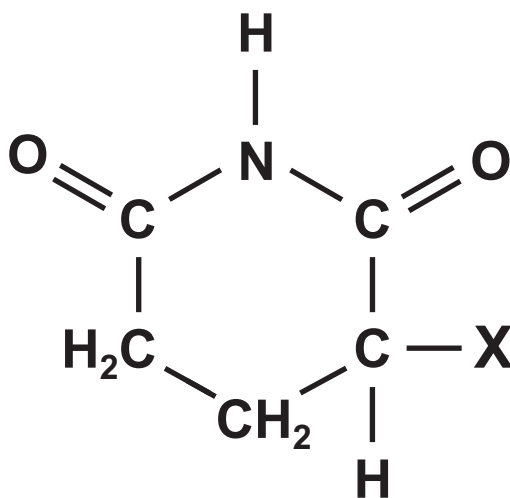
3(d) Mark with an asterisk (*) the chiral centre on the thalidomide molecule below. [1]



- 3(e) State what happens when a racemic mixture is formed from a sample containing only one isomer. (lines 29-34)**

You should include suitable diagrams of a simple molecule of your choice. [2]

- 3(f) The formula below shows part of the thalidomide molecule (with the other part being replaced by the letter **X**). Draw the structural formula of a product formed when this molecule is heated with dilute aqueous hydrochloric acid. [2]



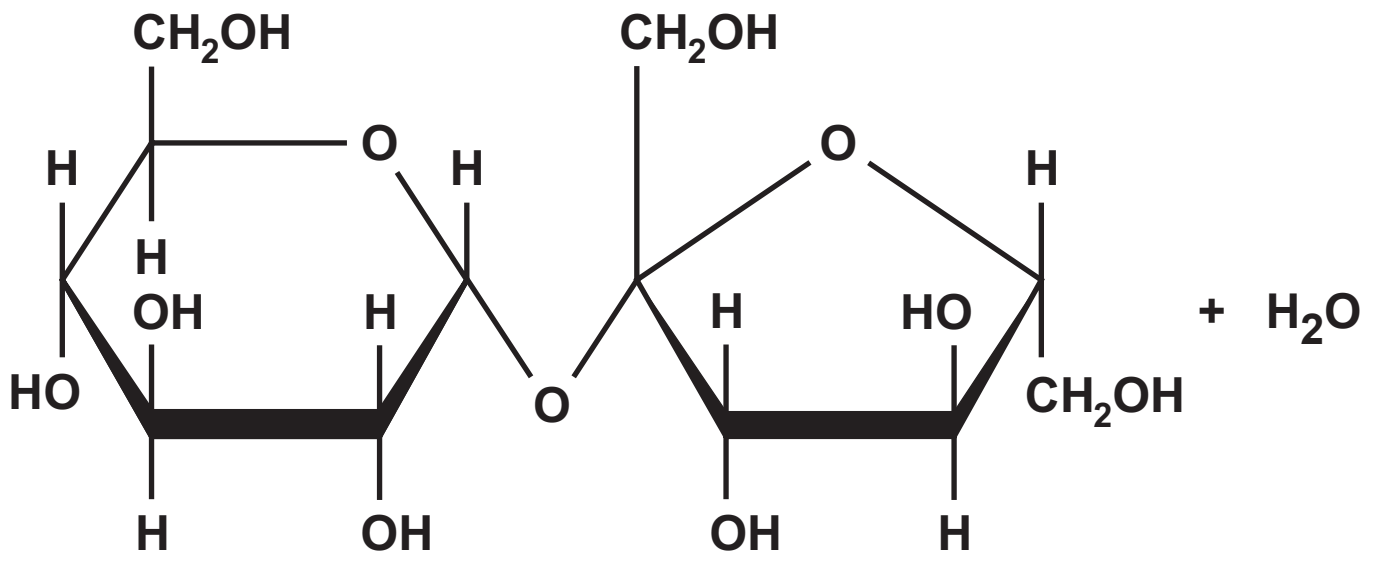
3(g) (i) Complete the equation (opposite page) to show clearly the difference in structure between glucose and fructose. You do NOT need to state which structure is which isomer.
(line 9) [1]

(ii) Explain why sucrose, glucose and fructose are all very soluble in water. [2]

Total [15]

TOTAL SECTION A [40]

15



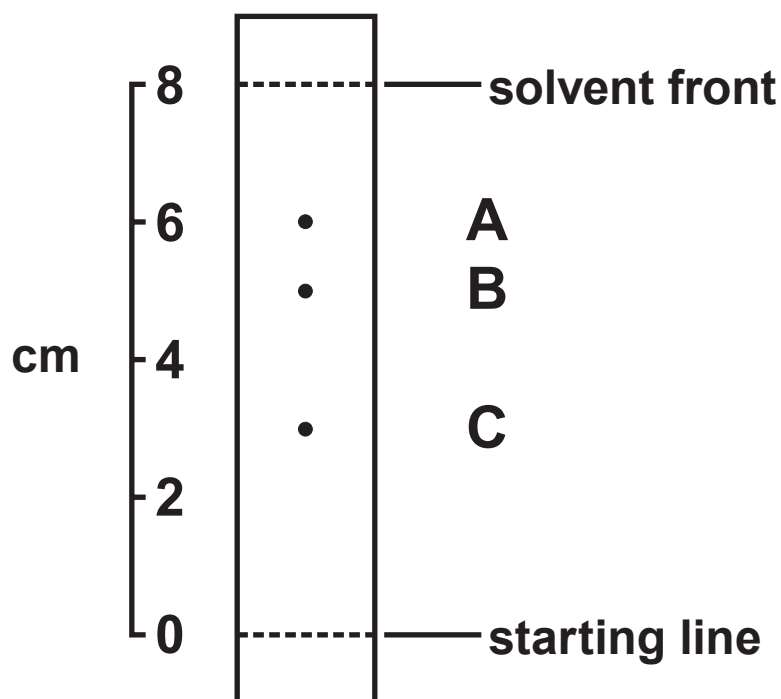
SECTION B

Answer BOTH questions in the separate answer book provided.

- 4. There are many different types of chromatography and spectroscopy that can be used to investigate the identity and structure of unknown substances. In this question you will consider some of these techniques.**
- (a) Explain briefly how the peaks in NMR spectra and the absorptions in IR spectra are formed. [3]**

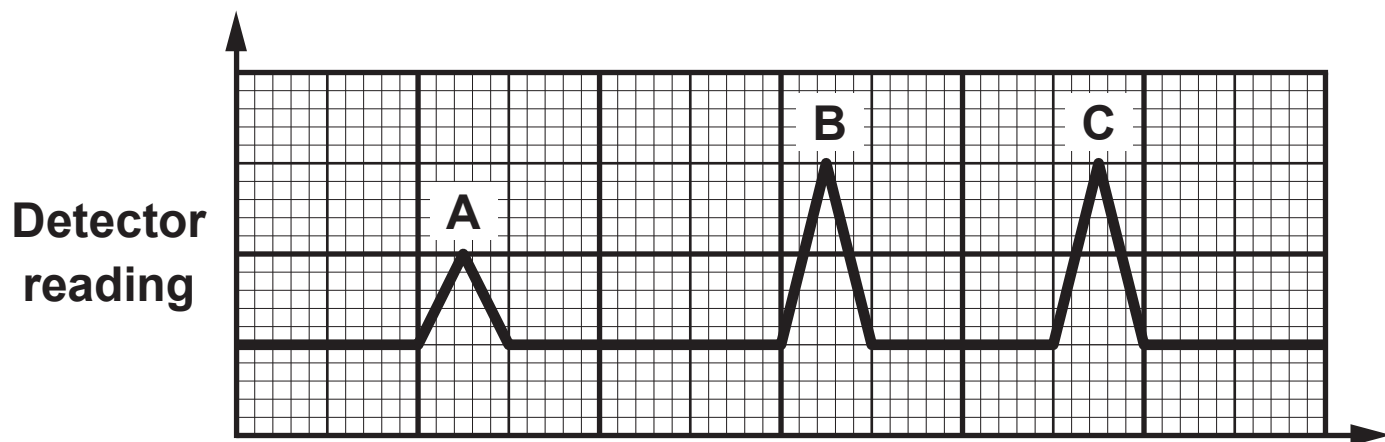
4(b) A sample of unknown substances was investigated using different chromatographic techniques.

(i) Thin layer chromatography gave the chromatogram shown below.

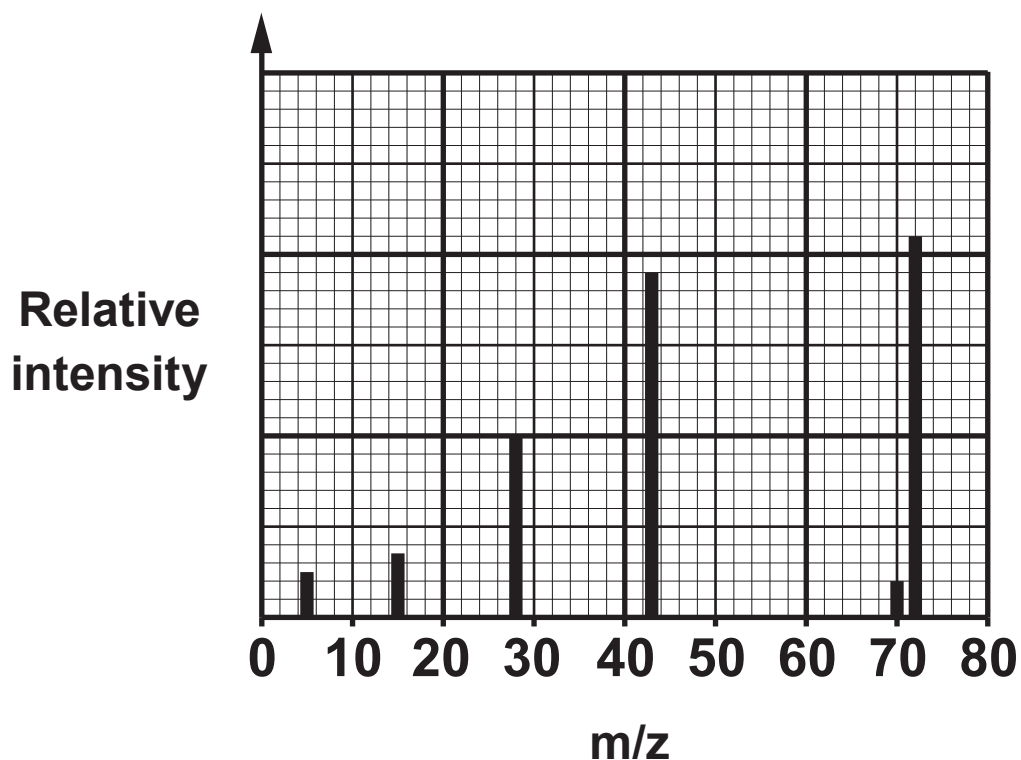


Calculate the R_f value for the substance that gives the spot labelled **B**. [1]

- 4(b) (ii) Gas chromatography gave the chromatogram shown opposite.**
- I. What label should be used for the x-axis? [1]**
 - II. Use the chromatogram to estimate the percentage of compound A in the sample. Explain how you reached this conclusion. [2]**
- (iii) Thin layer chromatography and gas chromatography give different information about unknown substances. Describe what information can be obtained from each type of chromatography. [2]**



- 4(c) (i) A compound **Y** contains carbon, hydrogen and oxygen. It has 66.7% by mass of carbon. The mass spectrum of compound **Y** is below.



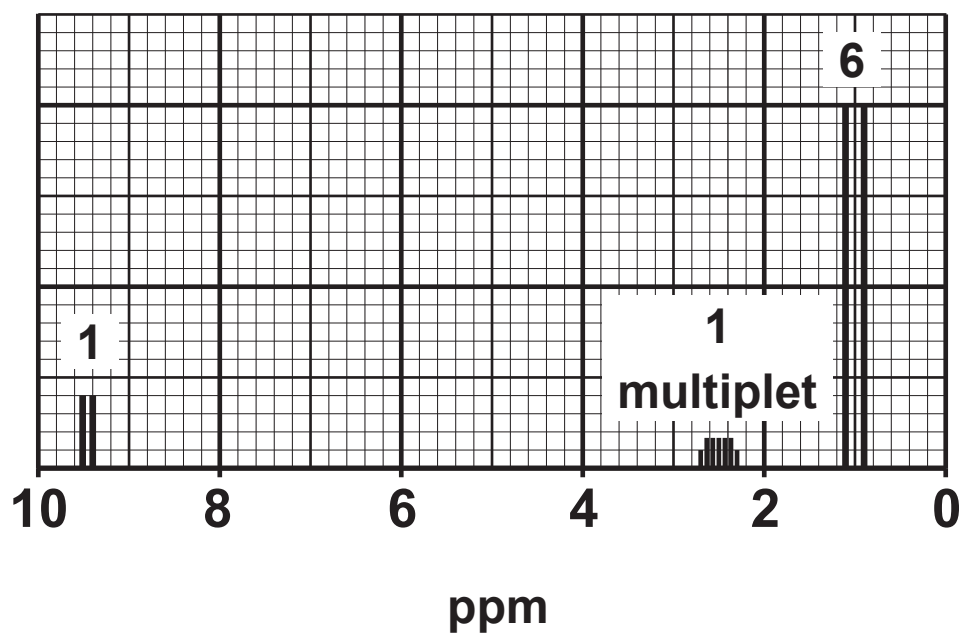
Use these data to determine the molecular formula of compound **Y**. Explain your reasoning. [4]

4(c) (ii) The NMR spectrum of compound Y is opposite.

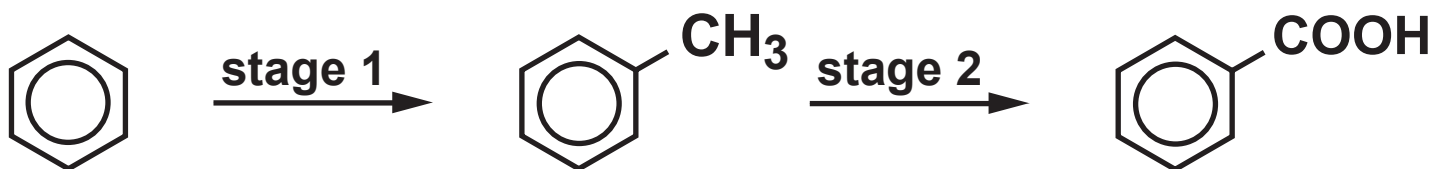
Use this spectrum to determine as much information as possible about the structure of compound Y. [4] QWC [2]

(iii) Use your answers to parts (i) and (ii) to give the structural formula of compound Y. [1]

Total [20]



5. Benzene can be made into benzenecarboxylic acid (benzoic acid) using a two-stage process.



- (a) Stage 1 proceeds using a mechanism that is similar to that of the halogenation of benzene. Describe the reaction in stage 1. You should include

- the reagent(s) needed
- the type of reaction
- the conditions needed
- details of the mechanism. [7]

- 5(b) Stage 2 involves refluxing methylbenzene with alkaline potassium manganate(VII), filtering the mixture whilst it is still hot and then adding hydrochloric acid. This produces a white precipitate of benzoic acid.**
- (i) Explain what is meant by reflux. [2]**
- (ii) Write the BALANCED equation for the reaction in stage 2 – the oxidation of methylbenzene to benzoic acid. Use [O] to represent alkaline potassium manganate(VII). [1]**
- (iii) Apart from neutralising any excess alkali, why is hydrochloric acid added after filtration? [1]**
- (iv) Benzoic acid is very much more soluble in hot water than it is in cold water. Use this fact to describe how you would purify the benzoic acid produced in stage 2. [3]**
- (v) Describe a method to show if the benzoic acid is now pure. [1]**

- 5(b) (vi) A student used 10.0 g of benzene to prepare benzoic acid as described above. He obtained 3.8 g of pure benzoic acid. Calculate the percentage yield of this process. [3]
- (vii) The percentage yield obtained in this particular preparation is usually low. Describe TWO reasons why this percentage yield is low, even if the reaction is carried out carefully. [2]

Total [20]

TOTAL SECTION B [40]

END OF PAPER