Candidate Name	Centre Number	Candidate Number
		2

GCE A level

1094/01

CHEMISTRY CH4

P.M. THURSDAY, 17 June 2010

1¾ hours

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

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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 (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.

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

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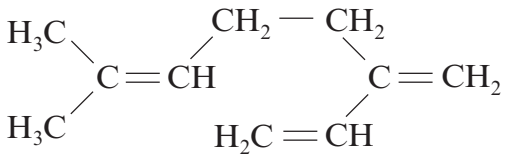
SECTION A

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

1. *(a)* Terpenes are the primary constituents of the essential oils of many types of plants and flowers.
An example is myrcene, one of the most important chemicals used in the perfume industry because of its pleasant odour. It has the structure shown below.



(i) State the molecular formula of myrcene. [1]

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(ii) Draw the **skeletal** formula of myrcene. [1]

(iii) Myrcene reacts with hydrogen to form a saturated hydrocarbon in the same way as alkenes of general formula C_nH_{2n}.

I. Explain what is meant by the term *saturated* hydrocarbon. [1]

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II. Using molecular formulae write an equation for this reaction. [1]

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(iv) Another terpene, α-farnasene, is responsible for the characteristic odour of green apples.
A 0.100 mol sample of α-farnasene reacted with 8.96 dm^3 of hydrogen to form a saturated hydrocarbon $C_{15}H_{32}$.
(1 mole of gas molecules occupy 22.4 dm^3 under these conditions.)

Calculate how many double bonds there are in each molecule of α-farnasene. [2]

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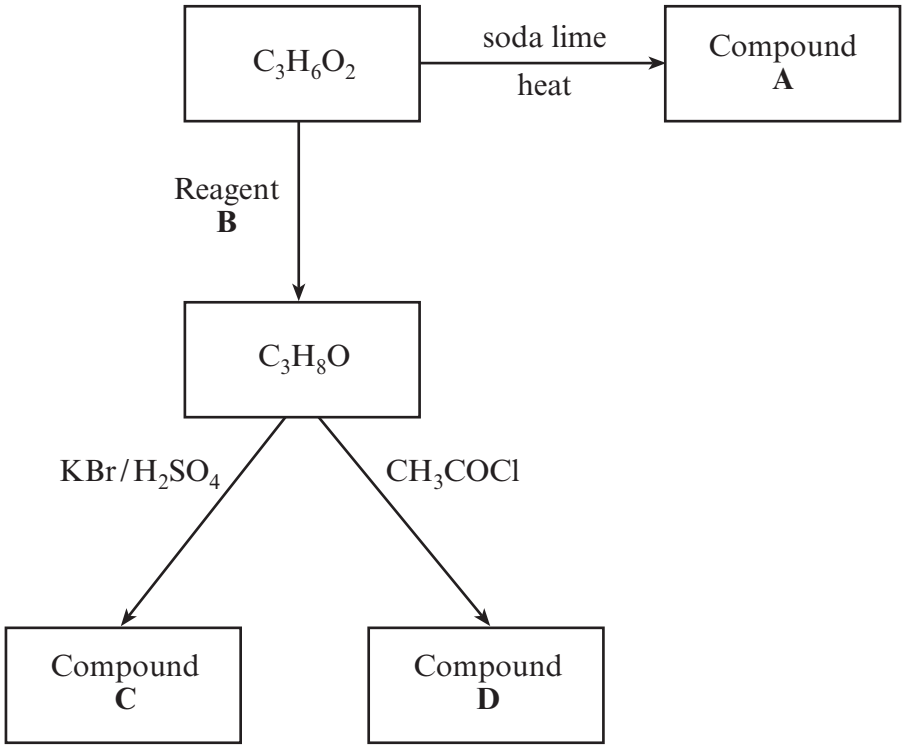
Examiner only

(b) Study the reaction scheme shown below:



(i) State the name of compound **A**. [1]

.....

(ii) Give the formula of reagent **B**. [1]

.....

(iii) Draw the displayed formula of compound **C**. [1]

(iv) State the **name** of compound **D**. [1]

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Total [10]

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Examiner only

2. *(a)* Explain the difference in structure between *primary* and *secondary* alcohols. [1]

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(b) Quantitative analysis of an alcohol shows that its percentage composition by mass is C 68.1%, H 13.7% and O 18.2%. It has a relative molecular mass of 88.1.

Calculate the empirical formula of the alcohol and show that its molecular formula is the same as the empirical formula. [3]

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(c) The following compounds have the same molecular formula, $C_5H_{10}O$.

A $CH_3CH_2COCH_2CH_3$ **B** $CH_3CH_2CH_2CH_2CHO$

C $CH_3CH_2CHCHCH_2OH$ **D** $CH_2CHCH_2CH(OH)CH_3$

(i) Draw the structure of an isomer of **B** that is also an aldehyde. [1]

(ii) I. State which **one** of the compounds **A–D** exhibits E-Z (trans-cis) isomerism. [1]

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II. Draw the structures of **both** isomers. [1]

(iii) Give one test, including reagents and expected observations, which would distinguish between **A** and **B**. [2]

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(iv) Give one test, including reagents and expected observations, which would distinguish between **C** and **D**. [2]

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(d) Ketones such as propanone react with hydrogen cyanide.

(i) Classify the type of reaction taking place. [1]

.....

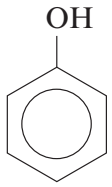
(ii) Draw, with the aid of curly arrows, the mechanism for this reaction. [3]

Total [15]

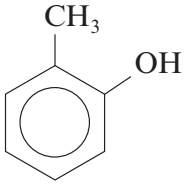
3. *Read the passage below and then answer the questions in the spaces provided.*

Phenol

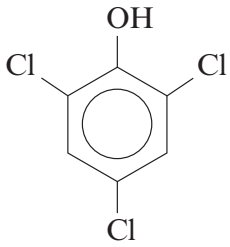
Phenol, formula C_6H_5OH, has an hydroxyl group joined directly to an aromatic ring.



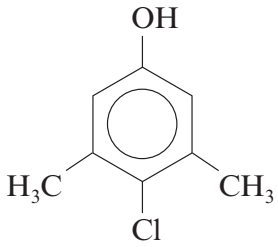
Phenol has many derivatives including 2-methylphenol.



Phenol was isolated from coal tar in 1835 and its original name was carbolic acid. It is a weak acid, between carboxylic acids and alcohols in strength. In 1865 the English surgeon Joseph Lister pioneered the use of phenol as the first surgical antiseptic and by the beginning of the 20th century phenol was commonly used as an antiseptic, but its use is not permitted today. Familiar pharmaceutical products such as TCP and Dettol are much more effective as antiseptics and disinfectants and do not have the toxicity of phenol itself.



TCP



Dettol

Nowadays most phenol is produced by the cumene process with less than 5% being made from coal tar. Recently a new process has been developed where phenol is made by the direct oxidation of benzene using nitrous oxide, N_2O, as the oxidising agent. This reaction could be of particular value since N_2O, a pollutant under strict control, is a by-product of the production of hexanedioic acid used to make nylon-6,6. The new process provides a very high yield of phenol and produces no significant aqueous waste products.

Phenol is very important since it is used in the production of

- epoxy and polycarbonate resins (e.g. as adhesives, in safety glasses and in drinking bottles),
- nylon,
- phenolic resins (e.g. as plywood adhesive, in fibreglass and in moulded electrical components),
- derivatives of ethanoic anhydride.

You would be unwise to handle phenol, but it is a key chemical in the manufacture of many everyday materials you do handle.

– End of passage –

Examiner only

(a) Describe a chemical test to show the presence of the –OH group in 2-methylphenol (line 4) by giving the reagent(s) and observation(s).

Reagent(s) ..... [1]

Observation(s) ..... [1]

(b) Explain why phenol is more acidic than alcohols but less acidic than carboxylic acids (line 6). [4]

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(c) Give the systematic name of Dettol (line 11). [1]

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(d) The new process for the production of phenol (line 13) can be represented by the following equation.

$$C_6H_6 + N_2O \longrightarrow C_6H_5OH + N_2$$

Calculate the atom economy of the reaction. [2]

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Examiner only

(e) Draw the displayed formula of hexanedioic acid (line 16). [1]

(f) State the name of a compound that can react with hexanedioic acid to form nylon-6,6. [1]

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(g) Draw the repeating unit in nylon-6,6 (line 16). [1]

(h) Nylon-6,6 is a typical example of a condensation polymer. Explain the difference between condensation polymerisation and addition polymerisation. [2]

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(i) Give **one** important industrial use of ethanoic anhydride. [1]

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Total [15]

Total Section A [40]

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SECTION B

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

4. *(a)* The reaction between but-1-ene and hydrogen bromide produces a mixture of **three** isomers.

(i) Draw the displayed formula of each of the three isomers. [3]

(ii) Outline how each of the isomers can be distinguished from one another. [3]

(QWC) [1]

(b) (i) Ethylamine can be produced by the reaction of ammonia with chloroethane.

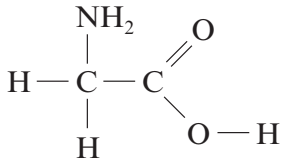
I. Write an equation for this reaction. [1]

II. Classify the type of reaction taking place. [1]

(ii) Phenylamine cannot be prepared in this way. Name the starting material and reagent(s) used to prepare phenylamine in a laboratory. [2]

(iii) Give one chemical test, including reagent(s), condition(s) and expected observations, which would distinguish between ethylamine and phenylamine. [3]

(c) Amino acids also contain an amine group. The simplest amino acid, aminoethanoic acid (glycine) has the formula



(i) Draw the displayed formula of 2-aminopropanoic acid (alanine). [1]

(ii) A dipeptide can be formed by reacting two amino acids. Draw the displayed formulae of the two different dipeptides which can be made by combining glycine and alanine. [2]

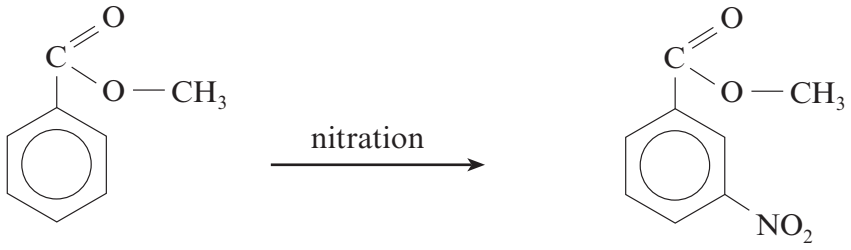
(iii) Proteins are natural polypeptides. Explain briefly what is meant by primary, secondary and tertiary protein structure. [3]

Total [20]

5. *(a)* Describe the structure of, and bonding in, benzene and explain why benzene is less ready to undergo addition reactions than alkenes. [6]

(QWC) [2]

(b) Frances wanted to prepare a nitro-aromatic compound in the laboratory, so her teacher told her to prepare methyl-3-nitrobenzoate by nitrating methyl benzoate using the following method.



methyl benzoate methyl-3-nitrobenzoate

- Prepare a nitrating mixture by mixing 2 cm^3 of concentrated nitric acid and 2 cm^3 of concentrated sulfuric acid in a test tube, cooling it in ice.
- Weigh 2.75 g of methyl benzoate in a small conical flask, place the flask in a beaker of ice and slowly add 5 cm^3 of concentrated sulfuric acid.
- Add the nitrating mixture a few drops at a time to the solution in the flask ensuring that the temperature stays below 10 °C.
- When the addition is complete, allow the mixture to stand at room temperature for 15 minutes.
- Pour the mixture onto crushed ice in a small beaker, stir and leave until all the ice has melted and crystals have formed.
- Filter the mixture, wash well with water and recrystallise it from ethanol.

At the end of the experiment Frances' yield was 2.70 g.

(i) Suggest why the teacher told her to nitrate methyl benzoate, not benzene. [1]

(ii) State why it is necessary to recrystallise the product before weighing it. [1]

(iii) Outline how Frances would recrystallise methyl-3-nitrobenzoate from ethanol. [3]

(iv) State how she could prove that the product was pure. [1]

(v) Methyl benzoate is a liquid at room temperature and has a density of 1.1 $g\,cm^{-3}$. Calculate the volume of 2.75 g of methyl benzoate. [1]

(vi) Calculate the percentage yield obtained by Frances. [3]

(vii) Methyl benzoate undergoes nitration by the same mechanism as benzene.

I. Classify the mechanism for the nitration of methyl benzoate. [1]

II. Give the formula of the species attacking the benzene ring. [1]

Total [20]

Section B Total [40]

WJEC
CBAC

GCE A level

1094/01-A

CHEMISTRY CH4
DATA SHEET

P.M. THURSDAY, 17 June 2010

Infrared Spectroscopy characteristic absorption values

Bond	Wavenumber/cm^{-1}
C—Br	500 to 600
C—Cl	650 to 800
C—O	1000 to 1300
C═C	1620 to 1670
C═O	1650 to 1750
C≡N	2100 to 2250
C—H	2800 to 3100
O—H	2500 to 3550
N—H	3300 to 3500

Nuclear Magnetic Resonance Spectroscopy

Candidates are reminded that the splitting of any resonance into **n** components indicates the presence of **n–1** hydrogen atoms on the **adjacent** carbon, oxygen or nitrogen atoms.

Typical proton chemical shift values (δ) relative to TMS = 0

Type of proton	Chemical shift (ppm)
$-CH_3$	0.1 to 2.0
$R-CH_3$	0.9
$R-CH_2-R$	1.3
$CH_3-C\equiv N$	2.0
$CH_3-C(=O)-$	2.0 to 2.5
$-CH_2-C(=O)-$	2.0 to 3.0
$-O-CH_3$, $-OCH_2-R$, $-O-CH=C<$	3.5 to 4.0
R—OH	4.5 *
$CH_2=C<$	4.8
$R-C(=O)-H$	9.8 *
$R-C(=O)-OH$	11.0 *

*variable figure dependent on concentration and solvent

THE PERIODIC TABLE