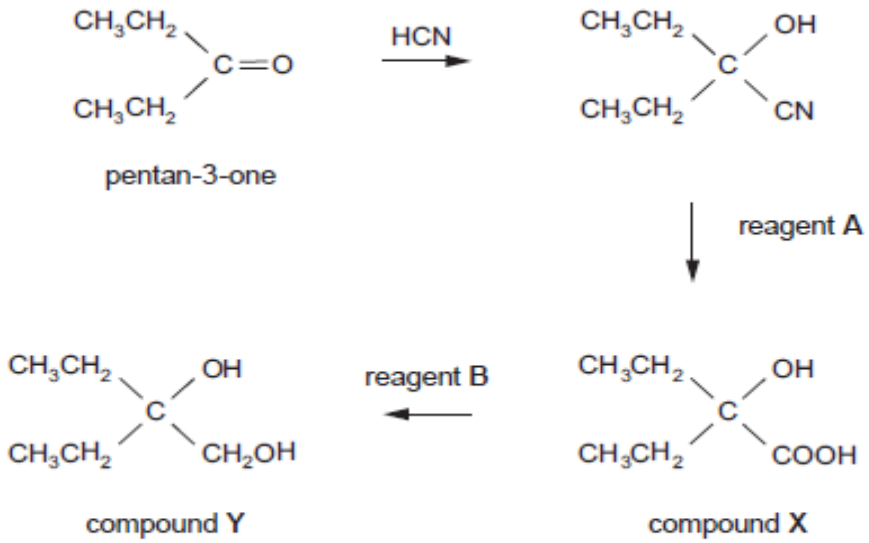
GCE A LEVEL CHEMISTRY

S21-A410

Assessment Resource E

Organic Chemistry and Analysis

1. Compound **Y** can be made by the following method.



(a) State the type of reaction mechanism taking place when hydrogen cyanide reacts with pentan-3-one. [1]

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(b) State the name of reagent **A**. [1]

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(c) Give the empirical formula of compound **X**. [1]

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(d) Identify reagent B. [1]

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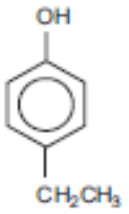
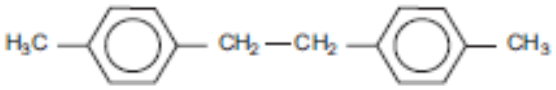
2. Draw the **displayed** formula of the ionic compound calcium ethanoate, $(CH_3COO)_2Ca$. [1]

3. Draw a dot and cross diagram of the methyl radical. [1]

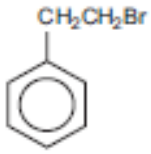
4. *(a)* An unknown compound is one of the six compounds whose structures are shown below.



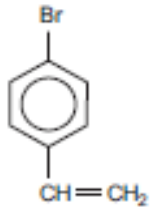
A



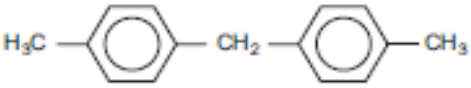
B



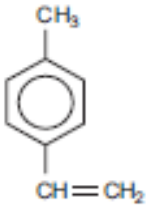
C



D



E



F

Show how you could use infrared spectroscopy to identify **four** of these compounds. In your answer you should state the bonds identified and their absorption values.

For the remaining **two** compounds discuss how high resolution ^{1}H NMR spectroscopy could be used to find the structure of the unknown compound. Your answer should include comments about the splitting pattern seen in the spectra. [6 QER]

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(b) Compound **L** is an aromatic compound of formula $C_8H_8Br_2$ (M_r 264).

A sample of compound **L** of mass 3.22 g was refluxed with excess aqueous sodium hydroxide and the resulting mixture acidified with nitric acid. On adding aqueous silver nitrate to this mixture 1.22×10^{-2} mol of silver bromide was obtained.

Use this information to suggest a structure for compound **L**. Explain your answer. [4]

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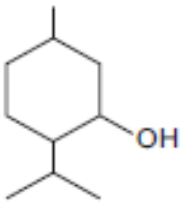
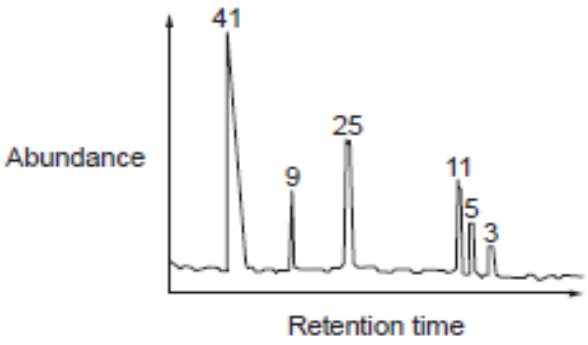
(c) Menthol, $C_{10}H_{20}O$, is a natural product that has important medicinal uses.



(i) Menthol can be isolated from peppermint oil. Analysis of this oil shows that its major component is menthol. It contains smaller quantities of other compounds. A simplified gas chromatogram of peppermint oil (showing relative peak areas) is shown below.



I. Calculate the percentage by volume of menthol in the oil. [1]

Percentage = ... %

II. The peak of relative area 5 is given by limonene. Limonene is a non-cyclic hydrocarbon whose mass spectrum shows a molecular ion (m/z) at 136.

Use this information to suggest a molecular formula for limonene.
Explain why limonene must be an unsaturated compound. [2]

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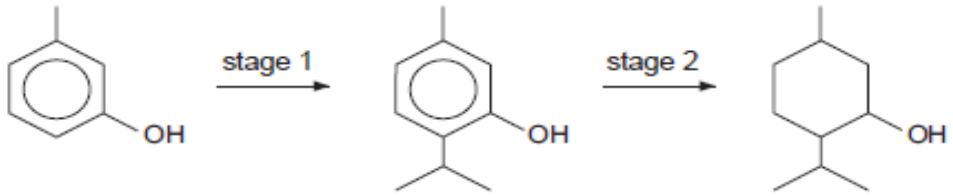
Molecular formula .....

(ii) One method for producing menthol is shown below.



menthol

I. Give the systematic name for the starting material. [1]

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II. Stage 1 is the Friedel-Crafts alkylation of the starting material.

Give the names of the reagent and the catalyst used in this stage. [1]

Reagent .....

Catalyst .....

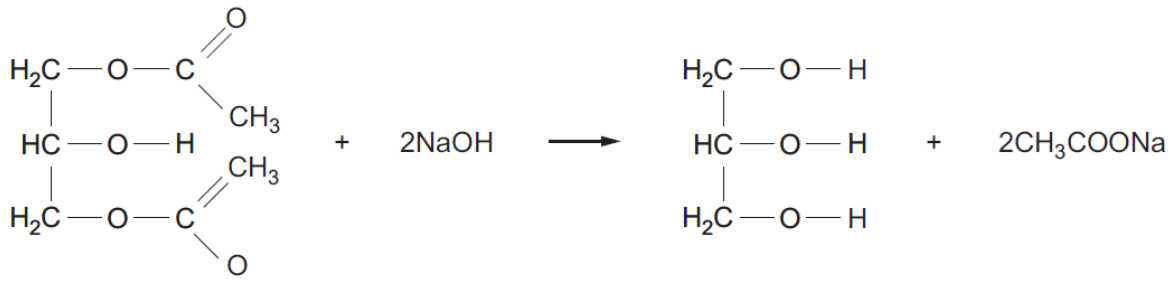
III. State the type of reaction occurring in Stage 2. [1]

.....

(iii) Menthol is a secondary alcohol.

Suggest the **skeletal** formula of menthane, $C_{10}H_{18}O$, which is formed by the oxidation of menthol. [1]

5. *(a)* Diacetin is an ester of propane-1,2,3-triol that is used by some plants to attract bees. It reacts with aqueous sodium hydroxide to produce propane-1,2,3-triol and sodium ethanoate.

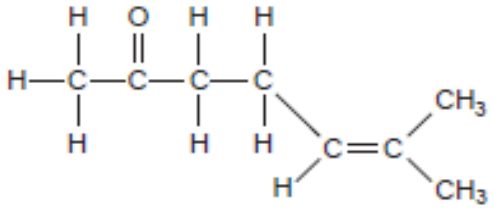


diacetin

1.58 g of diacetin was heated with 50.0 cm^3 of aqueous sodium hydroxide of concentration 0.500 mol dm^{-3}. After complete reaction with the diacetin 7.00 × 10^{-3} mol of sodium hydroxide remained.

Use this information to show that the relative molecular mass of diacetin is 176. [4]

(b) 2-Methylhept-2-en-6-one acts as an alarm pheromone in certain species of ants.



2-methylhept-2-en-6-one

(i) State why this compound does not show *E-Z* isomerism. [1]

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(ii) Draw the structure of a ketone with the same molecular formula that can exist as *E-Z* isomers. [1]

(iii) 2-Methylhept-2-en-6-one gives a positive triiodomethane test.

State the reagent(s) used for this test and the observation. [2]

Reagent(s) .....

Observation .....

(iv) The reaction of 2-methylhept-2-en-6-one with aqueous sodium tetrahydridoborate(III) results in the formation of a new compound which has forms that rotate the plane of plane polarised light.

Give the structure of the compound formed and explain why it has forms that rotate the plane of plane polarised light. [2]

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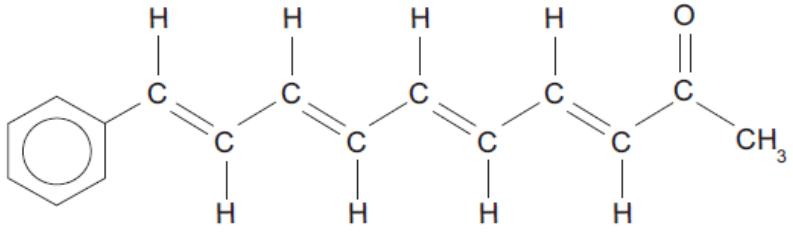
(c) (i) A species of sea slug produces an alarm pheromone which is a mixture of three compounds. One of these compounds is Navenone B.

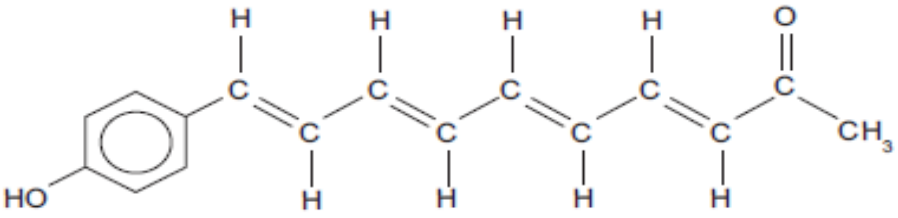


The visible spectrum of this compound shows an absorption maximum at 377 nm.

Calculate the energy of this absorption in $kJ\,mol^{-1}$. [3]

Energy = ... $kJ\,mol^{-1}$

(ii) Navenone C is a similar compound.



This compound reacts with hydrogen bromide and with bromine.

I. State what is seen when bromine is added to a solution of Navenone C. [2]

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II. State the type of reaction mechanism occurring when Navenone C reacts with hydrogen bromide. [1]

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III. Complete the table below to show the mole ratios of the added reagent and Navenone C.

The table is already completed for the reaction with bromine. [1]

Reagent added	Mole ratio Added reagent : Navenone C
hydrogen bromide	
bromine	6 : 1