Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in Chemistry 9CH0

Resource Set 1 – Topic Group 5

Topics included:

Topic 6: Organic Chemistry I

Topic 7: Modern Analytical Techniques I

Topic 17: Organic Chemistry II

Topic 18: Organic Chemistry III

Topic 19: Modern Analytical Techniques II

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

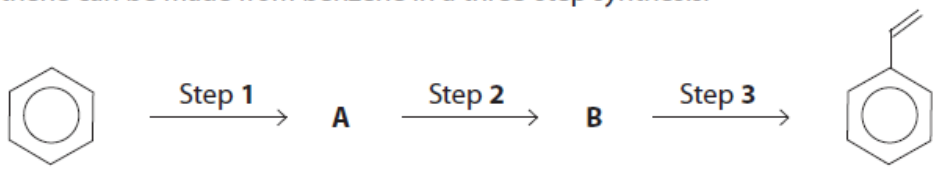
Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

7 Phenylethene, commonly known as styrene, is an important substance in the production of polystyrene which is used for some types of plastic packaging. Phenylethene can be made from benzene in a three-step synthesis.

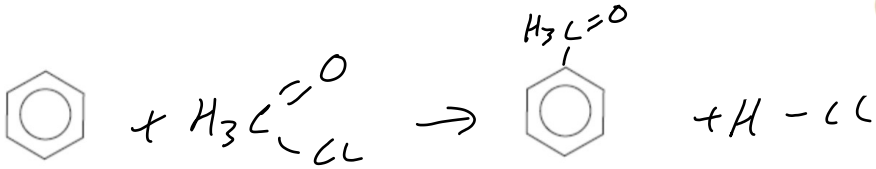


(a) Some of the following compounds can be used to make phenylethene from benzene.

Aluminium chloride	Chloroethane	Ethanal	Ethanol
Ethanoic acid	Ethanoyl chloride	Ethene	Ether
Hydrochloric acid, concentrated	Lithium tetrahydridoaluminate(III)	Phosphoric acid, concentrated	Sulfuric acid, concentrated

Selecting **only** from these compounds, devise a synthetic pathway for converting benzene into phenylethene, clearly identifying compounds **A** and **B** and stating the appropriate conditions for each step.

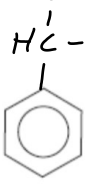
(5)

Step 1 :  + $H_3C-C(=O)-Cl$ → + H − Cl

benzene + ethanoyl chloride → phenylethanone + HCl

A

conditions : aluminium chloride catalyst + heat

Step 2 : Reduce A with $LiAlH_4$ in dry ether to make B, 1-phenylethanol : 

Step 3 : Dehydrate B with conc. phosphoric acid to make phenylethene

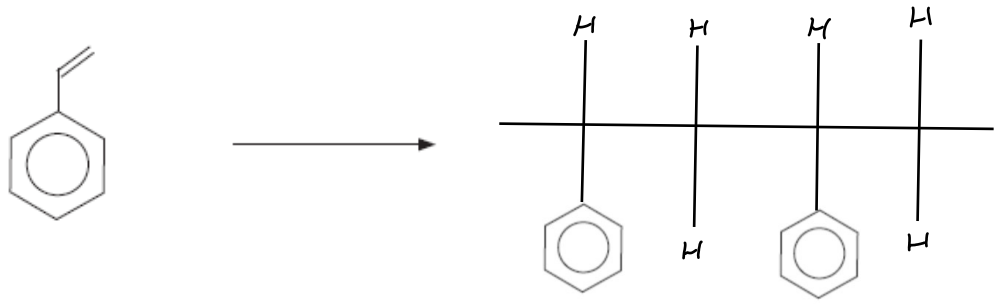
(b) Which reagent could produce a diol from phenylethene?

(1)

- ☐ **A** acidified potassium dichromate(VI)
- ☒ **B** acidified potassium manganate(VII)
- ☐ **C** aqueous sodium hydroxide
- ☐ **D** steam

(c) Draw a section of the polymer, polystyrene, showing **two** repeat units.

(1)



(d) Give one advantage and one disadvantage of the disposal of polystyrene by incineration.

(2)

One advantage is that this method does release some usable energy (via heat), unlike e.g. landfill
A disadvantage is the release of toxic fumes, which can be environmentally damaging. (air pollutant)

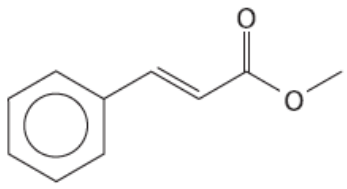
(e) Calculate the percentage by mass of carbon in phenylethene, giving your answer to an appropriate number of significant figures.

(2)

8 carbons = 96
$M_r = 96 + 8 = 104$ $\Rightarrow$ $\% = \frac{96}{104} \times 100 = 92.3\%$

(Total for Question 7 = 11 marks)

4 Methyl cinnamate, $C_{10}H_{10}O_2$, is a white crystalline solid used in the perfume industry.



methyl cinnamate

(a) Calculate the mass of carbon in 2.34 g of methyl cinnamate.

(2)

$n = \frac{m}{mr} = \frac{2.34}{120+10+32} = 0.0144$ mol

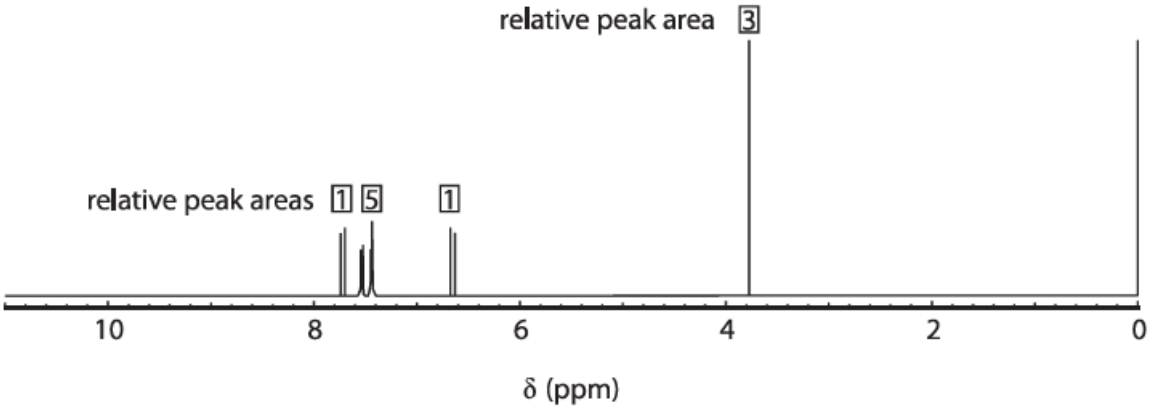
$\Rightarrow$ n of carbon $= 0.0144$

m of carbon $= n \times mr = 0.0144 \times 120$

$= 1.73$ g

(b) A sample of methyl cinnamate was analysed by high resolution proton NMR spectroscopy.

A simplified spectrum is shown.



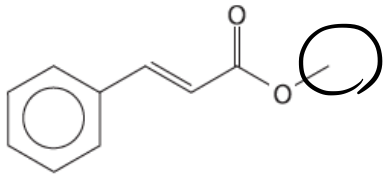
(i) Name the compound responsible for the peak at a chemical shift of 0 ppm, stating its purpose.

(2)

Tetramethylsilane (TMS). It is used to calibrate the measurements of chemical shift (used as a standard or reference point for comparison)

(ii) Identify the proton environment that causes the peak at a chemical shift of 3.8 ppm by circling it on the diagram shown. Fully justify your answer.

(3)

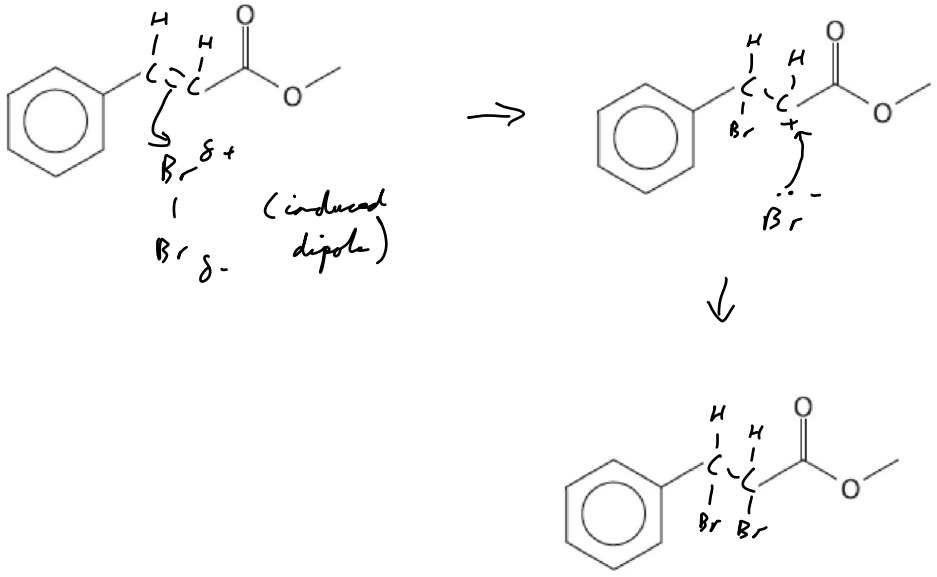


Peak area 3 is a singlet meaning no hydrogen atoms are bonded to adjacent carbon atom. CH_3 beside oxygen is the only one with no neighbouring hydrogen atoms.

(c) Methyl cinnamate undergoes an addition reaction in the dark with bromine.

(i) Draw the mechanism for the reaction between methyl cinnamate and bromine, Br_2.
Include curly arrows, and relevant lone pairs and dipoles.

(4)



(ii) Deduce the number of optical isomers of the addition product that can exist.

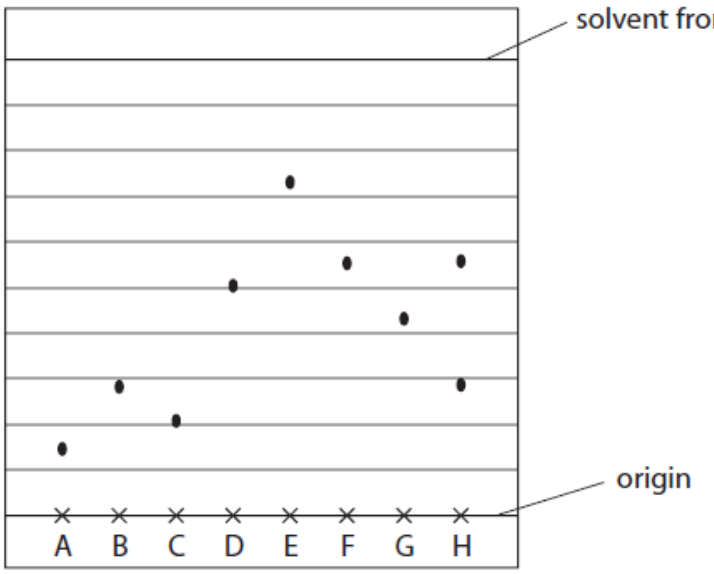
(1)

- ☐ **A** 2
- ☐ **B** 3
- ☒ **C** 4
- ☐ **D** 8

(Total for Question 4 = 12 marks)

3 Chromatography is a technique used to separate the components of a mixture.

(a) A sample of a tripeptide was hydrolysed and then placed on a thin layer chromatography (TLC) plate. Samples of possible amino acids present were also placed on the TLC plate for reference.
A simplified diagram of the developed TLC plate is shown.



A – Lysine	B – Serine	C – Histidine	D – Tyrosine
E – Isoleucine	F – Methionine	G – Proline	H – Hydrolysed tripeptide

(i) Calculate the R_f value for the amino acid lysine.
Give your answer to an appropriate number of significant figures.

(1)

$R_f = \frac{1.5}{10} = 0.15$

(ii) Identify by **name** the two amino acids present in the tripeptide, giving a reason for the lack of a third spot.

(3)

Serine and methionine

No third spot as either serine or methionine appears twice in the tripeptide, or the third acid has the same R_f value as serine or methionine.

(iii) Give **two** reasons why different amino acids have different R_f values.

(2)

They have different solubilities in the in the solvent (mobile phase)
They have different adsorption to the TLC plate (stationary phase).

(iv) In chromatography, a 'locating' reagent is often used when the components in a mixture are colourless.

Which reagent is used to locate the amino acid spots?

(1)

- ☒ **A** iodine
- ☐ **B** methyl orange
- ☒ **C** ninhydrin
- ☐ **D** phenolphthalein

(b) Gas chromatography can be used both to separate the components in a mixture and to determine the amount of each present.

(i) State why argon and nitrogen are suitable carrier gases for gas chromatography.

(1)

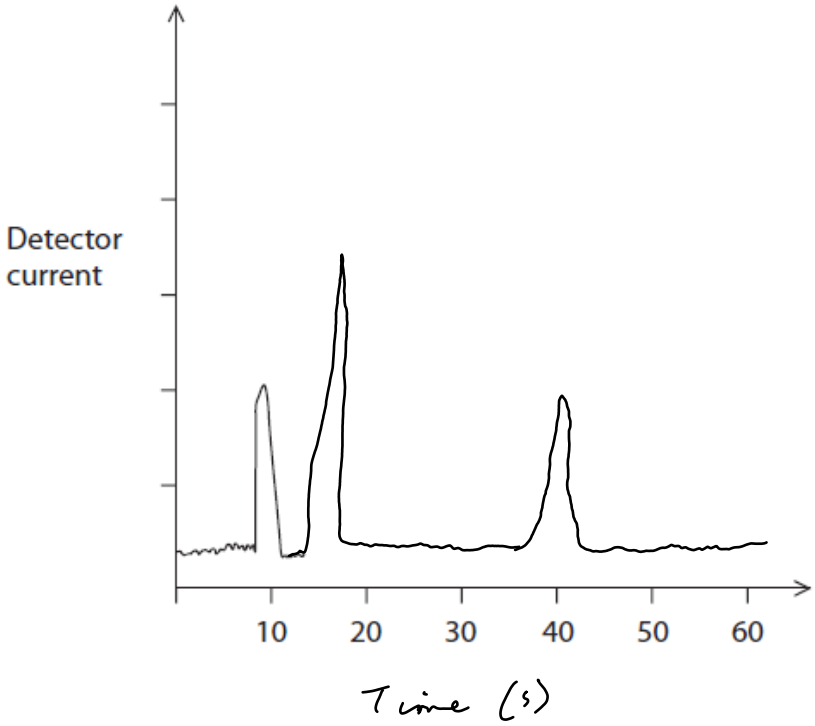
They are inert and so will not react with the mixture components

(ii) A mixture containing one part substance **X**, two parts substance **Y** and one part substance **Z** was separated by gas chromatography.

Substance **X** has a retention time of 10 seconds, substance **Y** of 15 seconds and substance **Z** of 40 seconds.

Complete the sketch of this chromatogram.

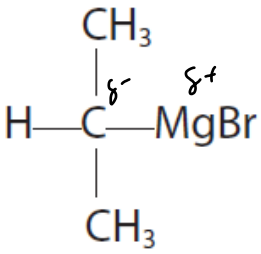
(3)



(Total for Question 3 = 11 marks)

5 Grignard reagents are used in organic synthesis as a way of increasing the length of the carbon chain in a molecule.

(a) The structure of the Grignard reagent formed by the reaction between 2-bromopropane and magnesium is



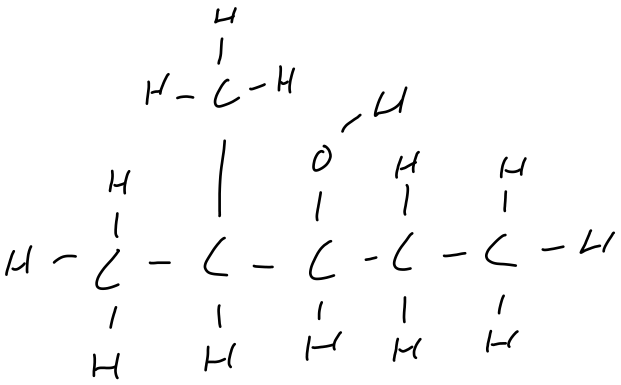
On the diagram, draw the permanent dipole involving the central carbon atom.

(1)

(b) The Grignard reagent in part (a) reacts with propanal.

(i) Draw the **fully displayed** formula of the final organic product of this reaction.

(1)



(ii) Name the organic product in (b)(i).

(1)

2-methylpentan-3-ol

(c) Identify, by using ticks, **two** boxes in the table to select appropriate terms that describe a Grignard reagent.

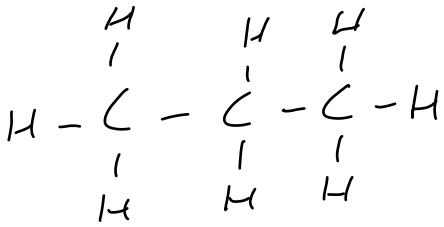
(2)

acid	
electrophile	
nucleophile	✓
oxidising agent	
reducing agent	✓

(d) The solvent used for Grignard reagents has to be completely **dry**.

By considering the dipole on the O—H bonds in water, predict the identity of the organic product that forms if water is added to the Grignard compound in part (a).

(1)



Propane

(Total for Question 5 = 6 marks)

Total for Test = 40 marks