Carboxyl groups

Question Paper

Level	Pre U
Subject	Chemistry
Exam Board	Cambridge International Examinations
Topic	Carboxyl groups-Higher functional group level
Booklet	Question Paper

Time Allowed: 32 minutes

Score: /27

Percentage: /100

Grade Boundaries:

Save My Exams! - The Home of Revision

For more awesome GCSE and A level resources, visit us at www.savemvexams.co.uk/

1. Evidence is accumulating that omega-3 oils help to protect us from schizophrenia and depression, and even improve learning and memory. Omega-3 oils are glyceryl esters of omega-3 fatty acids.

One omega-3 fatty acid is cervonic acid.

cervonic acid

(a) Which configuration of the C=C double bonds is present in this molecule?

.....[1]

The systematic name of cervonic acid (ignoring geometric isomerism) is docosa-4,7,10,13,16,19-hexaenoic acid. "Docosa" indicates that there is a 22-carbon chain. The numbers indicate the carbon atom where the C=C double bonds start, counting from the carboxylic acid (–COOH) functional group. "Hexaen" indicates that there are six double bonds in the chain. Two other omega-3 fatty acids are stearidonic acid and timnodonic acid.

stearidonic acid

timnodonic acid

(b) "Octadeca" indicates that there is an 18-carbon chain. Write down the systematic name for stearidonic acid. Ignore the geometric isomerism.

[1]

(c) How many geometric isomers are there of timnodonic acid, including the molecule shown?

.....[1]

(d) What is the name of the intermolecular force that will operate between the hydrocarbon chains? Ring the correct option. [1]

permanent dipole-permanent dipole

hydrogen bonding

instantaneous dipole-induced dipole

(e) Another fatty acid that is believed to have beneficial health effects is oleic acid.

"Omega" is the last letter of the Greek alphabet. By comparing oleic acid, which is not
an omega-3 acid, with the omega-3 fatty acids in part (a), suggest what "omega-3"
relates to in the structure of these oils and fatty acids.

.....[1]

(f) It is possible to differentiate between different types of fatty acids and oils in the laboratory by measuring the degree of unsaturation in the hydrocarbon chains. Halogens react with alkenes in an addition reaction.

Draw the structure of the product when propene reacts with Br₂ and name it systematically.

structure		
name		

Save My Exams! - The Home of Revision

For more awesome GCSE and A level resources, visit us at <u>www.savemyexams.co.uk/</u>

(g) Table 8.1 shows information about various fatty acids.

Table 8.1

fatty acid	molecular formula	molar mass /g mol ⁻¹	number of C=C double bonds
cervonic acid	$C_{22}H_{32}O_2$	328	6
stearidonic acid	C ₁₈ H ₂₈ O ₂	276	4
timnodonic acid	$C_{20}H_{30}O_2$	302	5
oleic acid		282	1

(i)	The degree of unsaturation in a fatty acid is commonly expressed by the mass
	of iodine that reacts with 100.0g of the acid. Use the information in Table 8.1 to
	calculate the mass of iodine that would react with 100.0 g of cervonic acid. Use an
	appropriate number of significant figures in your answer.

-		
	വ	ı
	_	ı

Save My Exams! – The Home of RevisionFor more awesome GCSE and A level resources, visit us at www.savemyexams.co.uk/

(h)	com acid	interhalogen compound IC l also reacts with alkenes in an addition reaction. It is monly used as $\it Wijs' reagent$, a 0.100 mol dm $^{-3}$ solution of IC l in glacial ethanoic. IC l reacts faster with alkenes than the pure halogens and so can be used to rmine volumetrically the unsaturation in fatty acids and oils.
	(i)	Suggest why IC $\!l$ reacts with alkenes faster than the pure halogens, C $\!l_{\!2}$, Br $_{\!2}$ and I $_{\!2}$.
		[1]
acid	and	rolumetric determination, 30 minutes is required for the reaction between the fatty Wijs' reagent to go to completion. A common solvent for Wijs' reagent and the fatty ,1,1-trichloroethane.
one	of ce	o design an experiment using Wijs' reagent to identify an unknown fatty acid that is ervonic acid, stearidonic acid or timnodonic acid. You have 0.100 g of the unknown olved in 20 cm ³ of 1,1,1-trichloroethane.
	shou hods	ld aim to produce data that is as accurate as possible using conventional laboratory
You	shou	ld use the information in Table 8.1.
	(ii)	The first part of the experiment involves adding an accurately known excess of Wijs' reagent to the fatty acid solution. The amount of Wijs' reagent should be at least 25% greater than the maximum amount that could be required to react with the fatty acid.
		Work out a suitable volume of Wijs' reagent to add to the fatty acid solution and explain how you would add this quantity in the laboratory.

Save My Exams! - The Home of Revision

For more awesome GCSE and A level resources, visit us at www.savemyexams.co.uk/

After this reaction is complete, $10\,\mathrm{cm^3}$ of a $2.0\,\mathrm{mol\,dm^{-3}}$ aqueous solution of KI is added to the non-aqueous fatty acid solution to convert the excess ICl to iodine, I_2 .

$$ICl + KI \rightarrow I_2 + KCl$$

This quantity of KI(aq) should be a large excess. Next, 100 cm³ of deionised water is added to the mixture. The iodine is distributed between the aqueous and non-aqueous phases.

(iii) The second part of the experiment involves determining the amount of iodine generated by the excess ICl. This is done using a 0.100 mol dm $^{-3}$ solution of sodium thiosulfate, Na $_2$ S $_2$ O $_3$.

$$I_2 + 2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6$$

The whole mixture is reacted with sodium thiosulfate in one batch since the iodine is distributed between the phases. In this reaction considerable shaking is needed to ensure adequate mixing of the phases.

Write out a method for both parts of the experiment that a fellow student could follow. The original fatty acid solution comes in a small sample bottle that is nearly full. Include safety considerations.

Save My Exams! – The Home of RevisionFor more awesome GCSE and A level resources, visit us at www.savemyexams.co.uk/

	[8]
(iv)	Explain how you would work out the identity of the fatty acid given the volume of thiosulfate obtained from the experiment.
	[4]

[Total: 27]