AS level Chemistry A

H032/02 Depth in chemistry

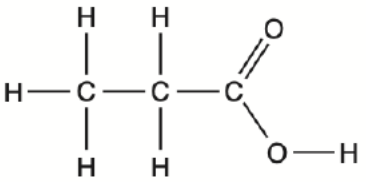
Question Set 5

5. Propanoic acid, CH_3CH_2COOH, is a member of the homologous series of carboxylic acids.

(a) Suggest the general formula for a carboxylic acid. $C_nH_{2n+1}COOH$

[1]

(b) The displayed formula for propanoic acid is shown below.



tetrahedral – 109.5°
4 bonding pairs of electrons around carbon which repel equally so are as far apart as possible.

(i) State the shape and bond angle around a carbon atom in the alkyl group of propanoic acid. Explain the shape.

[2]

(ii) Suggest a value for the C–O–H bond angle in propanoic acid. 104.5°

[1]

(c) Compound **D** is a neutral compound which is a structural isomer of propanoic acid, CH_3CH_2COOH.

The infrared spectrum of compound **D** is shown below.

Suggest **two** possible structures of compound **D**.Explain **all** your reasoning.

[4]

(d) 2-Chloropropanoic acid, $CH_3CHClCOOH$, can be made by reacting propanoic acid with chlorine in a radical substitution reaction.

(i) State the conditions for the reaction. UV light

[1]

(ii) Write the overall equation for the reaction.

[1]

$2CH_3CH_2COOH + Cl_2 \longrightarrow 2CH_3CHClCOOH + 2HCl$

(iii) The first step in the reaction mechanism involves homolytic fission of a chlorine molecule to form two chlorine radicals.

Why is this step an example of *homolytic fission*?

homolytic fission is the breaking of a covalent bond where one electron in the covalent bond goes to one atom, and the other goes to the other atom. **[2]**

(iv) Write **two** equations to show the propagation steps in the mechanism for this reaction. **[1]**

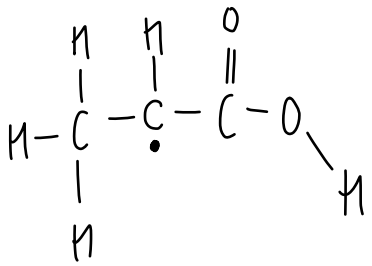
Use dots,•, to show the unpaired electrons on radicals.

$CH_3CH_2COOH + Cl\bullet \longrightarrow CH_3\dot{C}HCOOH + HCl$

$CH_3\dot{C}HCOOH + Cl_2 \longrightarrow CH_3CHClCOOH + Cl\bullet$ **[1]**

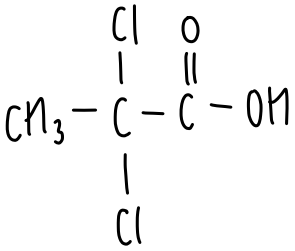
(v) Draw the displayed formula of the radical formed in the first propagation step.

Use a dot,•, to show the position of the unpaired electron.



(vi) Further substitution forms a mixture of organic products.

Draw the structure of an organic product formed from 2-chloropropanoic acid by further substitution.



Total Marks for Question Set 5: 15