33. Carboxylic acids and derivatives

33.1 Carboxylic acids

Paper 4

Question Paper

1 **(a)** Explain why trichloroethanoic acid, CCl_3COOH, is more acidic than ethanoic acid, CH_3COOH.

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..... [1]

2 Fig. 6.1 shows two reactions of ethanedioic acid, HOOCCOOH.

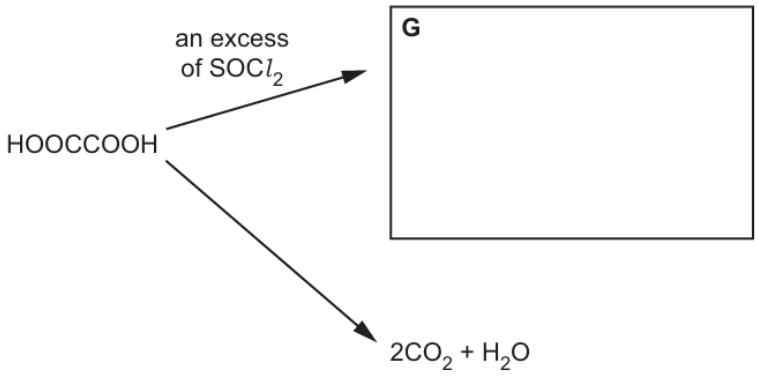

Fig. 6.1

(b) Identify **two** different reagents that oxidise HOOCCOOH to form carbon dioxide and water.

.....

..... [2]

(c) HOOCCOOH ionises as shown.

$$HOOCCOOH \rightleftharpoons HOOCCOO^- + H^+$$

HOOCCOOH is a much stronger acid than methanoic acid, HCOOH.

Suggest an explanation for this difference in acidity.

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..... [2]

3 **(a)** Compare the relative acidities of benzoic acid (C_6H_5COOH), phenylmethanol ($C_6H_5CH_2OH$), and phenol (C_6H_5OH).
Explain your reasoning.

..... > ..... > .....
most acidic least acidic

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.....

[3]

(b) A series of nine separate experiments is carried out as shown in Table 5.1.

Complete the table by placing a tick (✓) in the relevant box if a reaction occurs. Place a cross (✗) in the box if no reaction occurs.

Table 5.1

	benzoic acid	phenylmethanol	phenol
Na(s)			
NaOH(aq)			
Na_2CO_3(aq)			

[3]

4 **(a)** Compare the relative acidities of ethanol, ethanoic acid, chloroethanoic acid and phenol.
Explain your reasoning.

..... > ..... > ..... > .....
most acidic least acidic

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[4]

(b) An excess of ethanedioic acid, HOOCCOOH(aq), is reacted with warm acidified $KMnO_4$(aq).

State the type of reaction undergone by ethanedioic acid.
Describe what you would observe.
Write an equation for this reaction.

Your equation can use [O] or [H] as necessary.

type of reaction .....

observations .....

equation .....

[2]

5 **(a)** The structural and displayed formulae of three aromatic compounds, **A**, **B** and **C**, are shown in Fig. 7.1.

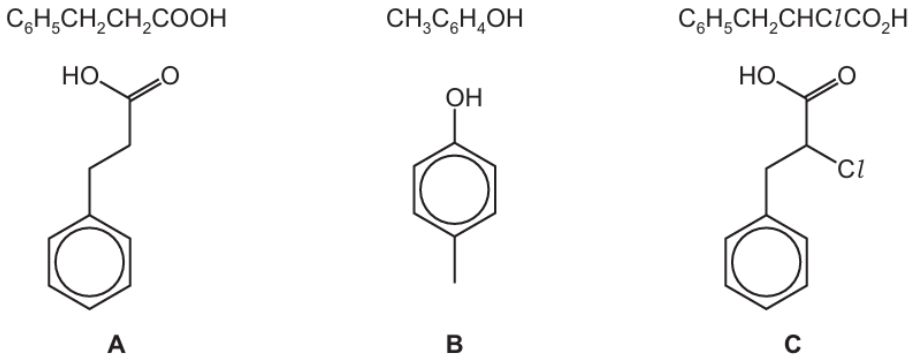

Fig. 7.1

Compare the relative acidities of **A**, **B** and **C**.

..... > ..... > .....
most acidic least acidic

Explain your answer.

.....

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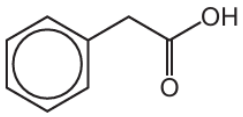
.....

..... [3]

6 The structure of phenylethanoic acid is shown.



(b) Phenylethanoic acid, ethanol and phenol can all behave as acids.

Compare and explain the relative acidities of these three compounds.

..... > ..... > .....
most acidic least acidic

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..... [4]

7 **(a)** Compare and explain the relative acidities of 2-chloropropanoic acid, 3-chloropropanoic acid, and propanoic acid. Explain your answer.

..... > ..... > .....
most acidic least acidic

explanation .....

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[3]

8 **(a)** Ethanoic acid, CH_3CO_2H and trichloroethanoic acid, CCl_3CO_2H, are both carboxylic acids. Ethanoic acid can be used to make ethanamide, CH_3CONH_2.

Place these three compounds in order of acidity, starting with the **least** acidic.
Explain your answer.

..... < ..... < .....

least acidic most acidic

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[3]

(b) Methanoic acid, HCO_2H, and ethanedioic acid, HO_2CCO_2H, are two other carboxylic acids.

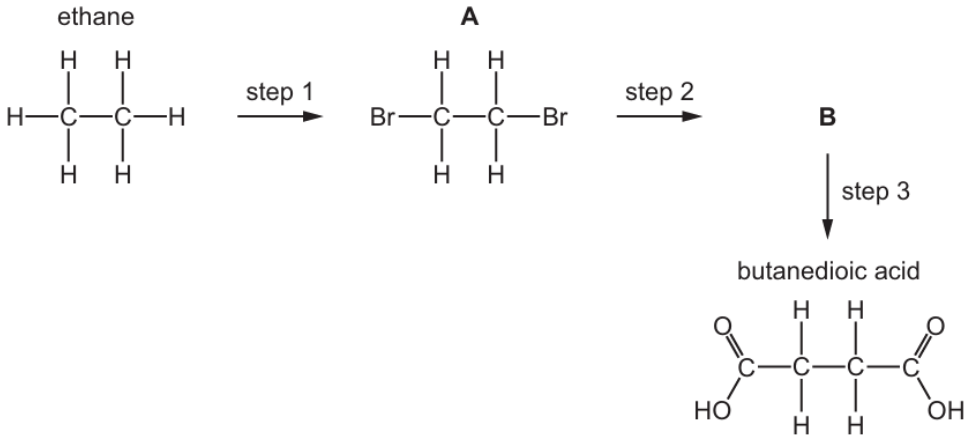
(i) State which, if any, of ethanoic acid, methanoic acid and ethanedioic acid will react with Fehling's reagent.

..... [1]

(ii) State which, if any, of ethanoic acid, methanoic acid and ethanedioic acid will react with warm acidified manganate(VII) ions.

..... [1]

9 Butanedioic acid can be made in a three-step synthesis using ethane as the starting material.



(e) Butanedioic acid cannot be oxidised by a warm, aqueous solution of any commonly used oxidising agents but ethanedioic acid can.

(i) Identify the oxidising agent that could be used to oxidise ethanedioic acid.

..... [1]

(ii) State the product(s) of the reaction in **(e)(i)**.

..... [1]

(f) Compare and explain the relative acidities of hexanoic acid, hexan-1-ol and phenol.

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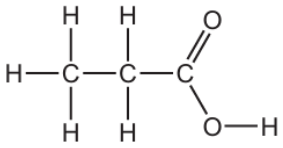
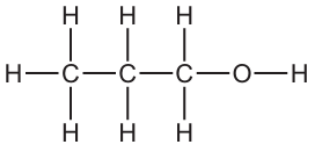
..... [3]

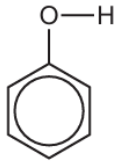
10 The three substances shown all have some acidic properties.



propanoic acid



propan-1-ol



phenol

(b) (i) Give the order of the relative acidities of propanoic acid, propan-1-ol and phenol, stating the most acidic first.

..... [1]

(ii) Explain your answer to **(i)**.

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..... [2]

(c) Methanoic acid, HCO_2H, has a similar acid strength to propanoic acid.

Describe a chemical test to distinguish between these two acids. Name the acid which gives a positive result in this test and describe the observations that would be made.

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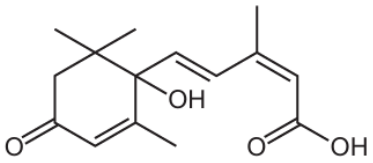
..... [2]

11 Abscisic acid, $C_{15}H_{20}O_4$, is a plant hormone.



abscisic acid, $C_{15}H_{20}O_4$

(c) If abscisic acid is treated with an excess of hot, concentrated, acidified $KMnO_4$, three different carbon-containing products are formed.

(i) Draw the skeletal formula of the carbon-containing product with the **largest** molecular mass.

[1]

(ii) Identify the carbon-containing product with the **smallest** molecular mass. Explain how this product arises.

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..... [2]

(iii) Identify the third carbon-containing product of this reaction by giving its displayed or structural formula.

[1]