Exercise walk-through

Carboxylic acids ▪ 18.1

eXercise

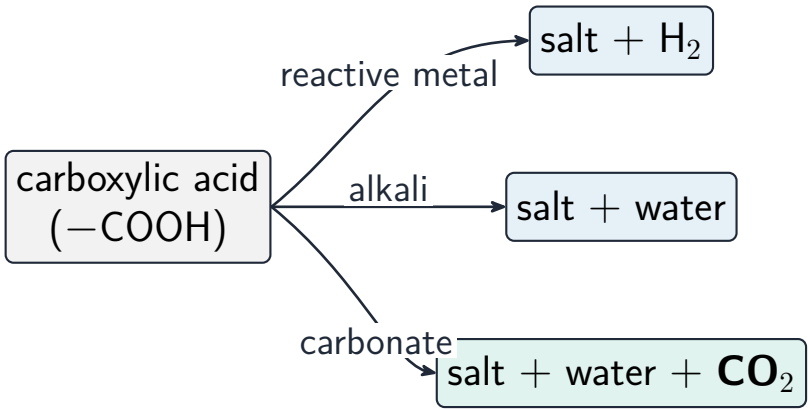
You must be able to

- recall how carboxylic acids are made (oxidation, hydrolysis of nitriles/esters)
- describe the reactions with metals, alkalis and carbonates
- describe esterification and reduction by LiAlH

Method — Making and reacting carboxylic acids

A **carboxylic acid** has the –COOH group (a weak acid). Made by: oxidising a primary alcohol/aldehyde (reflux); hydrolysing a nitrile or ester then acidifying.
Acid reactions: with a metal → salt + H ; with an alkali → salt + water; with a carbonate → salt + water + CO (the fizz is a test)
Two reactions change the functional group: **esterification** with an alcohol (conc. H SO) → ester; **reduction** by LiAlH → primary alcohol.

Method — Making and reacting carboxylic acids



fizzing CO_2
= a test

Method — Making and reacting carboxylic acids

the –OH (acid) and –H (alcohol) leave as water; the C–O–C ester link forms

(concentrated H_2SO_4 catalyst; reversible)

Carboxylic acids form esters with alcohols

Practice 2.1 ▪ 1 mark

Write the equation for ethanoic acid reacting with sodium carbonate.

Solution 2.1

Method: Making and reacting carboxylic acids

Worked steps

$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$ B1.

Practice 2.2 ▪ 2 marks

State a chemical test, with result, that shows a compound is a carboxylic acid.

Solution 2.2

Method: Making and reacting carboxylic acids

Worked steps

add a carbonate (e.g. sodium carbonate) B1; effervescence / fizzing of CO is seen B1.

Exam-style 3.1 ▪ 1 mark

Which reagent reduces a carboxylic acid to a primary alcohol?

A NaBH

B LiAlH

C acidified K Cr O

D concentrated H SO

Solution 3.1

Method: Making and reacting carboxylic acids

A NaBH

B LiAlH ✓

C acidified K Cr O

D concentrated H SO

Worked steps

B. LiAlH reduces a carboxylic acid to a primary alcohol.

Exam-style 3.2 ▪ 1 mark

Ethanoic acid reacts with magnesium to give:

A an ester and water

B a salt and hydrogen

C a salt, water and CO

D no reaction

Solution 3.2

A an ester and water

B a salt and hydrogen ✓

C a salt, water and CO

D no reaction

Worked steps

B. A reactive metal gives a salt and hydrogen.

Exam-style 3.3 ▪ 2 marks

(a) Write the equation for the reaction of ethanoic acid with sodium hydroxide and name the type of reaction.
(b) State the reagents and conditions to make ethanoic acid from ethanol.

Solution 3.3

Worked steps

(a) $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$ B1; neutralisation A1.
(b) acidified K Cr O (or KMnO) B1; heat under reflux A1.

Exam-style 3.4 ▪ 2 marks

Explain why carboxylic acids fizz with a carbonate but alcohols do not.

Solution 3.4

Method: Making and reacting carboxylic acids

Worked steps

carboxylic acids are acidic — they release H which reacts with the carbonate to give CO M1; alcohols are not acidic enough to react with a carbonate A1.