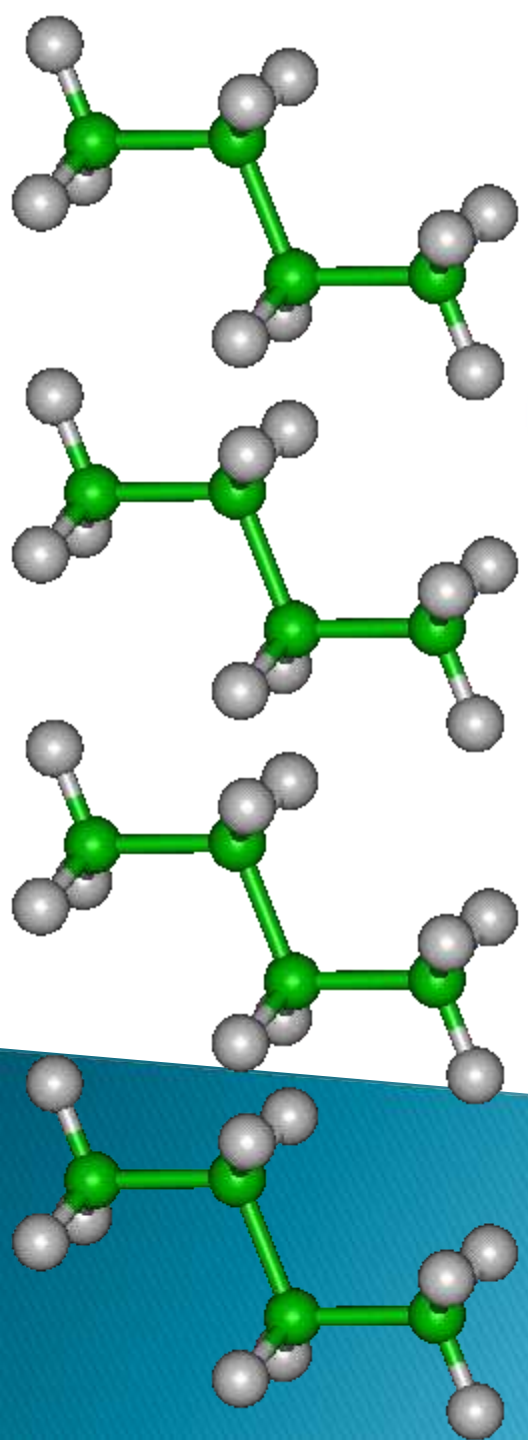


Carboxylic Acids

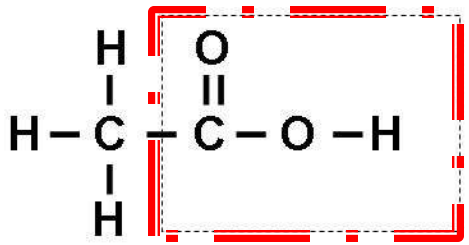
Let's Recall

Homologous Series	Functional Group	Formula	General Formula (m≥0, n≥1)	Suffix	Example
Alkane	Alkyl	RH	C_nH_{2n+2}	-ane	Ethane
Alkene	Alkenyl	$R_2C=CR_2$	C_nH_{2n}	-ene	Ethene
Alcohol	Hydroxyl	ROH	$C_nH_{2n+1}OH$	-ol	Methanol

What are Carboxylic Acids?

- Belong to a homologous series of organic compounds similar to alkanes, alkenes and alcohols
- The hydrocarbon chains contain the functional group –COOH (carbonyl group)

Structural Formula



=

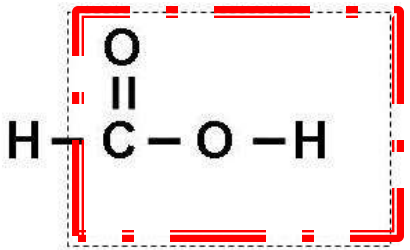
Chemical Formula

CH_3COOH

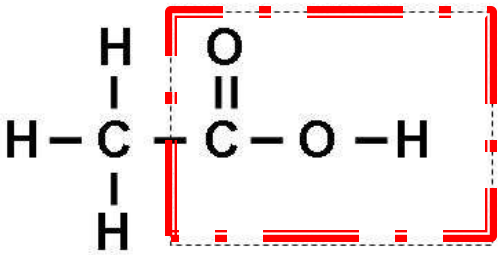
or

CH_3CO_2H

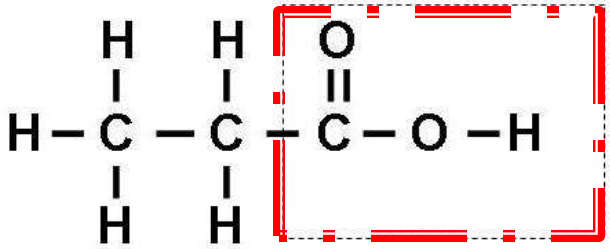
Naming the Carboxylic Acids



- Methan***oic* acid**
- Total of one carbon atom (meth-)
- C_0H_1COOH



- Ethan***oic acid***
- Total of two carbons atoms (eth-)
- C_1H_3COOH



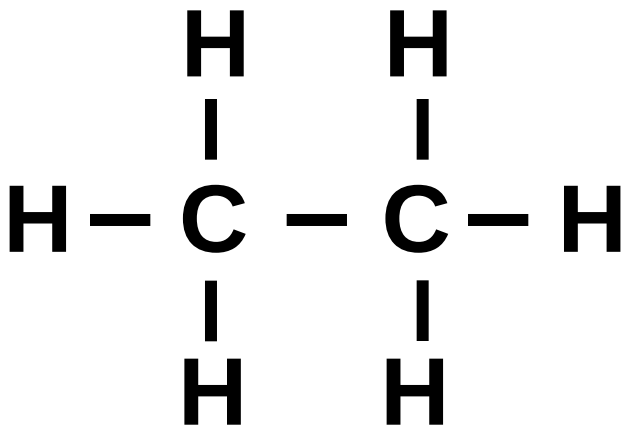
- Propan***oic acid***
- Total of three carbon atoms (propan-)
- C_2H_5COOH

**Take note of the functional group's location, highlighted by the dotted box*

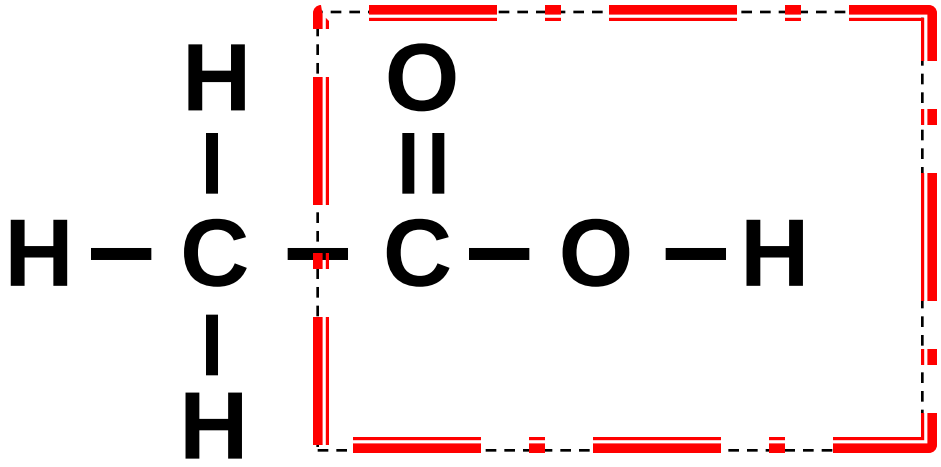
Naming Carboxylic Acids

- Replace the ‘e’ with ‘oic acid’ at the end of the name of the hydrocarbon

Example:



ethan**e**



ethan***oic acid***

Physical Properties of Ethanoic Acids

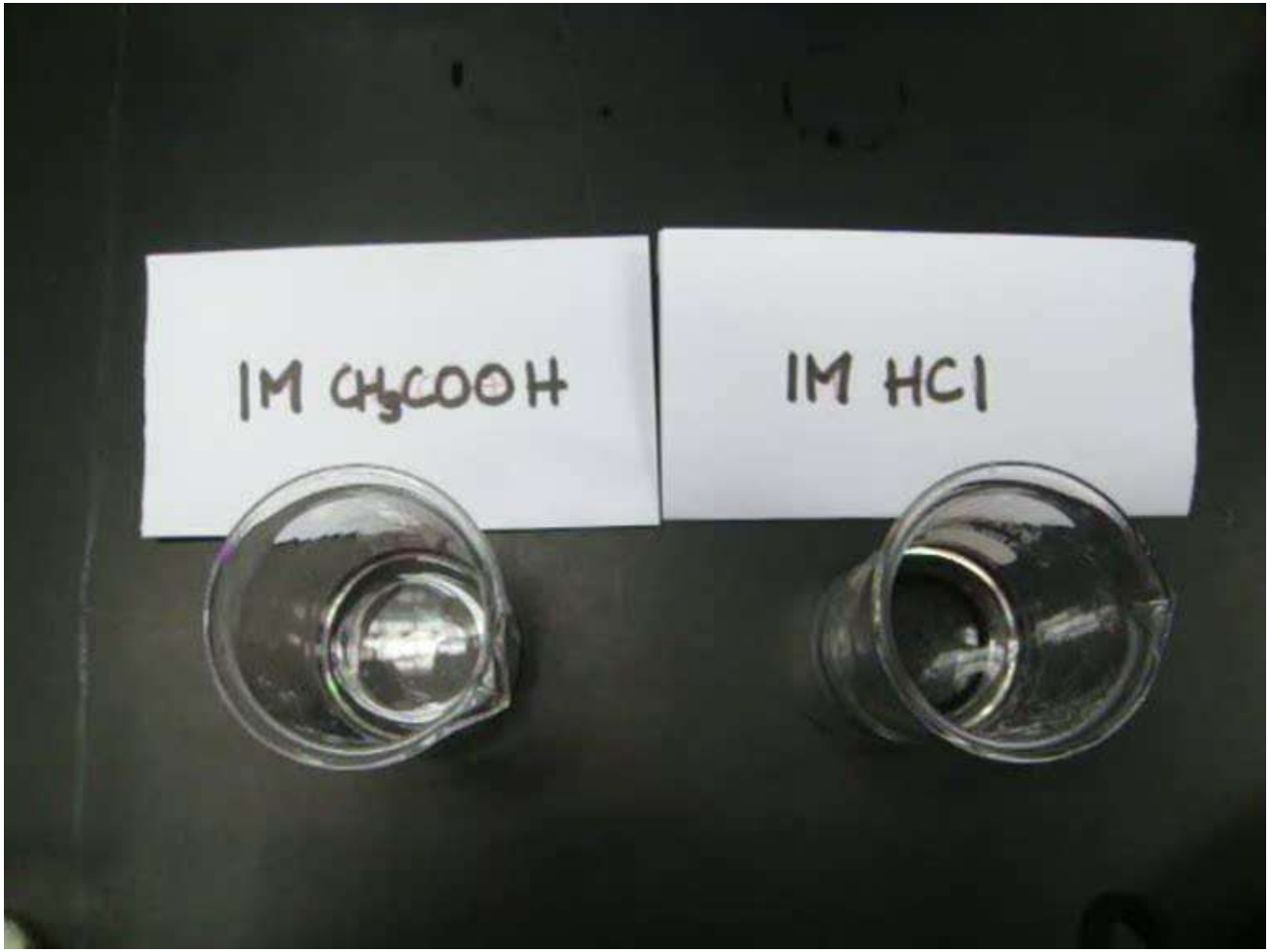
- Similar to its alcohol:
  - *Colourless liquid* at room temperature & relatively low boiling point of 118°C
  - Completely *miscible* (able to dissolve) in water
- Has a characteristic 'sour-ish' smell
- Is a *weak acid* of pH 3

It's time to predict and discuss!

Are carboxylic acids the same as the acids we have learnt about in the chapter on acids and bases?

Watch and observe!!

Video of demonstration



Chemical Properties of Carboxylic Acids

- As carboxylic acid is **weak**, its reactions produce the **same** outcomes as those learnt from the chapter of Acids, Bases and Salts

- But, the reactions are less vigorous

Acid Properties

Weak acids (pH ≈ 3).

- Most of the acid molecules are unionised in water.

For example: 1.0 mol/dm^3 solution of ethanoic acid

$$CH_3COOH(aq) \rightleftharpoons CH_3COO^-(aq) + H^+(aq)$$

Pure acid	1000	0	0
Acid in water	996	4	4

Acid Properties

Reaction with **bases**

- to form a salt and water

For example:

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

Acid Properties

Reaction with *reactive* **metals**

- to form a salt and hydrogen

For example:

$$2CH_3COOH + Mg \longrightarrow (CH_3COO)_2Mg + H_2$$

Acid Properties

Reaction with **carbonates**

- to form a salt, carbon dioxide and water

For example:

$$2CH_3COOH + Na_2CO_3 \longrightarrow 2CH_3COONa + CO_2 + H_2O$$

Uses of Carboxylic Acids

Ethanoic acid is the most important organic acid

- It is used in vinegar as preservative and flavourings.

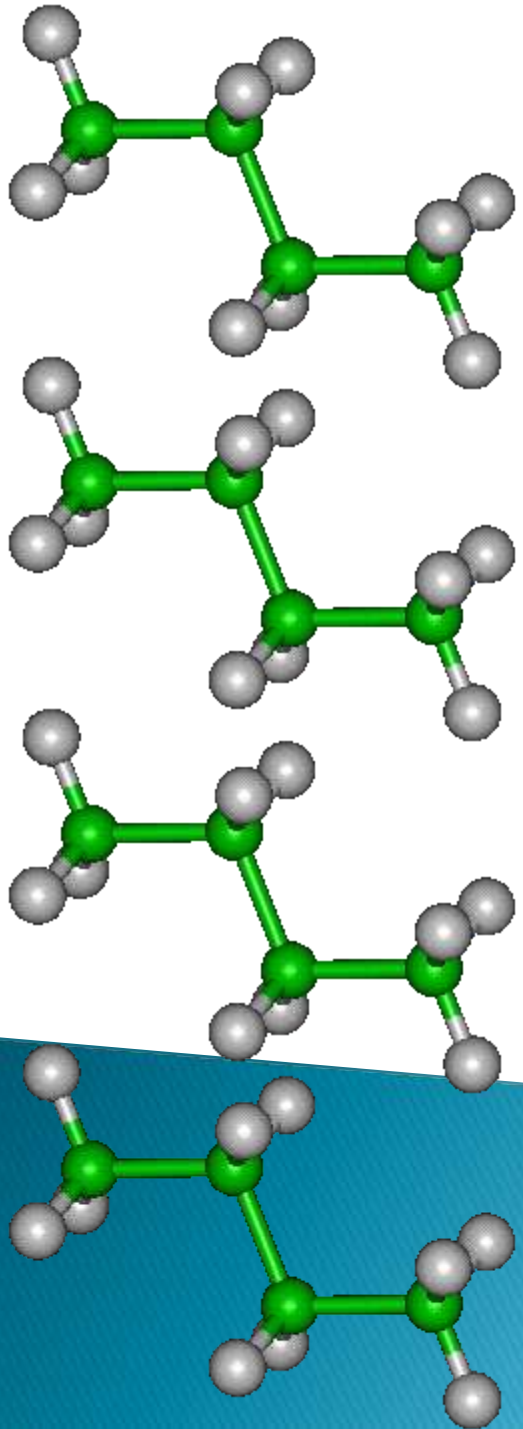
Other Important Organic Acids

Organic acid	Where it is found
Lactic acid	Sour milk
Oxalic acid	Rhubarb plant
Citric acid	Limes, lemons
Formic acid	Insect bites
Tartaric acid	Grape juice
Acetic acid	Vinegar
Malic acid	Apples and pears

Uses of Organic Acids

- Making of drugs, dyes, paints, insecticides, plastics.

- Making of esters.

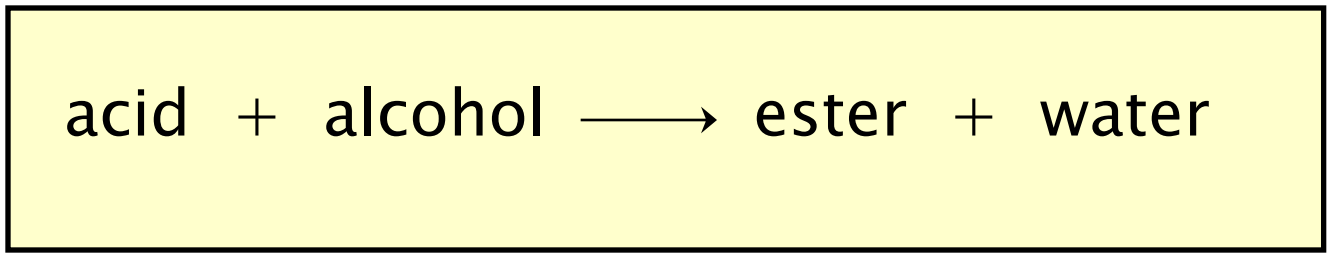


Esters

Esterification

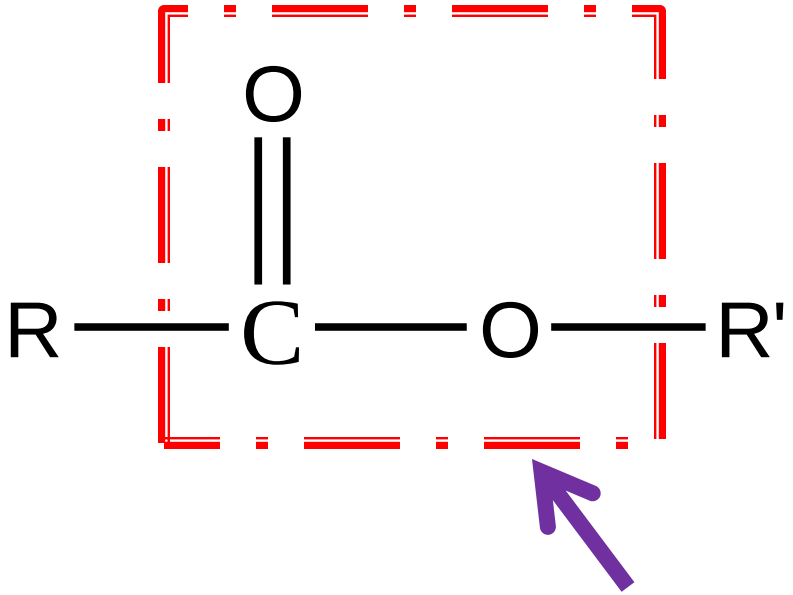
- **Carboxylic acids** reacts with **alcohols**
  - to form esters
  - in the presence of a few drops of concentrated sulphuric acid as catalyst

General equation:



What are esters?

- Have the general formula RCOOR’



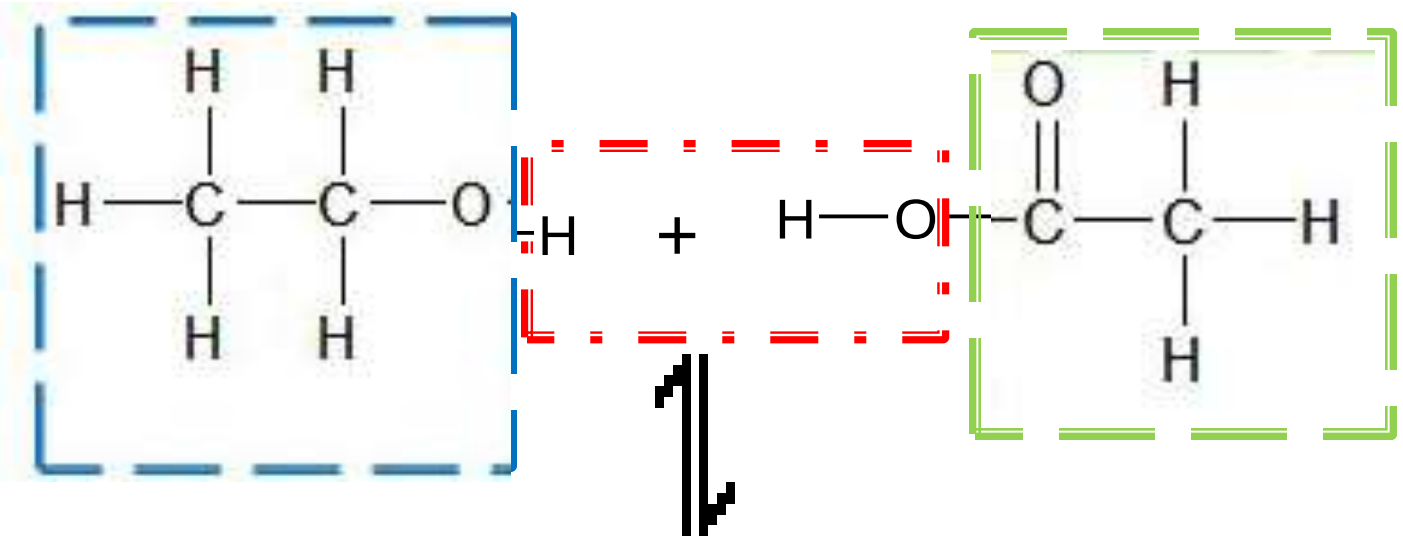
Functional group of ester

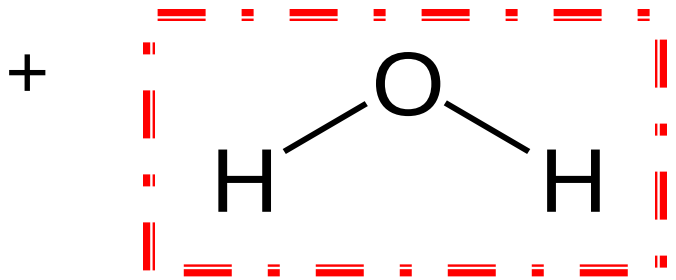
How to name esters?

Alcohol + Carboxylic acid → Ester + Water

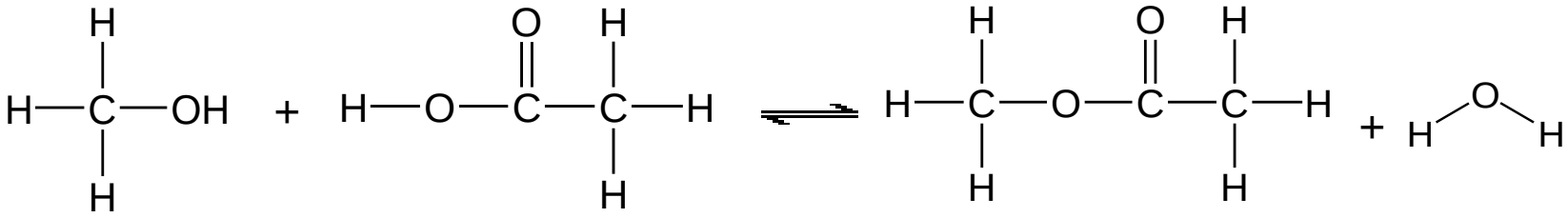
Alkanol + Alkanoic acid → Alkyl alkanoate + Water

R'OH + RCOOH → RCOOR' + H_2O


H
H
H
C
C
O
H
H
H
+
H
O
O
H
C
C
H
H


+
O
H
H

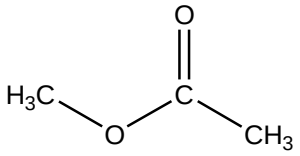
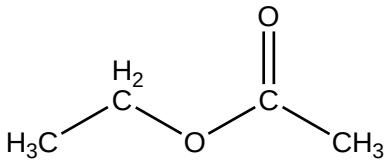
Esterification



methanol + ethanoic acid ⇌ methyl ethanoate + water

$CH_3OH + CH_3COOH \rightleftharpoons CH_3COOCH_3 + H_2O$

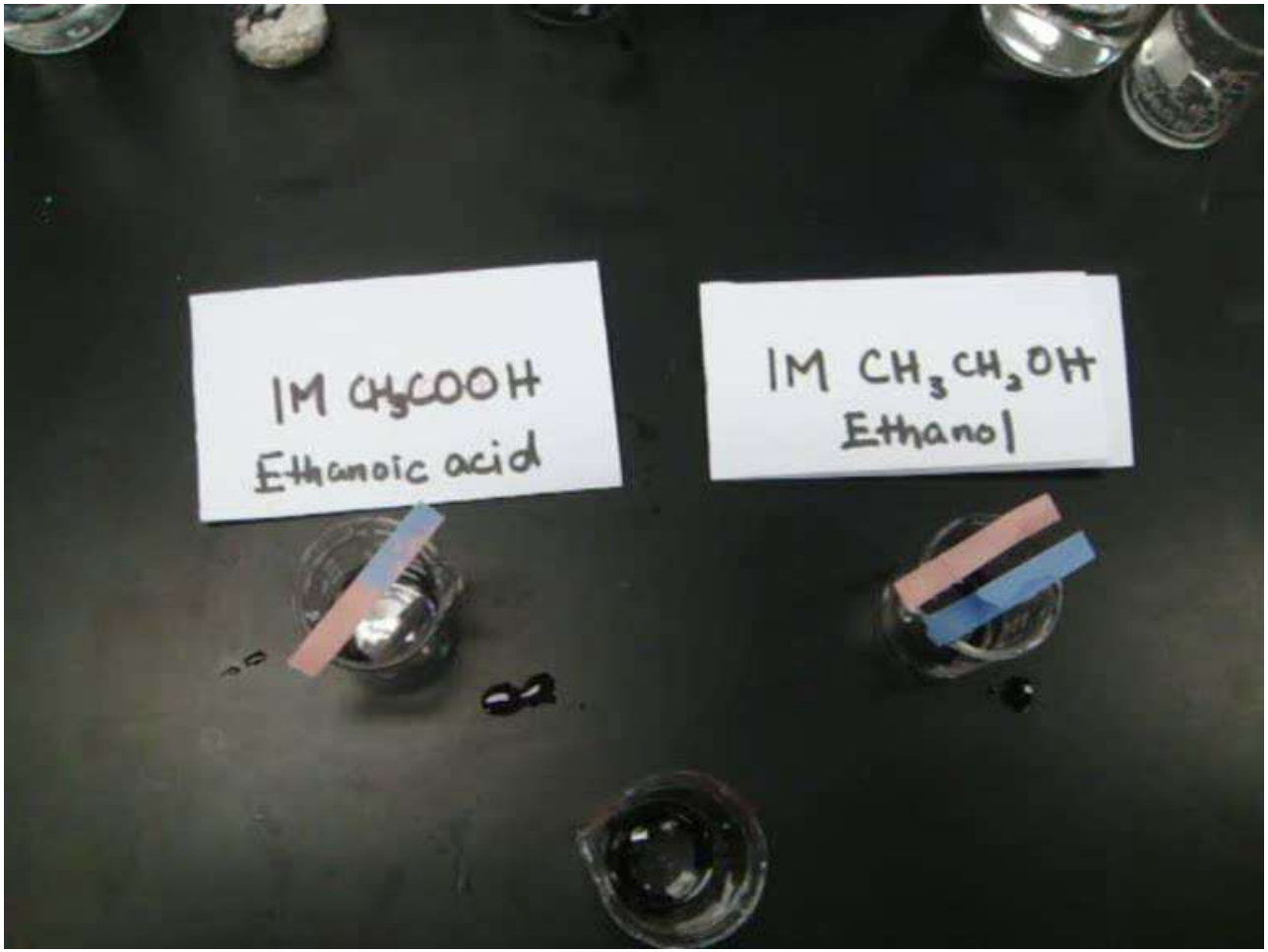
Esters

Chemical name	Molecular formula	Structural formula	Alcohol used	Organic acid used
methyl ethanoate	HCOOH		methanol	ethanoic acid
ethyl ethanoate	CH_3COOH		ethanol	ethanoic acid

Time to watch and predict again!

Are esters acidic, neutral or basic?

Video of demonstration



Properties of esters

- Esters are neutral compounds with a sweet smell
- Colourless and insoluble in water

Uses of Esters

- Fruity flavours for perfumes, sweets, drinks and cakes
  - Artificial pineapple flavour is an ester made from ethanol and butanoic acid, called ethyl butanoate.
- Solvents for organic compounds, such as glues, varnishes and paints.

Summary

Homologous Series	Functional Group	Formula	General Formula (m≥0, n≥1)	Suffix	Example
Alkane	Alkyl	RH	C_nH_{2n+2}	-ane	Ethane
Alkene	Alkenyl	$R_2C=CR_2$	C_nH_{2n}	-ene	Ethene
Alcohol	Hydroxyl	ROH	$C_nH_{2n+1}OH$	-ol	Methanol
Carboxylic acid	Carboxyl	RCOOH	$C_mH_{2m+1}COOH$	-oic acid	Ethanoic acid
Ester	Ester	RCOOR’	$C_mH_{2m+1}COOC_nH_{2n+1}$	Alkyl alkanoate	Ethyl butanoate

How it all ties up