

Sample Diploma Problem

Use the following information to answer question 23.

Students on a camping trip prepare their dinners using a camp stove fuelled by a cylinder of compressed propane gas, $C_3H_8(g)$.

23. Which two WHMIS symbols should appear on the outside of a cylinder of compressed propane gas?

A.



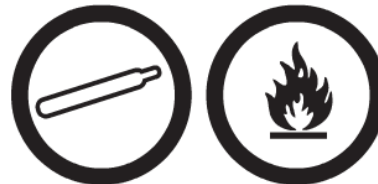
B.



C.



D.



Functional Groups



Curriculum

- identify and name carbon compounds, using International Union of Pure and Applied Chemistry (IUPAC) nomenclature that contain up to three carbon atoms in the parent chain and a single occurrence of one type of functional group, including simple halogenated hydrocarbons
- describe the common uses of hydrocarbons, including simple halogenated hydrocarbons, alcohols, carboxylic acids and esters;

Functional Group

- Definition: a characteristic arrangement of atoms or bonds within a molecule that determines the most important chemical and physical properties of a class of compounds

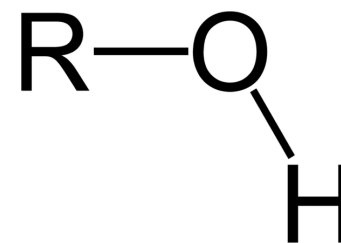


Data Booklet Page 9

$R-O-H$	alcohol	$ \begin{array}{c} H \quad H \\ \quad \\ H-C-C-O-H \\ \quad \\ H \quad H \end{array} $	ethanol
$ \begin{array}{c} O \\ // \\ R-C \\ \backslash \\ O-H \end{array} $	carboxylic acid	$ \begin{array}{c} H \quad O \\ \quad // \\ H-C-C \\ \quad \backslash \\ H \quad O-H \end{array} $	ethanoic acid
$ \begin{array}{c} O \\ // \\ R-C \\ \backslash \\ O-R' \end{array} $	ester	$ \begin{array}{c} H \quad O \quad H \\ \quad \quad \\ H-C-C-O-C-H \\ \quad \quad \\ H \quad \quad H \end{array} $	methyl ethanoate
$R-Q$	halogenated hydrocarbon	$ \begin{array}{c} H \quad H \\ \quad \\ H-C-C-Cl \\ \quad \\ H \quad H \end{array} $	chloroethane
$\dots \left[x-y \right]_n \dots$	polymer	$ \dots \left[\begin{array}{c} H \quad H \\ \quad \\ C-C \\ \quad \\ H \quad H \end{array} \right] \dots $	polyethene

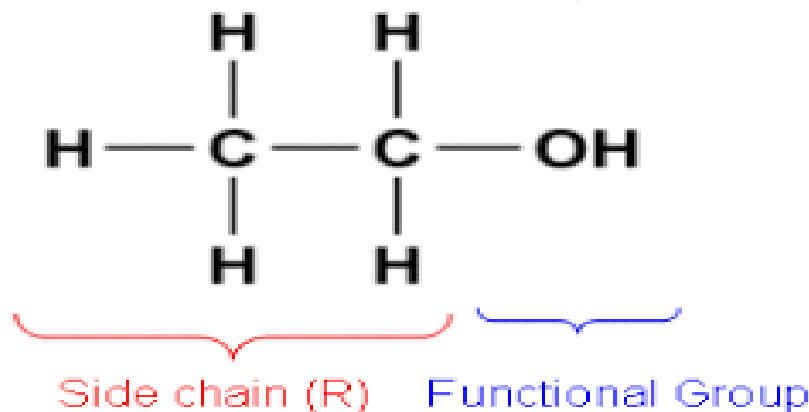
R usually represents a carbon group
R' usually represents a different carbon group
Q represents a halogen (fluoro-, chloro-, bromo-, iodo-)

x-y represents the monomer unit
n represents a whole number

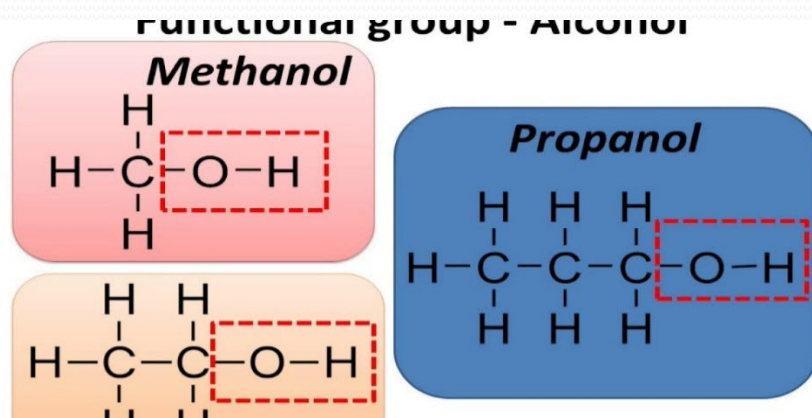


Alcohols

- **Alcohols** are organic compounds that have an “OH” or hydroxyl functional group bonded to a carbon atom.
- The general formula for alcohols is **R-OH**, where “R” is an alkyl group or some other part of a compound.



- This organic molecular compound must not be confused with the **polyatomic hydroxide ion** which is bound to a cation in ionic compounds such as sodium hydroxide, $\text{NaOH}_{(s)}$
 - The **hydroxide ion** has gained one electron to become negatively charged, OH^- .
- The **hydroxyl group** is covalently bound to another non-metal atom and is found in molecular compounds.



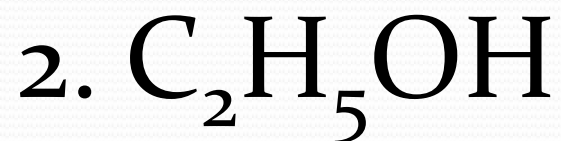
Hydroxyl or Hydroxide

Hydroxyl

Hydroxide

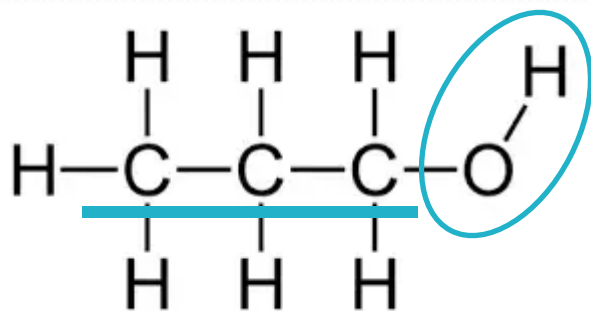
Board Question

- Identify which of the compounds below are alcohols.



Alcohol Naming Rules

1. Number the longest carbon chain that contains the -OH group, then number the carbons so as to give the carbon bonded to the -OH group the lowest possible number.



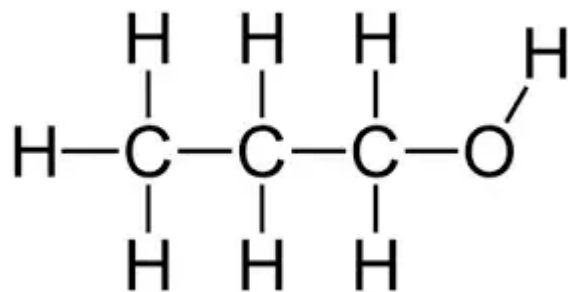
3 carbons = prop

OH = functional group

Alcohol suffix is “ol”

2. Indicate the position of the -OH group by changing the ending of the parent alkane chain by: dropping the “e”, then writing the number on which carbon the -OH group was found, and then add “ol”.

3. Indicate by number the position of any other groups attached to the parent chain.



Propan-1-ol

Drawing Alcohols

propan-2-ol

refers to the location of the hydroxyl functional group

Example



3 methyl Hexan-1-ol

Board Question



butanol

Board Question

- Draw butan-2-ol

Uses of Alcohols

Example	Use
methanol	solvents, fuels, production of pharmaceuticals, disinfectants
ethanol	solvents, fuels, alcoholic beverages, production of pharmaceuticals, disinfectants
glycol	solvents
isopropanol	disinfectants

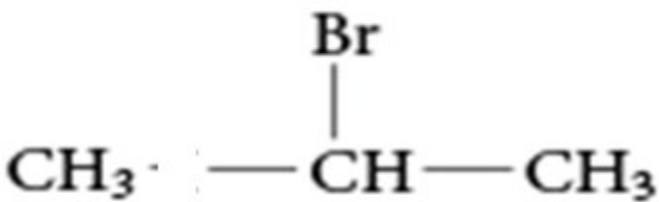


Naming halogenated hydrocarbons

- Step 1: Name the parent hydrocarbon chain
- Step 2: Find all halogen atoms in the molecule
 - Fluorine becomes **fluoro**.
 - Chlorine becomes **chloro**.
 - Bromine becomes **bromo**.
 - Iodine becomes **iodo**.

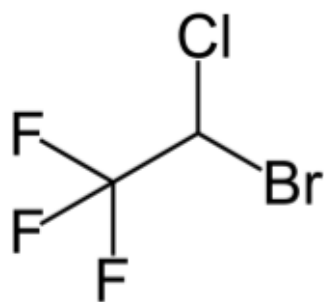
- Step 3: determine the appropriate prefixes to represent halogens
 - 2 = di
 - 3 = tri
 - 4 tetra
- Step 4: Communicate where each halogen atom appears in parent chain.
 - * if more than 1 halogen appears place in alphabetical order

Example

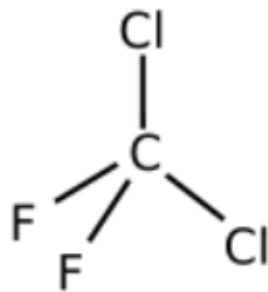


2-bromopropane

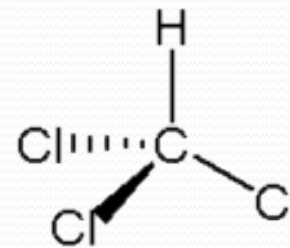
Examples of Alkyl Halides



halothane
(an inhaled anesthetic)



Dichlorodifluoromethane
(CFC-12)



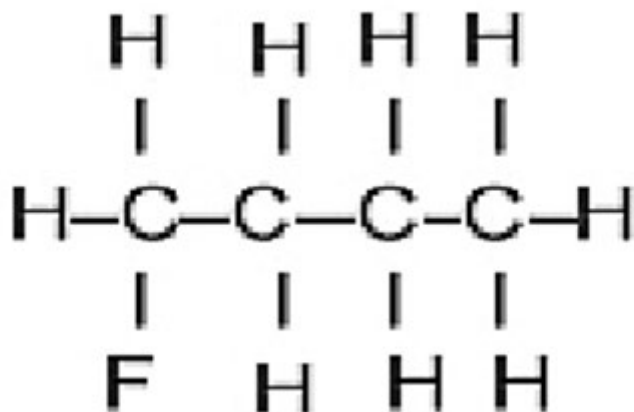
Chloroform



Chloroform

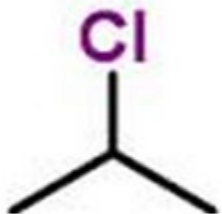


Board Question



1-florobutane

Board Question



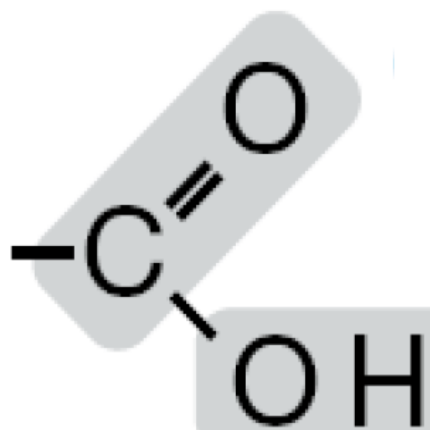
2-chloropropane

draw

- 1,2-dichloro-1-fluoroethane

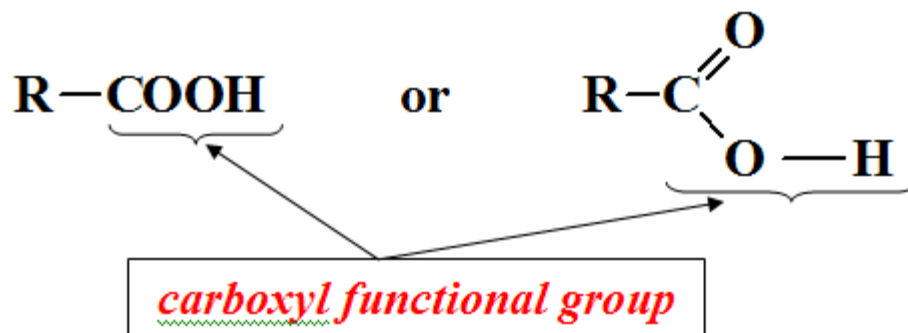
Carboxyl functional group

Carboxyl Functional Group



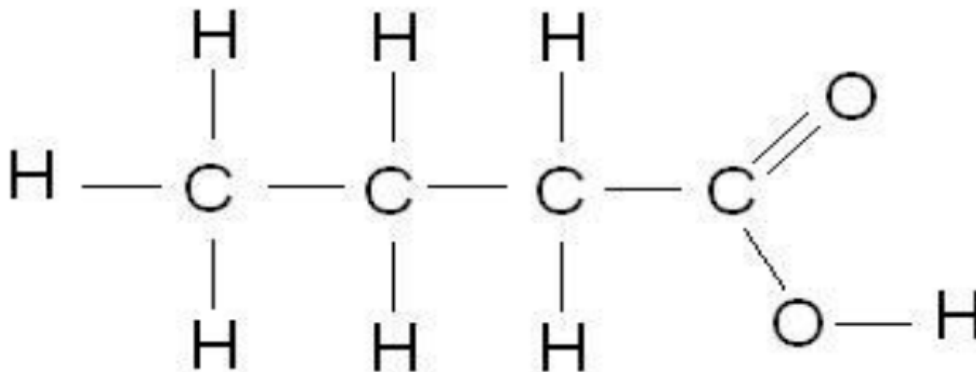
Carboxylic Acids

- There are two classifications of acids, **inorganic and organic or carboxylic acids**.
- Inorganic acids include species such as $\text{HCl}_{(\text{aq})}$, $\text{HF}_{(\text{aq})}$ and $\text{H}_2\text{SO}_{4(\text{aq})}$
- Organic acids are differentiated by the presence of a **carboxyl functional group** and a general formula can be expressed as $\text{R} - \text{COOH}$
- The carboxyl functional group really looks like the structure below:



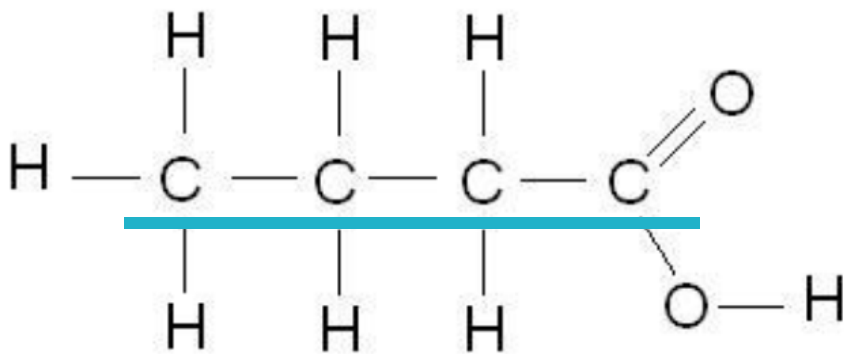
Naming carboxyl acids

- R-**COOH** indicates the acid functional group in formulas
- Name of parent chain is changed to **-oic acid**



Naming Carboxylic Acids

- Carboxylic acids are named by determining the alkane parent name by counting the number of carbons, including the carboxyl group, then dropping the “e” and adding “oic acid” at the end.
- Carbon #1 is always the carbon in the carboxyl functional group.



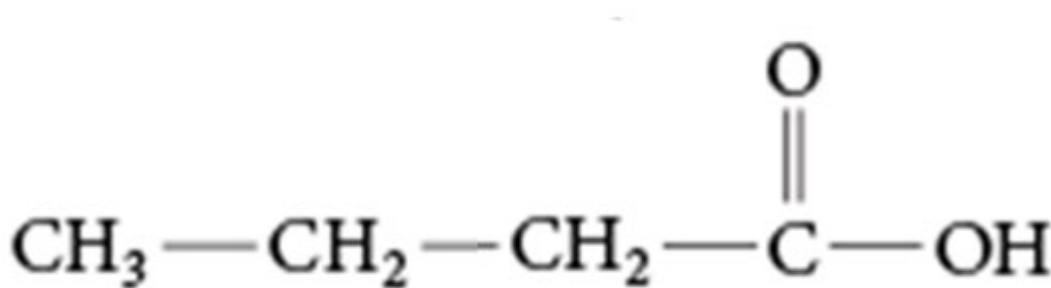
4 c = butane
Full name:
butanoic acid

Examples

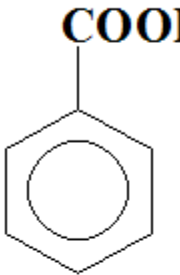
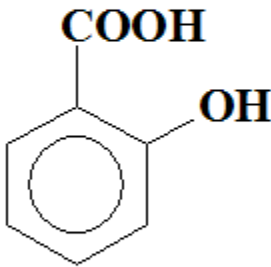
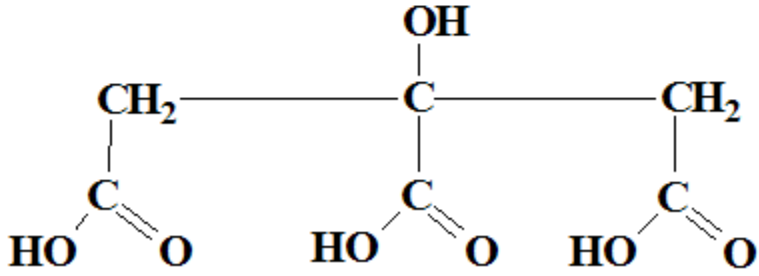
- HCOOH
- Methanoic acid

- $\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$ or $\text{CH}_3(\text{CH}_2)_2\text{COOH}$
- Butanoic acid

Board Question

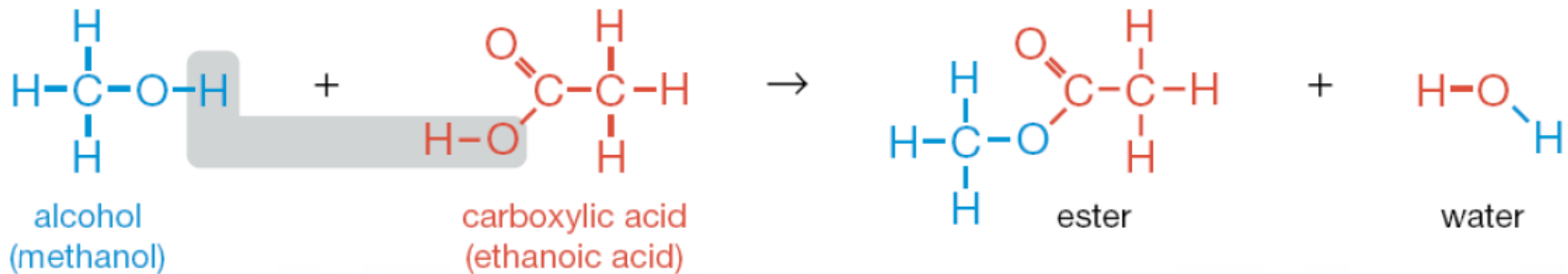


Butanoic acid

Name	Structural Formula	Uses
<ul style="list-style-type: none"> <i>benzoic acid</i> <i>benzene carboxylic acid</i> 		<ul style="list-style-type: none"> <i>food preservatives</i> <i>several perfumes</i>
<ul style="list-style-type: none"> <i>2-hydroxybenzoic acid</i> 		<ul style="list-style-type: none"> <i>food preservatives</i> <i>dyes and medicinals</i>
		<ul style="list-style-type: none"> <i>in citrus fruits</i> <i>tart flavour in soft drinks and sherbet</i> <i>as a blood coagulant</i> <i>in Alka-Seltzer™</i>

Esters

- Esters are formed through the reaction between an organic acid and an alcohol, in a reaction called **esterification**.
- The products of this reaction are an **ester and water**.



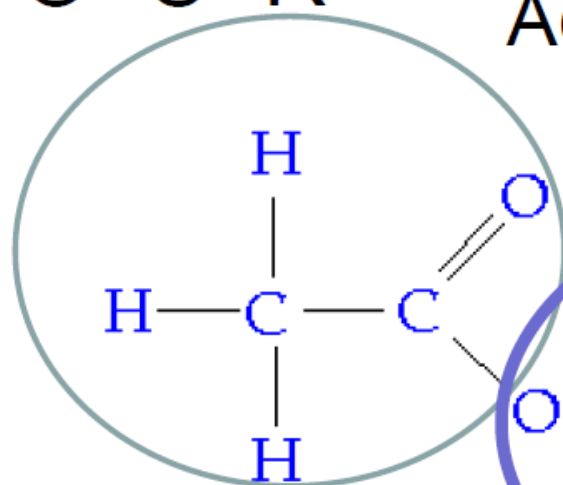
The reaction above is called an ***ESTERIFICATION REACTION***

- Esters are 2 carbon chains joined by an oxygen atom

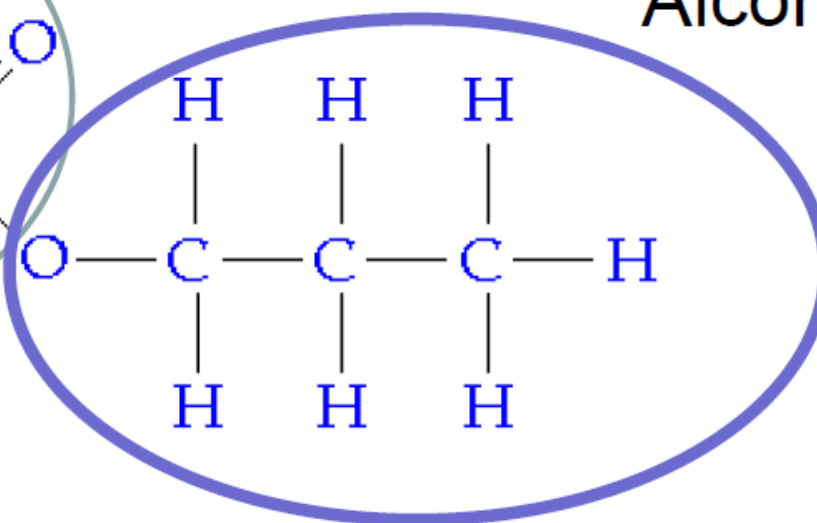


- $\text{R}-\text{O}-\text{C}-\text{R}'$

Acid part

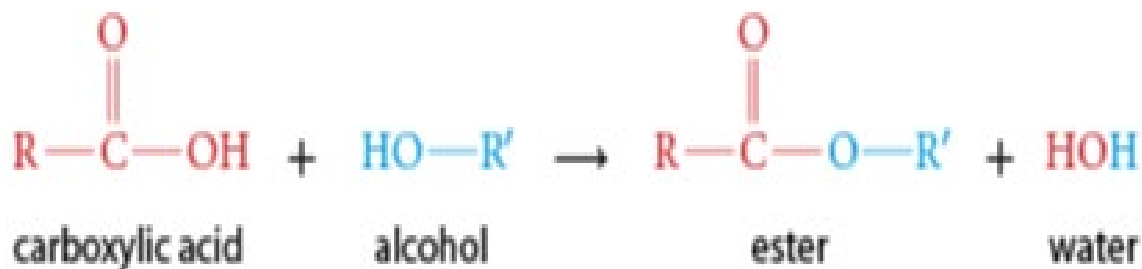
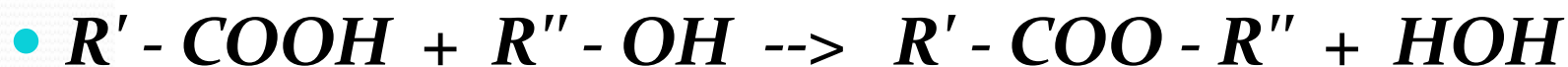


Alcohol part



- During this esterification, a hydroxyl is removed from the carboxyl group of the organic acid and a hydrogen is removed from the hydroxyl group of the alcohol. They form to make the water.

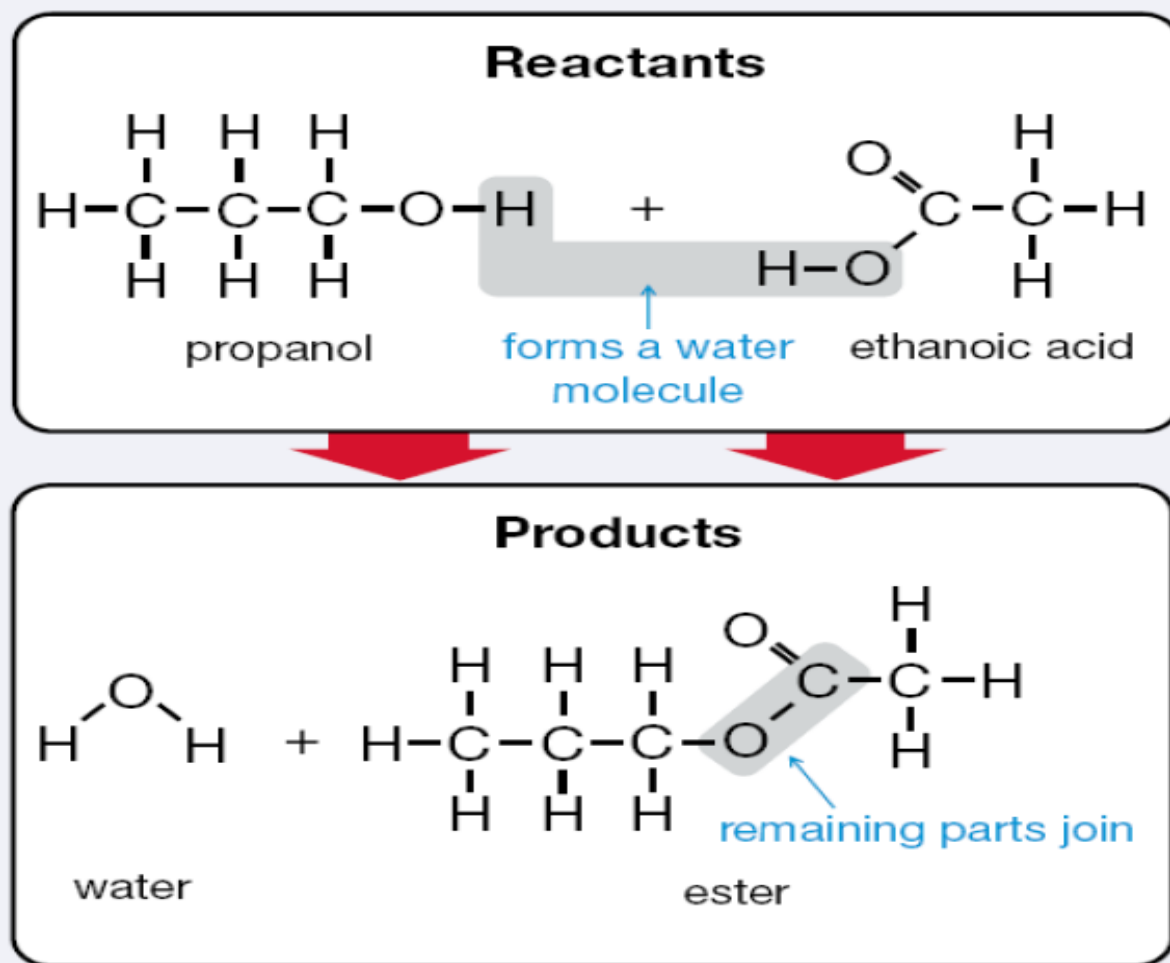
- General equation can be expressed as follows:



Example Problem 2.8

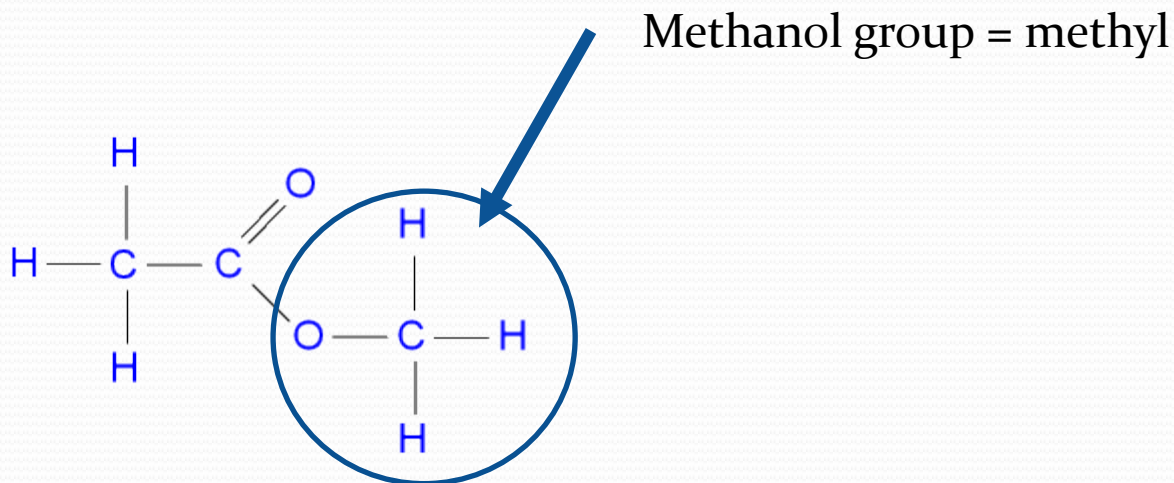
A chemical reaction occurs between propanol and ethanoic acid. Use a structural diagram to show the reactants and products for this reaction.

Solution

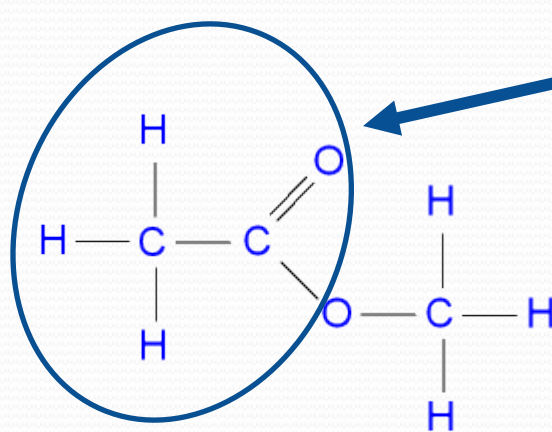


How to name newly formed Esters

- To name the ester that is formed we take the alcohol name and place it down first, giving an alkyl name to it, as derived from the alcohol used.

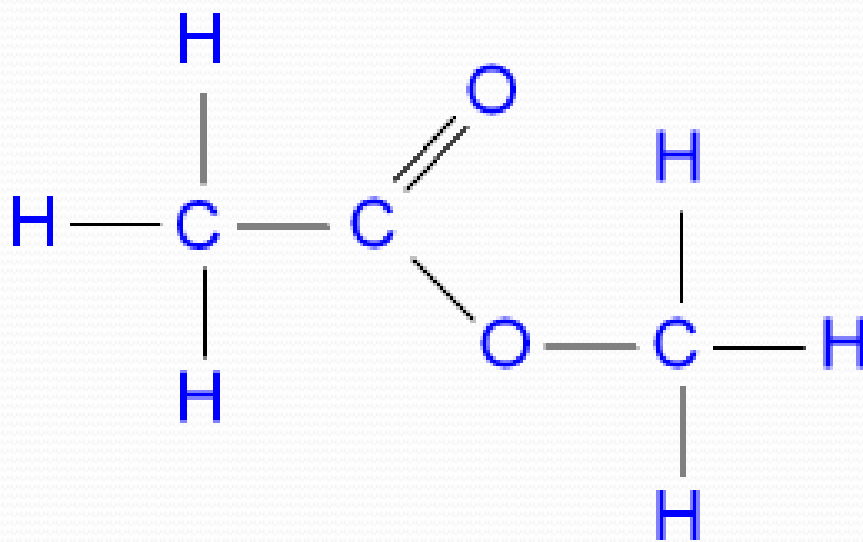


- Next, we use the acid name as the parent name for the last part. We drop the “oic acid” and insert “oate” at the end.



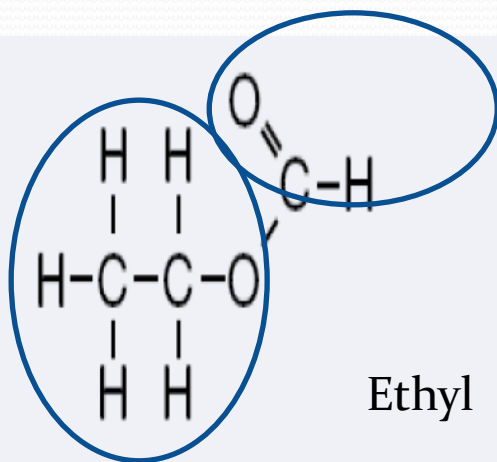
Ethanoic acid
becomes ethanoate

- Full name: methyl ethanoate
 - (note: 2 words).

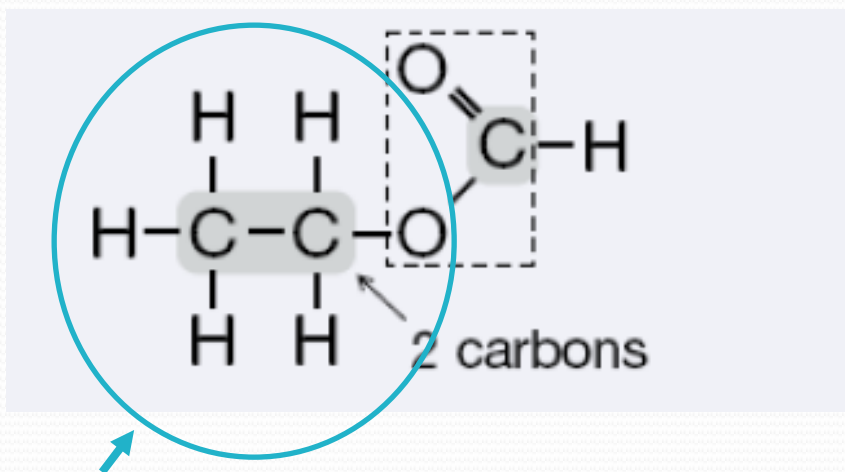


- The ester depicted here produces an aroma similar to that of raspberries. Write the systematic name for this ester

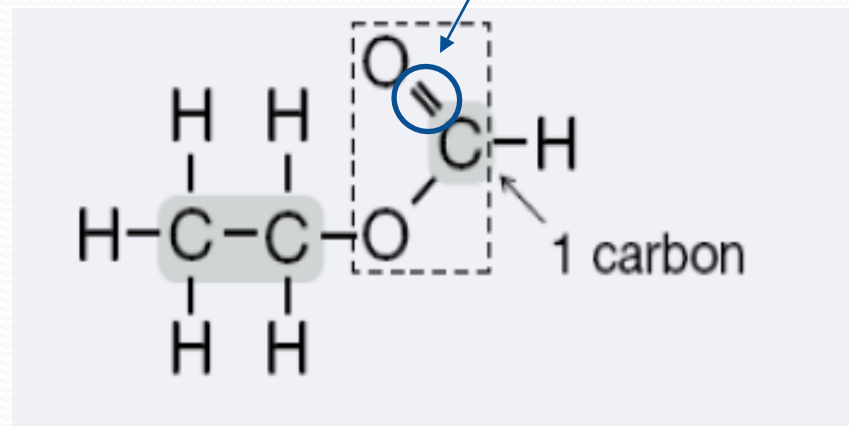
Ethyl methanoate



methanoate



alcohol Ethanol becomes ethyl



1 carbon = methan-

Add suffix oate for ester

Full name: Ethyl methanoate

How to name newly formed Esters

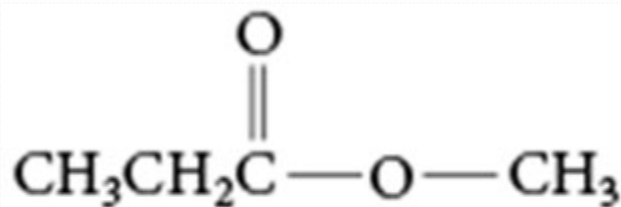
Practicing forming esters:

ethanoic acid + methanol \rightarrow methyl ethanoate + water

Examples

- methanoic acid + ethanol

Example



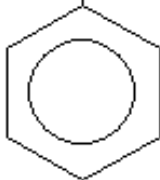
- **Memory Technique:** Name the oxygen with single bond first and the oxygen with the double bond second

Board Question

- ethanoic acid + pentan-1-ol

Board Question

1102213

Name	Structural Formula	Sources or Uses
ethyl methanoate	$\begin{array}{c} \text{O} \\ \parallel \\ \text{H}-\text{C}-\text{O}-\text{CH}_2-\text{CH}_3 \end{array}$	<ul style="list-style-type: none"> <i>rum flavour and odor</i>
ethyl ethanoate	$\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{C}-\text{O}-\text{CH}_2-\text{CH}_3 \end{array}$	<ul style="list-style-type: none"> <i>fingernail polish remover</i>
pentyl propanoate	$\begin{array}{c} \text{O} \\ \parallel \\ \text{C}_2\text{H}_5-\text{C}-\text{O}-\text{C}_5\text{H}_{11} \end{array}$	<ul style="list-style-type: none"> <i>apricot flavour and odor</i>
ethyl butanoate	$\begin{array}{c} \text{O} \\ \parallel \\ \text{C}_3\text{H}_7-\text{C}-\text{O}-\text{C}_2\text{H}_5 \end{array}$	<ul style="list-style-type: none"> <i>artificial peach and pineapple flavour</i>
<u>octyl ethanoate</u>	$\begin{array}{c} \text{O} \\ \parallel \\ \text{CH}_3-\text{C}-\text{O}-\text{C}_8\text{H}_{17} \end{array}$	<ul style="list-style-type: none"> <i>orange flavour and odor</i>
ethyl benzoate	$\begin{array}{c} \text{COOC}_2\text{H}_5 \\ \\ \text{C}_6\text{H}_5 \end{array}$ 	<ul style="list-style-type: none"> <i>cherry flavour and odor</i>