

identify the IUPAC nomenclature for describing the esters produced by reactions of straight-chained alkanoic acids from C1 to C8 and straight-chained primary alkanols from C1 to C8

The naming of esters follows a straight forward pattern using IUPAC nomenclature.

The table below will give you a start. Copy it and attempt to complete it.

Alkanol	Alkanoic acids							
	methanoic acid	ethanoic acid	propanoic acid	butanoic acid	pentanoic acid	hexanoic acid	heptanoic acid	octanoic acid
methanol	methyl methanoate	methyl ethanoate	methyl propanoate		methyl pentanoate			methyl octanoate
ethanol	ethyl methanoate							
propanol	propyl methanoate							
butanol	butyl methanoate		butyl propanoate					
pentanol								
hexanol			hexyl propanoate					
heptanol								
octanol				octyl butanoate				octyl octanoate

There is no need to learn all the ester names. Just remember the naming pattern you used.

Did you note that the alkanol always forms the first part of the ester's name having its ending changed from '...anol' to '...yl' and the alkanoic acid forms the second part of the ester's IUPAC name with its ending changing from '...oic acid' to '... oate'?

Source: HSC Online

Carboxylic Acid Derivatives

The strong-smelling compounds you prepared in Investigation 10-A do not fit into any of the organic families you have studied so far. According to their molecular formulas, however, they are isomers of carboxylic acids. They are *esters*. Because an ester is obtained by replacing the —OH group of a carboxylic acid with a different group, it is called a **derivative** of a carboxylic acid. Carboxylic acids have several important derivatives. Later in this section, you will study two of these derivatives: esters and amides.

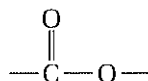
As you saw in the investigation, a carboxylic acid reacts with an alcohol to produce an ester. Water is the second product of this reaction. A strong acid, such as H_2SO_4 , is used to catalyze (speed up) the reaction. The reverse reaction can also occur, as you will see later in this section.



The reaction of a carboxylic acid with an alcohol to form an ester is called an **esterification reaction**. An esterification reaction is one type of condensation reaction.

Esters

An **ester** is an organic compound that has the following functional group:



The general formula for an ester is RCOOR' , where R is a hydrogen atom or a hydrocarbon, and R' is a hydrocarbon. You can think of an ester as the product of a reaction between a carboxylic acid and an alcohol, as shown in Figure 10.22.

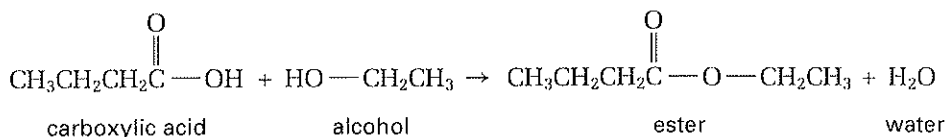


Figure 10.22 When heated, butanoic acid reacts with ethanol to produce an ester called ethyl butanoate.


To name an ester, you must recognize that an ester can be thought of as having two distinct parts. The main part of the ester contains the —COO group. When numbering the main chain of a carboxylic acid, the carbon atom in the carboxyl group is always given position number 1. The second part of an ester is the alkyl group.

To name an ester, follow the steps below.

How to Name an Ester

Step 1 Identify the main part of the ester, which contains the $\text{C}=\text{O}$ group. This part comes from the parent acid. Begin by naming the parent acid.

Step 2 Replace the *-oic acid* ending of the name of the parent acid with *-oate*.

 **PROBEWARE**

www.mcgrawhill.ca/links/atlchemistry

If you have access to probeware, go to the website above for a probeware activity covering some of the material in this section.

Step 3 The second part of an ester is the alkyl group that is attached to the oxygen atom. Name this as you would name any other alkyl group.

Step 4 Put the two names together. Note that esters are named as two words. (See Figure 10.23.)

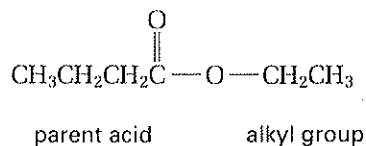


Figure 10.23 The main part of this molecule is based on butanoic acid. The other part of the ester is an ethyl group. The full name is ethyl- + -butanoate → ethyl butanoate

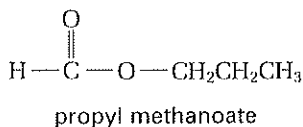
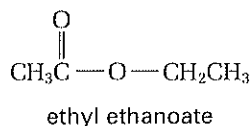
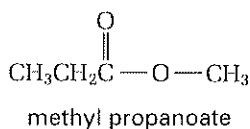
Sample Problem

Naming and Drawing Esters

Problem

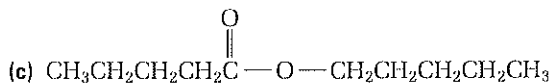
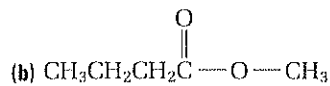
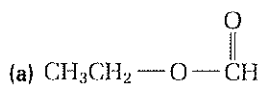
Name and draw three esters that have the molecular formula $\text{C}_4\text{H}_8\text{O}_2$.

Solution



Practice Problems

36. Name each ester.



37. For each ester in the previous question, name the carboxylic acid and the alcohol that are needed to synthesize it.

38. Draw each ester.

(a) methyl pentanoate

(d) propyl octanoate

(b) heptyl methanoate

(e) ethyl 3,3-dimethylbutanoate

(c) butyl ethanoate

Continued

Continued...

39. Write the molecular formula of each ester in the previous question. Which esters are isomers of each other?
40. Draw and name five ester isomers that have the molecular formula $C_5H_{10}O_2$.

Table 10.8, below, describes some of the physical properties of esters. As you will see, esters have different physical properties than carboxylic acids, even though esters and carboxylic acids are isomers of each other.

Table 10.8 Physical Properties of Esters

Polarity of functional group	Like carboxylic acids, esters are usually polar molecules.
Hydrogen bonding	Esters do not have an O–H bond. Therefore, they cannot form hydrogen bonds with other ester molecules.
Solubility in water	Esters can accept hydrogen bonds from water. Therefore, esters with very low molecular masses are soluble in water. Esters with carbon chains that are longer than three or four carbons are not soluble in water.
Melting and boiling points	Because esters cannot form hydrogen bonds, they have low boiling points. They are usually volatile liquids at room temperature.

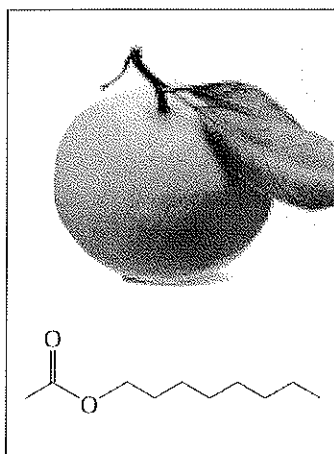


Figure 10.24 Octyl ethanoate is found in oranges.

Additional Characteristics of Esters

- Esters often have pleasant odours and tastes, so they are used to produce perfumes and artificial flavours. In fact, the characteristic tastes and smells of many fruits come from esters. (See Figure 10.24.)

Reactions of Esters

Esters undergo hydrolysis reactions. In a hydrolysis reaction, the ester bond is *cleaved*, or split in two, to form two products. Acid hydrolysis of an ester is the reverse of an esterification reaction: it produces a carboxylic acid and an alcohol. Hydrolysis usually requires heat. There are two methods of hydrolysis: acidic hydrolysis and basic hydrolysis. Both methods are shown in Figure 10.25. Soap is made by the basic hydrolysis of ester bonds in vegetable oils or animal fats.

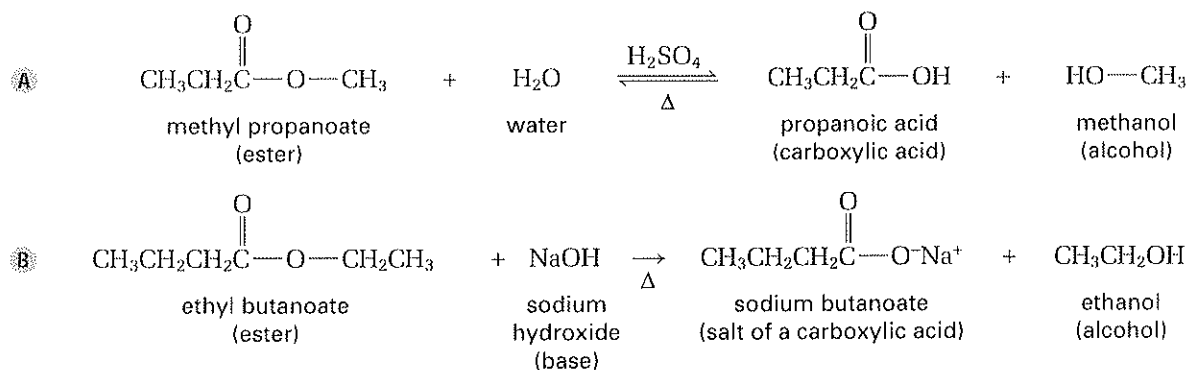


Figure 10.25 (A) The acidic hydrolysis of an ester produces a carboxylic acid and an alcohol. (B) The basic hydrolysis of an ester produces the salt of a carboxylic acid and an alcohol. To name the salt, place the name of the cation first (e.g., sodium) then follow it with the root and ending of the acid as if you were naming an ester.