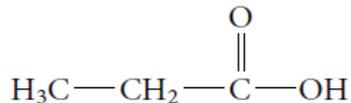


Naming and Drawing Carboxylic Acids (Student textbook page 61)

116. Name the following carboxylic acid.



What Is Required?

You must name a carboxylic acid.

What Is Given?

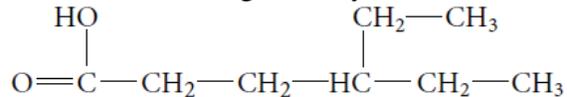
You are given the structure.

Plan Your Strategy	Act on Your Strategy
Identify the root.	The longest carbon chain that includes the carbonyl group is 3 carbon atoms long and has only single bonds. The root is propan-.
Identify the suffix.	The compound is a carboxylic acid, so the suffix is -oic acid.
Identify the prefix.	There are no side groups.
Name the compound.	propanoic acid

Check Your Solution

The compound is a carboxylic acid. The length of the carbon chain and position of the carboxyl group agree with the structure.

117. Name the following carboxylic acid.



What Is Required?

You must name a carboxylic acid.

What Is Given?

You are given the structure.

Plan Your Strategy	Act on Your Strategy
Identify the root.	The longest carbon chain that includes the carbonyl group is 6 carbon atoms long and has only single bonds. The root is hexan-.
Identify the suffix.	The compound is a carboxylic acid, so the suffix is -oic acid.
Identify the prefix.	There is an ethyl group on carbon atom 4, so the prefix is 4-ethyl.
Name the compound.	4-ethylhexanoic acid

Check Your Solution

The compound is a carboxylic acid. The length of the carbon chain, position of the carboxyl group, and the name and position of the side group agree with the structure.

118. Draw the condensed structural formula for the following carboxylic acid.
butanoic acid (common name: butyric acid)

What Is Required?

You must draw a condensed structural formula for the carboxylic acid.

What Is Given?

You are given the name.

Plan Your Strategy	Act on Your Strategy
Identify the root and draw and number the carbon chain.	The root is butan-, so the main carbon chain has four carbon atoms with only single bonds. $\begin{array}{cccc} \text{C} & - & \text{C} & - & \text{C} & - & \text{C} \\ 4 & & 3 & & 2 & & 1 \end{array}$
Identify the suffix. Add the necessary atoms to the structure and number the carbon atoms.	The suffix is -oic acid, so it is a carboxylic acid. Add a double bonded oxygen atom and a hydroxyl group to the carbon atom at the end. The carbonyl carbon atom is always number 1. $\begin{array}{ccccccc} & & & & \text{O} & & \\ & & & & & & \\ \text{C} & - & \text{C} & - & \text{C} & - & \text{C} & - & \text{OH} \\ 4 & & 3 & & 2 & & 1 & & \end{array}$
Identify the prefix.	There is no prefix so there are no side groups.
Add enough hydrogen atoms to give each carbon atom a total of four bonds.	$\begin{array}{ccccccc} & & & & \text{O} & & \\ & & & & & & \\ \text{H}_3\text{C} & - & \text{CH}_2 & - & \text{CH}_2 & - & \text{C} & - & \text{OH} \\ 4 & & 3 & & 2 & & 1 & & \end{array}$

Check Your Solution

The compound is a carboxylic acid. The length of the main chain and the position of the carbonyl carbon agree with the name.

119. Draw the condensed structural formula for the following carboxylic acid.
4-ethyloctanoic acid

What Is Required?

You must draw a condensed structural formula for a carboxylic acid.

What Is Given?

You are given the name.

Plan Your Strategy	Act on Your Strategy
Identify the root and draw and number the carbon chain.	<p>The root is octan-, so the main carbon chain has eight carbon atoms.</p> $\begin{array}{cccccccc} \text{C} & - & \text{C} \\ 1 & & 2 & & 3 & & 4 & & 5 & & 6 & & 7 & & 8 \end{array}$
Identify the suffix. Add the necessary atoms to the structure.	<p>The suffix is -oic acid, so it is a carboxylic acid. Add a double-bonded oxygen atom and a hydroxyl group to carbon atom number 1.</p> $\begin{array}{cccccccc} \text{HO} & & 1 & & 2 & & 3 & & 4 & & 5 & & 6 & & 7 & & 8 \\ & & \text{C} & - & \text{C} \\ & & \parallel & & & & & & & & & & & & & & \\ & & \text{O} & & & & & & & & & & & & & & \end{array}$
Identify the prefix.	<p>The prefix is 4-ethyl, so there is an ethyl group on carbon atom 4.</p> $\begin{array}{cccccccc} & & & & \text{CH}_2 & - & \text{CH}_3 & & & & & & & & & & \\ & & & & & & & & & & & & & & & & \\ \text{HO} & & 1 & & 2 & & 3 & & 4 & & 5 & & 6 & & 7 & & 8 \\ & & \text{C} & - & \text{C} \\ & & \parallel & & & & & & & & & & & & & & \\ & & \text{O} & & & & & & & & & & & & & & \end{array}$
Add enough hydrogen atoms to give each carbon atom a total of four bonds.	$\begin{array}{cccccccc} & & & & \text{CH}_2 & - & \text{CH}_3 & & & & & & & & & & \\ & & & & & & & & & & & & & & & & \\ \text{HO} & & 1 & & 2 & & 3 & & 4 & & 5 & & 6 & & 7 & & 8 \\ & & \text{C} & - & \text{CH}_2 & - & \text{CH}_2 & - & \text{HC} & - & \text{CH}_2 & - & \text{CH}_2 & - & \text{CH}_2 & - & \text{CH}_3 \\ & & \parallel & & & & & & & & & & & & & & \\ & & \text{O} & & & & & & & & & & & & & & \end{array}$

Check Your Solution

The compound is a carboxylic acid. The length of the main chain, the position of the carboxyl group, and the position of the side group agree with the name.

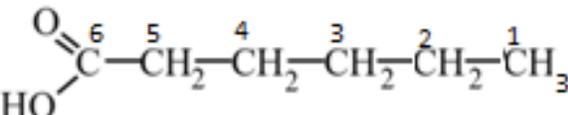
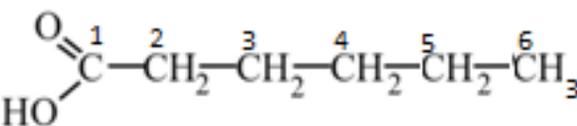
122. Explain why the following carboxylic acid is named incorrectly or cannot exist. If it can exist, give the proper name.
hexan-6-oic acid

What Is Required?

You must explain how the carboxylic acid is named incorrectly and then name it correctly or explain why it cannot exist.

What Is Given?

You are given the name of a carboxylic acid.

Plan Your Strategy	Act on Your Strategy
Draw the structure and number it according to the name.	
Identify any errors.	The carboxyl carbon is always given the number 1. The suffix should not include a number for the carboxyl carbon because it is always number one. (A dicarboxylic acid will have a carboxyl group at both ends of the chain.)
Number the structure correctly.	Number the structure to give the carboxyl carbon the number 1.  The original name incorrectly numbered the structure.
Name the structure correctly.	The root is still hexan-, and the suffix is -oic acid. The name is hexanoic acid.

Check Your Solution

The carboxyl carbon now has the lowest numbering, and the name agrees with the structure.

123. Explain why the following carboxylic acid is named incorrectly or cannot exist. If it can exist, give the proper name.
butan-2-oic acid

What Is Required?

You must explain how the carboxylic acid is named incorrectly and then name it correctly or explain why it cannot exist.

What Is Given?

You are given the name of a carboxylic acid.

Plan Your Strategy	Act on Your Strategy
Draw the structure and number it according to the name.	$ \begin{array}{ccccccc} & & \text{O} & & & & \\ & & & & & & \\ \text{CH}_3 & - & \text{C} & - & \text{CH}_2 & - & \text{CH}_3 \\ 1 & & 2 & & 3 & & 4 \\ & & & & & & \\ & & \text{OH} & & & & \end{array} $
Identify any errors.	If you try to put the carboxyl carbon in the middle of the chain, it would have five bonds which is not possible.
Explain why the structure is not possible.	In this structure, carbon atom 2 has 5 bonds, but carbon can only have 4 bonds. This is the reason that the carboxylic acid group must always be on the end of a carbon chain. Therefore, this structure cannot exist.

Check Your Solution

This structure cannot exist because the carboxylic acid group must always be on the end of the carbon chain and a carbon atom can only form 4 bonds.

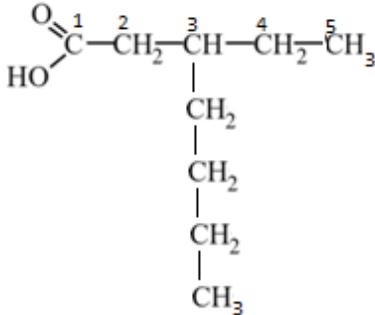
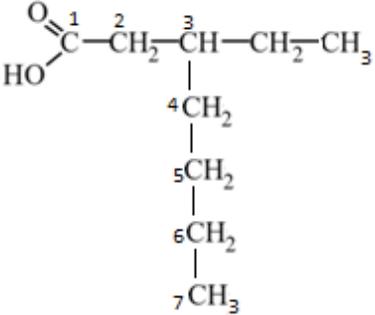
124. Explain why the following carboxylic acid is named incorrectly or cannot exist. If it can exist, give the proper name.
3-butylpentanoic acid

What Is Required?

You must explain how the carboxylic acid is named incorrectly and then name it correctly or explain why it cannot exist.

What Is Given?

You are given the name of a carboxylic acid.

Plan Your Strategy	Act on Your Strategy
Draw the structure and number it according to the name.	
Identify any errors.	The main chain was not identified correctly. It has to be the longest chain that includes the carboxyl group.
Number the structure correctly.	<p>Number the structure so the main chain has the longest carbon chain in the structure and starts at the carboxyl carbon.</p>  <p>The name given did not use the longest chain as the main chain.</p>
Name the structure correctly.	The main chain has 7 carbon atoms, so the root is heptan-. The structure is a carboxylic acid so the suffix is -oic acid. There is an ethyl group on carbon atom 3, so the prefix is 3-ethyl. The correct name is 3-ethylheptanoic acid.

Check Your Solution

The name now includes the longest carbon chain as the main chain, and the side group agrees with the name.

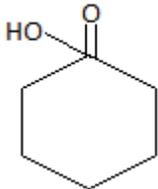
125. Explain why the following carboxylic acid is named incorrectly or cannot exist. If it can exist, give the proper name.
cyclohexanoic acid

What Is Required?

You must explain how the carboxylic acid is named incorrectly and then name it correctly or explain why it cannot exist.

What Is Given?

You are given the name of a carboxylic acid.

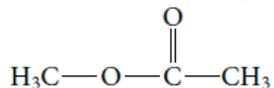
Plan Your Strategy	Act on Your Strategy
Draw the structure.	
Explain why the structure is not possible.	In this structure, the carboxylic acid would have 5 bonds, but carbon atoms can only have 4 bonds. Therefore, this structure cannot exist.

Check Your Solution

The structure cannot exist because carbon can only form four bonds and, therefore, a carboxylic acid cannot exist inside a cyclic hydrocarbon.

Naming and Drawing Esters
(Student textbook page 65)

126. Name the following ester.



What Is Required?

You must name an ester.

What Is Given?

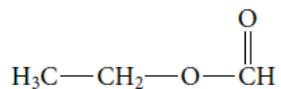
You are given the structure.

Plan Your Strategy	Act on Your Strategy
Identify the root.	<p>The carbonyl carbon atom ($>\text{C}=\text{O}$) is part of a two-carbon group.</p> $\text{H}_3\text{C}-\text{O}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$ <p>Thus, the parent acid is ethanoic acid. The root is ethan-.</p>
Identify the suffix.	<p>The compound is an ester, so the suffix is -oate.</p>
Identify the prefix.	<p>The prefix is the name of the alkyl group derived from the parent alcohol. It has one carbon atom, so it is a methyl group. The prefix is methyl-.</p> $\text{H}_3\text{C}-\text{O}-\overset{\text{O}}{\parallel}{\text{C}}-\text{CH}_3$
Write the name.	methylethanoate

Check Your Solution

The compound is an ester. The length of the chain and the alkyl group in the name correctly represent the structure.

127. Name the following ester.



What Is Required?

You must name an ester.

What Is Given?

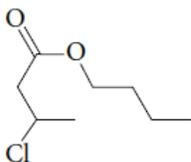
You are given the structure.

Plan Your Strategy	Act on Your Strategy
Identify the root.	The $>\text{C}=\text{O}$ carbon atom is part of a one-carbon group. $\text{H}_3\text{C}-\text{CH}_2-\text{O}-\overset{\text{O}}{\parallel}{\text{C}}\text{H}$ Thus, the parent acid is methanoic acid. The root is methan-.
Identify the suffix.	The compound is an ester, so the suffix is -oate.
Identify the prefix.	The prefix is the name of the alkyl group derived from the parent alcohol. It has two carbon atoms, so it is an ethyl group. The prefix is ethyl. $\text{H}_3\text{C}-\text{CH}_2-\text{O}-\overset{\text{O}}{\parallel}{\text{C}}\text{H}$
Write the name.	ethylmethanoate

Check Your Solution

The compound is an ester. The length of the chain and the alkyl group in the name correctly represent the structure.

128. Name the following ester.

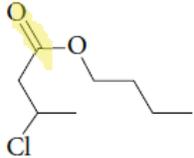
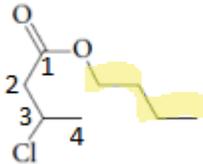


What Is Required?

You must name the ester.

What Is Given?

You are given the structure.

Plan Your Strategy	Act on Your Strategy
Identify the root.	<p>The $>C=O$ carbon atom is part of a four-carbon group.</p>  <p>Thus, the parent acid is butanoic acid. The root is butan-.</p>
Identify the suffix.	<p>The compound is an ester, so the suffix is -oate.</p>
Identify the prefix.	<p>The prefix has two parts. The first part is based on the name of the alkyl group derived from the parent alcohol. It has four carbon atoms, so it is a butyl group. The prefix is butyl-.</p>  <p>The second part of the prefix is based on the chlorine atom on the main carbon chain on the carbon 3 atom main chain. Thus, the second part of the prefix is 3-chloro-. The prefix is butyl-3-chloro-.</p>
Write the name.	butyl 3-chlorobutanoate

Check Your Solution

The compound is an ester. The length of the chain, the alkyl group, and the side group on the main chain in the name correctly represent the structure.

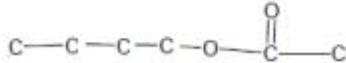
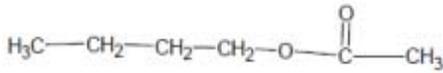
129. Draw the condensed structural formula for the following ester.
butyl ethanoate

What Is Required?

You must draw a condensed structural formula.

What Is Given?

You are given a name.

Plan Your Strategy	Act on Your Strategy
Identify the root.	The root is ethan-, so the main carbon chain has two carbon atoms.
Identify the suffix. Draw the basic structure described by the root and the suffix.	The suffix is -oate, so the compound is an ester and related to ethanoic acid. This means that the carbon atom on the end of the main chain is a carbonyl carbon. 
Identify the prefix. Draw the basic part of the structure described by the prefix.	The prefix is butyl, which is related to the alcohol, butanol. Thus the second part of the structure has four carbon atoms bonded, through an oxygen atom, to the carbonyl carbon of the main chain. 
Add enough hydrogen atoms to give each carbon atom a total of four bonds.	

Check Your Solution

If the ester bond was broken by the insertion of water, the products would be ethanoic acid and butanol. This is in agreement with the name.

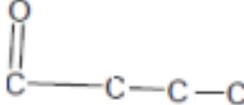
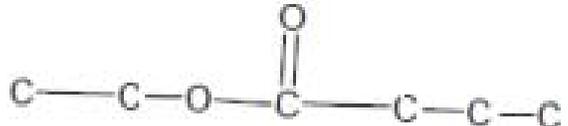
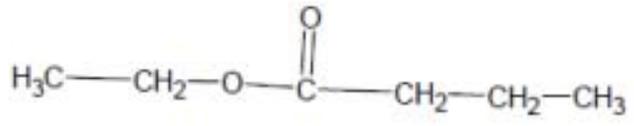
130. Draw the condensed structural formula for the following ester.
ethyl butanoate

What Is Required?

You must draw a condensed structural formula of an ester.

What Is Given?

You are given a name.

Plan Your Strategy	Act on Your Strategy
Identify the root.	The root is butan-, so the carbon chain has four carbon atoms.
Identify the suffix. Draw the basic structure described by the root and the suffix.	<p>The suffix is -oate, so the compound is an ester and related to butanoic acid. This means that the carbon atom on the end of the main chain is a carbonyl carbon.</p> 
Identify the prefix. Draw the basic part of the structure described by the prefix.	<p>The prefix is ethyl-, which is related to the alcohol, ethanol. Thus the second part of the structure has two carbon atoms bonded through an oxygen atom, to the carbonyl carbon of the main chain.</p> 
Add enough hydrogen atoms to give each carbon atom a total of four bonds.	

Check Your Solution

If the ester bond was broken by the insertion of water, the products would be butanoic acid and ethanol. This is in agreement with the name.

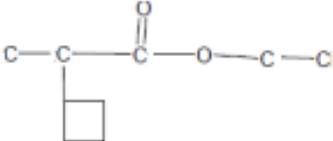
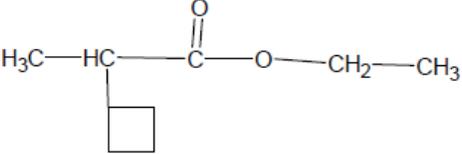
131. Draw the condensed structural formula for the following ester.
ethyl 2-cyclobutylpropanoate

What Is Required?

You must draw a condensed structural formula for an ester.

What Is Given?

You are given a name.

Plan Your Strategy	Act on Your Strategy
Identify the root.	The root is propan-, so the main carbon chain has three carbon atoms with only single bonds.
Identify the suffix. Draw the basic structure described by the root and the suffix.	The suffix is -oate, so the compound is an ester and related to propanoic acid. This means that the carbon atom on the end of the main chain is a carbonyl carbon. 
Identify the prefix. Draw the basic part of the structure described by the prefix.	The prefix is ethyl 2-cyclobutyl-, which is related to the alcohol, ethanol. Thus, the second part of the structure has two carbon atoms bonded, through an oxygen atom, to the carbonyl carbon of the main chain. The second part of the prefix is 2-cyclobutyl, so there is a cyclobutyl group on carbon atom 2. 
Add enough hydrogen atoms to give each carbon atom a total of four bonds.	

Check Your Solution

If the ester bond was broken by the insertion of water, the products would be 2-cyclobutylpropanoic acid and ethanol. This is in agreement with the name.

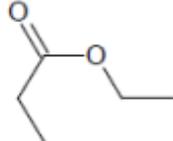
132. Draw the line structure of the ester formed from the following reaction.
propanoic acid and ethanol

What Is Required?

You must draw a line structure of an ester.

What Is Given?

You are given the name of the carboxylic acid and alcohol reactants.

Plan Your Strategy	Act on Your Strategy
Identify the root.	The root is related to the carboxylic acid, which is propanoic acid. The root is propan-, so the main carbon chain has three carbon atoms with only single bonds. 
Identify the suffix. Draw the structure described by the root and the suffix.	The compound is an ester, so the suffix is -oate and related to propanoic acid. This means that the carbon atom on the end of the main chain is a carbonyl carbon. 
Identify the prefix. Draw the structure described by the prefix.	The prefix is related to the alcohol, ethanol. The prefix is ethyl-. Thus the second part of the structure has two carbon atoms bonded, through an oxygen atom, to the carbonyl carbon of the main chain. 

Check Your Solution

When a carboxylic acid and alcohol react, an ester is formed. The carboxylic acid forms the chain with the carbonyl carbon, and the alcohol forms the chain bonded, through an oxygen atom, to the carbonyl carbon of the main chain.