1
Organic Chemistry

THE previous chapter have covered the chemical properties of what we call inorganic compounds. These are for example cooking salt (NaCl), water (H_2O) or ammonia (NH_3). This chapter covers organic compounds, which are chemicals based on carbon and hydrogen. We used organic compounds in the form of numerous materials such as fuels, perfumes, plastics or drugs. They all have common properties, from their smells to their powerful action. We will address first the naming of organic compounds as well as the properties of these important chemicals. Finally we will address the different groups of functional atoms that give unique properties to molecules such as caffeine or cocaine.

GOALS

1. Identify organic chemicals
2. Name linear hydrocarbons
3. Name cyclic hydrocarbons
4. Name hydrocarbons with substituents
5. Identify functional groups

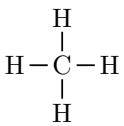
1.1 Alkanes

This first section will introduce organic chemistry, covering the most simple organic compounds: the alkanes. Alkanes simply contain carbon and hydrogen and are also called hydrocarbons. First you will be introduced to a few organic chemicals without paying to much attention to their names. Then, you will learn about a series of different organic formulas that can represent the same compound. Finally, you will learn the naming rule of alkanes, which basically extend to other–more complex–organic chemicals.

> Discussion: Think about any drug you have taken recently. Paste its structure and indicate at least one functional group in the molecule.

Identifying organic compounds How do we know when we have an organic or an inorganic chemical? Organic chemicals are based on carbon and hydrogen. They can contain other nonmetallic elements such as oxygen, nitrogen or sulfur. Here a few examples: CH_4, C_2H_6, C_6H_6 or CH_3COOH. Mind that carbonates (Na_2CO_3), carbon monoxide (CO) or carbon dioxide (CO_2) are not organic compounds.

Methane The simplest organic compound is methane: CH_4. Methane is a fuel and the main constituent of natural gas. Going back a few chapters, the Lewis structure of methane is:



Methane, CH_4

This structure is very representative in this chapter as it shows that each carbon atom has to be connected to four different atoms.

Table ?? Prefixed for alkane naming			
# Carbons	prefix	# Carbons	prefix
1	Meth	6	Hex
2	Eth	7	Hepta
3	Pro	8	Octa
4	But	9	Nona
5	Pent	10	Deca

▼Methane (CH_4) is used as a fuel for ovens, homes, water heaters.

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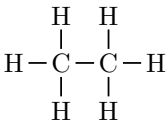
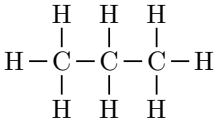
`Alkanes` Alkanes are simple organic compounds made of Carbon and Hydrogen with all carbons connected by means of simple bonds–these are single lines to represent the connections between atoms. The naming of alkanes results of adding a prefix to the sufix *ane*. The prefix depends on the number of carbons in the molecule. Table **??** shows a list of the different prefixes. For example, the alkane with one carbon is called methane. Another example of alkanes would be ethane that contains two carbons:



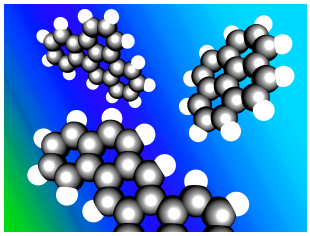
Ethane, C_2H_6

or propane:



Propane, C_3H_8

▼Hydrocarbons are made of carbon and hydrogen.



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`General formula for alkanes` At this point we saw two different alkanes: methane (CH_4), butane (C_2H_6) and propane (C_3H_8). The general formula for an alkane with n carbon atoms is:

$$C_nH_{2n+2} \tag{1.1}$$

As an example, the formula for methane ($n = 1$) is CH_4 and the formula for octane ($n = 8$) is C_8H_{18}.

▼The octane rating of gas is a standard measure of the performance of engine fuels, originally determined by mixing a gasoline made entirely of heptane and 2,2,4-trimethylpentane (a highly branched octane).

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Sample Problem 1

Write down the molecular formula for decane and pentane.

SOLUTION

Using Equation **??** we have that the molecular formula for decane ($n = 10$) would be: $C_{10}H_{22}$. Similarly, the molecular formula for pentane ($n = 5$) would be: C_5H_{12}.

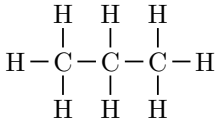
▶Answer: (decane) $C_{10}H_{22}$; (pentane) C_5H_{12}

STUDY CHECK

Name the alkane with formula C_7H_{16} and give the formula for nonane.

▶Answer: heptane, C_9H_{20}.

Alkanes contain CH_3 and CH_2 units Let us analyze the formula of propane. In this formula there are two different types of carbons. One is the end of the chain carbon, in the left and in the right. The other type of carbon is the central carbon. The extremes are bounded to three hydrogen, whereas the central is bounded to two hydrogens.



The extremes are indeed CH_3 units and the center is a CH_2 unit. So, another way to represent ethane would be:

$$CH_3 - CH_2 - CH_3 \qquad \text{Ethane, } C_2H_6$$

At this point you have seen three different ways to represent organic molecules. Let us use propane as an example. One is the *molecular formula*, which in the case of propane is C_3H_8. Another different way to represent propane is with its *expanded structural formula*, that is by representing all C and all H in the molecule. Another molecular representation is the *condensed structural formula*, that is by using CH_3 and CH_2 units. Here the three formulas:

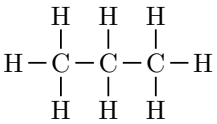
C_3H_8	$CH_3 - CH_2 - CH_3$	
molecular formula	condensed formula	expanded structural formula

Table ?? Alkane names based on the number of carbons in the chain

Number of Carbons	Prefix	Condensed Structural formula
1	Meth	CH_4
2	Eth	$CH_3 - CH_3$
3	Prop	$CH_3 - CH_2 - CH_3$
4	But	$CH_3 - CH_2 - CH_2 - CH_3$
5	Pent	$CH_3 - CH_2 - CH_2 - CH_2 - CH_3$
6	Hex	$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$
7	Hepta	$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$
8	Oct	$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$
9	Non	$CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_2 - CH_3$

Sample Problem 2

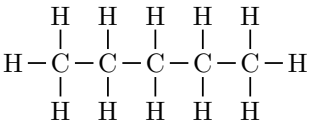
Write down the condensed and expanded formulas for pentane.

SOLUTION

Pentane has five carbons, hence its condensed formula will have two CH_3 units and three CH_2 units:

$$CH_3 - CH_2 - CH_2 - CH_2 - CH_3$$

The expanded formula for pentane would be:

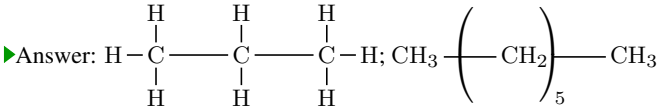


Expressing this in an abbreviated way, we have that the answer is also:

▶ Answer: $CH_3-\left(CH_2\right)_3-CH_3$

STUDY CHECK

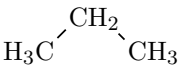
Write down the condensed and expanded formulas for heptane.

▶Answer:  ; $CH_3-\left(CH_2\right)_5-CH_3$

ZigZag Let us analyze the structure of propane again. This molecule has three carbons in the form of a C-C chain such as: C-C-C. However, C-C chains with more than more three carbons are not linear. So instead of representing propane as:

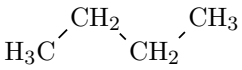
$$H_3C-CH_2-CH_3$$

we could represent this molecule by means of a zigzag:



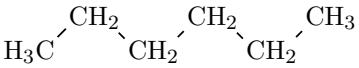
Propane, C_3H_8

Another example would be butane:



Butane, C_4H_{10}

Skeletal formula A final way to represent molecules in this chapter is simply using lines. This is called the skeletal formula, as you only represent the C-C skeleton of the molecule. Let us use hexane an an example. We can represent this molecule as in this two ways:



condensed formula

skeletal formula

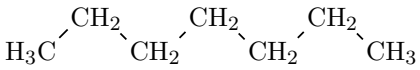
The ending of a skeletal formula represents a CH_3 and the points in between represents CH_2.

Sample Problem 3

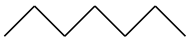
Write down the condensed and skeletal formulas for heptane.

SOLUTION

Heptane has seven carbons, hence its condensed formula will have two CH_3 units and five CH_2 units:



The skeletal formula for would be:

Answer: 

STUDY CHECK

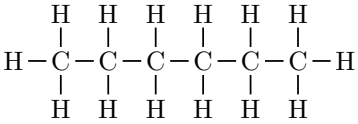
Draw the skeletal formula of decane.

Answer: 

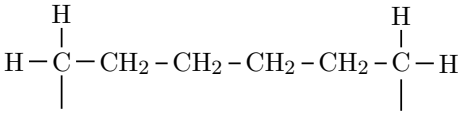
1.2 Cycloalkanes

This section deals with cyclic alkanes. Alkanes are perfect examples of hydrocarbons, with C-C chains and all carbon atoms saturates with hydrogen. Cycloalkanes are in essence alkanes that have a cyclic structure. We will cover the molecular, condensed and skeletal formulas for these chemicals.

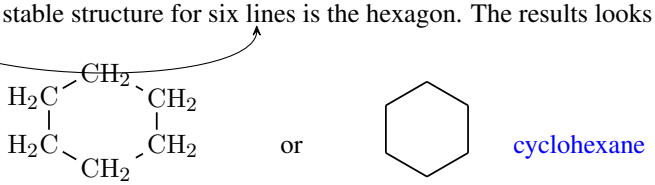
Cyclic alkanes Let us use the expanded estructure of hexane as an example.



A cycloalkane results of eliminating the left and right hydrogen and connecting the molecule in the form of a cycle:

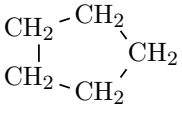


As the most stable structure for six lines is the hexagon. The results looks like



or cyclohexane

Naming cyloalkanes The naming of alkanes and cycloalkanes is very similar. You just need to add the cyclo prefix to the name. For example, the alkane with five carbons is called pentane. The corresponding cycloalkane is called cyclopentane:

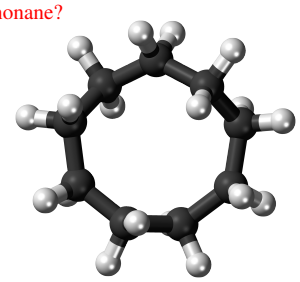


or  Cyclopentane

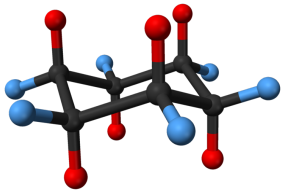
Sample Problem 4

Write down the condensed structure and name the following cycloalkane:

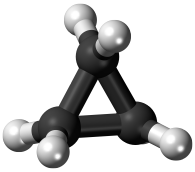
▼Cyclononane contains 9 carbons in a cycle.
Q: What is the molecular formula Cyclononane?



▼Cyclohexane has a chair shape.
Q: How many H are there in cyclohexane?

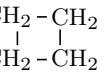


▼Cyclopropane has only three carbons and a lot tension in its cycle.
Q: Would cyclopropane be a stable of unstable molecule?



SOLUTION

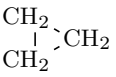
The cycloalkane has four carbons and its name is cylcobutane. Its condensed structure is



▶Answer: CH_2-CH_2 / CH_2-CH_2

STUDY CHECK

Write down the condensed structure and name the following cycloalkane:



▶Answer: cyclopropane, CH_2 / CH_2 / CH_2

General formula for cycloalkanes The general formula for an cycloalkane with n carbon atoms is:

$$C_nH_{2n} \tag{1.2}$$

As an example, the formula for cyclopropane ($n = 4$) is C_4H_8 and the formula for cyclooctane ($n = 8$) is C_8H_{16}.

Sample Problem 5

Write down the molecular formula for cyclodecane and cyclopentane.

SOLUTION

Using Equation **??** we have that the molecular formula for cyclodecane ($n = 10$) would be: $C_{10}H_{20}$. Similarly, the molecular formula for cyclopentane ($n = 5$) would be:

▶Answer: C_5H_{10}.

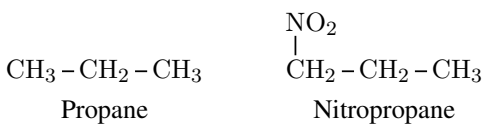
STUDY CHECK

Name the alkane with formula C_7H_{14} and give the formula for cyclononane.

▶Answer: cycloheptane, C_9H_{18}.

1.3 Alkanes with substituyents

At this point you should be familiar with alkanes. These organic compounds are carbon-based chemicals made of lines of C-C hydrocarbon chains. Often times these hydrocarbons have other groups of atoms attached to the hydrocarbon chains and these are called substituents. This section cover the naming of alkanes with substituents. Here an example of an alkane and an alkane with a substituent:



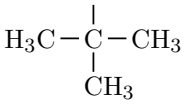
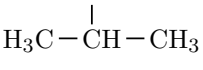
$CH_3-CH_2-CH_3$ — Propane

NO_2 / $CH_2-CH_2-CH_3$ — Nitropropane

Substituents There are many different substituents which can be found connected to an alkane chain. Their names are indicated in Figure 1.8. The easiest substituents are

halogens and atoms of chorine (Cl —), bromine (Br —) or iodine (I —) can connect to an alkane. The name of these substituents is chloro, bromo and iodo. Other substituents can contain carbon, like a methyl (CH_3 —) or a ethyl (CH_3CH_2 —). There are even more complex substituents such as tert-butyl

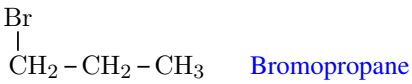
Table ?? Substituents name

Substituents	name	Substituents	name
CH_3 —	Methyl	F —	Fluoro
CH_3CH_2 —	Ethyl	Cl —	Chloro
$CH_3CH_2CH_2$ —	Propyl	Br —	Bromo
NH_2 —	Amino	I —	Iodo
NO_2 —	Nitro	$CH_2=CH$ —	Vinyl
	t-butyl		Isopropyl

Alkanes with a single substituent Let us consider the following example. The condensed formula for propane is

Propane

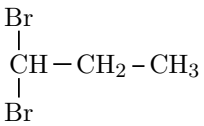
Now, this would be propane with a substituent:



Bromopropane

As you can see a bromine atom substitutes one of the hydrogen atoms of the second first of the molecule (starting from the left).

Alkanes with two or more equal substituents In the same way as when you have a single bromine atom attached to propane, you can also have two Br —. In this case you need to use the prefix *di* to indicate there are two identical bromines. For example, the name of the following molecule would be

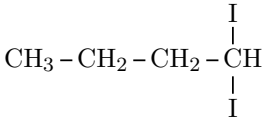


Dibromopropane

Similarly, you should use the prefix *tri* for three equal substituents.

Sample Problem 6

Name the following hydrocarbon:



SOLUTION

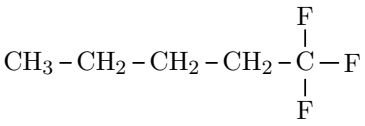
The carbon chain has four carbons and hence the ending of the name would be: butane. Also there are two iodines (iodo substituents) attached to the carbon chain. As there are two of the same iodo atoms, we need to use the prefix *di*.

The full name would be:

▶Answer: Dioiodobutane.

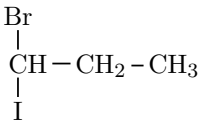
STUDY CHECK

Name the following hydrocarbon:



▶Answer: Trifluoropentane.

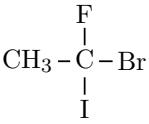
Alkanes with different substituents Now imagine you have two different halogens as substituents: Br — and I — like in next example



As they have different names you cannot use the prefix *di*. Still, when you indicate the names of the substituents you need to order them according to the *abc*. So bromo goes first in the name and iodo after. You also need to separate the different substituents with a '-'. The final name of the hydrocarbon above would be: Bromo-Iodopropane.

Sample Problem 7

Name the following hydrocarbon:



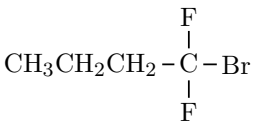
SOLUTION

The carbon chain has two carbons and hence the ending of the name would be: ethane. Also there are three different substituents: iodine (iodo substituents), bromine (bromo substituents) and fluorine (fluoro substituents). We need to order them according to the *abc*, hence the order would be: bromo, then fluoro and finally iodo. The full name of the alkane would be:

▶Answer: Bromo-Fluoro-Iodoethane.

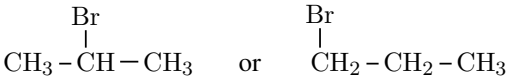
STUDY CHECK

Name the following hydrocarbon:

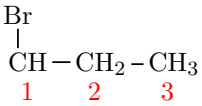


▶Answer: Bromodifluorobutane.

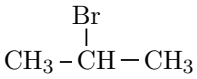
Numbering the chain Substituents are atoms or groups of atoms that can plug into a alkane chain. You could envision plugging these atoms at different points of the chain. For example:



In the right example Br is plugged to the left C atom, whereas in left example C is plugged to the middle carbon. Hence, it is important first, to learn how to number a hydrocarbon chain. Let us use propane as an example. This molecule has three atoms. In order to number the chain, you start by selecting the extreme that is the closest to the substituent, and use this carbon as number one. Next carbon would be carbon number two and so on until you arrive to carbon number three.



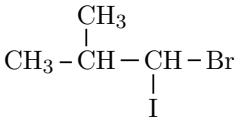
As the Br atom in the carbon number one, the name of the molecule would be: 1-bromopropane or simply bromopropane. Differently, when the substituent is in a carbon different than one, you need to indicate that location. For example:



2-Bromopropane

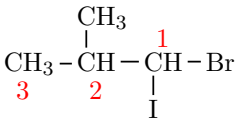
Sample Problem 8

Name the following hydrocarbon:



SOLUTION

First we find the ending of the name: as the molecule has three carbons in the main chain, the ending of the name would be: propane. Then we need to number the chain so that the number one carbon is the closest to the substituents:

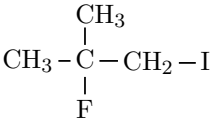


A methyl is connected to carbon two, and two halogens, a iodo and a bromo are connected to carbon number one. The substituents are: 2-methyl, 1-bromo, 1-iodo. If we order them: 1-bromo-1-iodo-2-methyl. And the final name would be:

▶Answer: 1-bromo-1-iodo-2-methylpropane.

STUDY CHECK

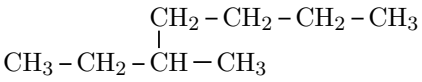
Name the following hydrocarbon:



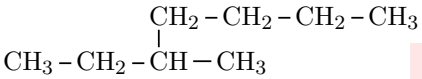
▶Answer: 1-iodo-2-fluoro-2-methylpropane.

Finding the longest chain Alkanes with substituents are more complex than simple alkanes and often time they contain more than one hydrocarbon chain. Therefore,

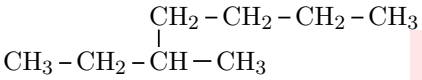
one can envision several ways to number the chain. The rule is to locate the longest chain. Let us use the following hydrocarbon. How many chains can you find, and which is the longest chain?



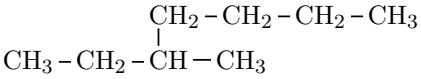
The answer should be three chains. Let me highlight the three different possibilities and the number of atoms in each chain:



4 Carbons

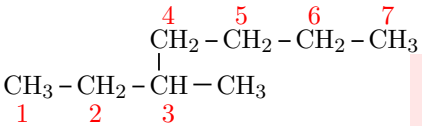


7 Carbons



6 Carbons

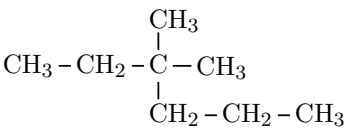
As the longest chain has seven carbons, the name of the molecule would be heptane. Still you need to add the substituents before that name. After you locate the longest chain you need to number the chain so that the substituents are located the closest to the carbon number one the possible:



So in carbon number three a methyl is located. Hence the final name of the molecule would be: 3-methylheptane.

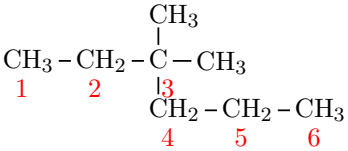
Sample Problem 9

Name the following hydrocarbon:



SOLUTION

First we locate the longest chain. We have five possible chains, and the longest one has six carbons. Hence the name of the hydrocarbon would be hexane. Now we need to number the carbons so that we start numbering the closes to the substituents the possible.

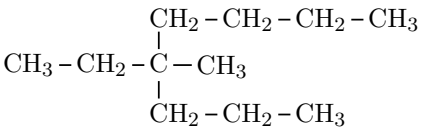


We have two methyl connected to carbon number three. Hence the final name will be:

▶Answer: 3-dimethylhexane.

STUDY CHECK

Name the following hydrocarbon:

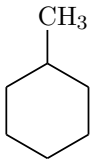


▶Answer: 4-ethyl-4-methyloctane.

1.4 Cylcoalkanes with substituyents

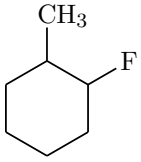
Cycloalkanes are cyclic alkanes. This section covers the naming of cycloalkanes with substituents. The naming rules are the same as the rules for naming alkanes. This means first you will find the ending on the name by counting the number of carbons. Then you will locate each substituent and number the carbon chain so that these substituents are close to carbon number one. All substituents have a number depending on the carbon number. Finally, all substituents should be order according to the *abc*.

Cylcoalkanes with one substituyent Let us take a look at the following cycloalkane:

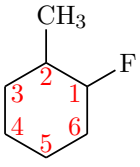


this is a cyclohexane connected to a methyl substituent. As there is only one substituents, there is no need to number the carbon chain. Hence the name would be: methylcyclohexane.

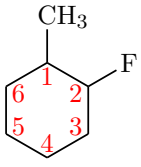
Cylcoalkanes with two substituyent Let us take a look at the following cycloalkane:



this is a cyclopentane connected to two different substituents: a methyl and a fluoro. In order to name this molecule we need to number the carbons first, and there are two different ways to number the cyclohexane ring:



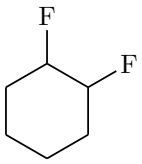
1-Fluoro-2-methylcyclohexane



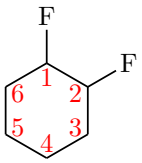
(wrong) Fluoro-1-methylcyclohexane

we will choose the name that gives the lowest numbers: 1-Fluoro-2-methylcyclohexane.

Cylcoalkanes with repeated substituyent Let us take a look at the following cycloalkane, which has two repeated fluorine substituents:



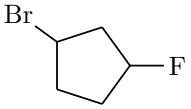
After numbering the chain:



The name would be: 1,2-difluorocyclohexane.

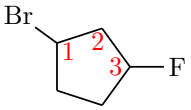
Sample Problem 10

Name the following hydrocarbon:



SOLUTION

The molecule is a cyclopentane with two substituents: fluoro and bromo. I will start numbering in bromo and continue until bromo. This way I will have small numbers and follow the abc rule:

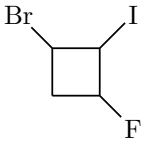


And the name of the molecule would be:

▶Answer: 1-bromo-3-fluorocyclopentane.

STUDY CHECK

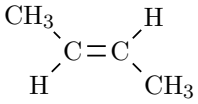
Name the following hydrocarbon:



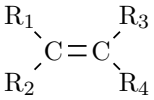
▶Answer: 1-bromo-3-fluoro-2-bromocyclopropane.

The previous sections covered hydrocarbons, either alkanes or cyclocalkanes. Both alkanes and cyclocalkanes are molecules based on carbon and hydrogen. This section will introduce the idea of functional group. You have certainly taken painkillers for a headache or over-the-counter drugs to get over a cold. Maybe you drink coffee and perhaps you like tea. All these medications as well as drinks contain active organic molecules. These active molecules differ from plain hydrocarbons, which are simply made of carbon and hydrogen. Active molecules contain functional groups such as alcohol, ethers, carboxylic acids, amines, amides or aromatic groups. These groups of atoms have a specific function and give activity to the molecule. The goal of this section is not for you to identify the action mechanisms of these complex active molecules, but simply to identify the different groups.

Alkene group: double bonds Alkenes contain at least one double bond between carbons. An example would be:

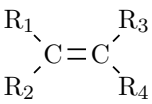
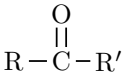
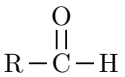
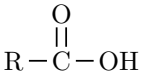
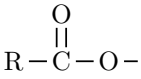
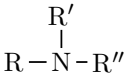
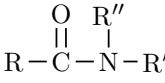
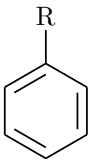
 or $CH_3CH_2-HC=CH-CH_3$

As both sides of an alkene can be connected to different hydrocarbon chains we normally represent this as:

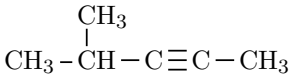
 Alkene

where R and R' represents any hydrocarbon chain.

Table ?? Functional groups name

Substituents	name	Substituents	name
	Alkene		Ketone
$R-C\equiv C-R'$	Alkyne		Aldehyde
$R-OH$	Alcohol		Carboxylic acid
$R-SH$	Thiol		Ester
$R-O-R'$	Ether		Amine
	Amide		fenil

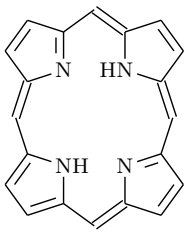
Alkyne group: tripe bonds Alkenes contain at least one tripple bond between carbons. An example would be:

$CH_3-C\equiv C-C(CH_3)_3$ or 

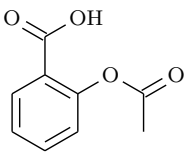
Again we could use R and R' to represent any hydrocarbon chain:

$R-C\equiv C-R'$ Alkyne

▼porphyrin has several amine groups.
Q: How many amine groups has porphyrin?

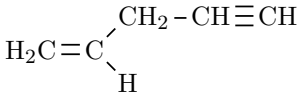


▼Aspirin contains an aromatic cycle, a carboxylic acid and a ester.
Q: What is the molecular formula of aspirin?



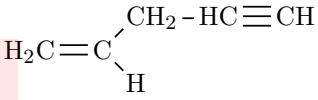
Sample Problem 11

Identify the alkene and alkyne groups in the molecule:



SOLUTION

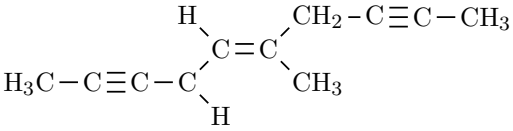
A double bond is carbon atoms sharing two pairs of electrons, whereas a triple bond is a pair of atoms sharing three pairs of electrons. They are represented with a double and triple line, respectively. In the question:



▶Answer: (left) alkene; (right) alkyne

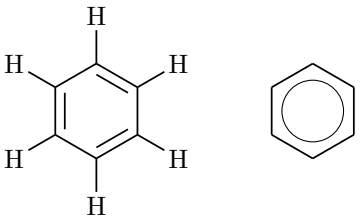
STUDY CHECK

Identify the alkene and alkyne groups in the molecule:



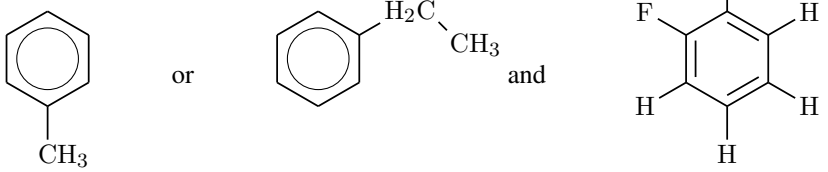
▶Answer: (center) alkene; (right, left) alkyne

Aromatic group Aromatic groups are based on bezene, a ciclohexane with a series of alternates double bonds, which is often represented as a circle:



Benzene Benzene

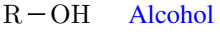
Examples of molecules containing aromatic groups are:



▼Esters give flavor to many fruits.
Q: What is the formula for the smallest ester?

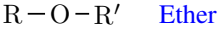
© wikipedia

Alcohol, ether and thiols group Alcohols contain an –OH group attached to a carbon.



Alcohol

Whereas ethers have oxygen atoms attached to two carbon atoms:



Ether

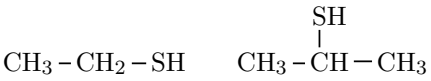
▼Vinegar contains acetic acid, the smallest carboxylic acic.
Q: What is the formula for acetic acid?

Examples of alcohols and ether are:

alcohol ether

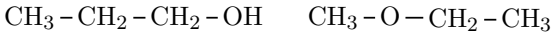
Thiols contain a $-SH$ group attached to a carbon. They are equivalent to alcohols but based in sulfur:

Examples of thiols are:



Sample Problem 12

Classify the following molecules as alcohol or ether.



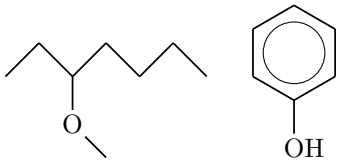
SOLUTION

The OH groups is an alcohol, and we find this group in the left molecule. Differently, the right molecule is an ether as it contains the $R-O-R'$ group.

▶Answer: (left) alcohol; (right) ether.

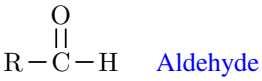
STUDY CHECK

Classify the following molecules as alcohol or ether.

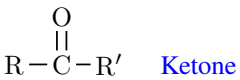


▶Answer: (left) ether; (right) alcohol.

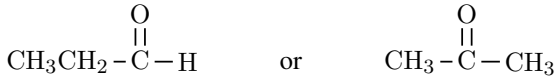
Aldehydes and ketones Ketones and aldehydes both contain a C=O group. Still these are two different groups and ketones have a C=O group bounded to two different carbon atoms



whereas aldehydes have the same C=O group but this time bounded to a carbon and a hydrogen.



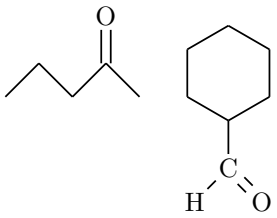
Examples of aldehydes and ketones are:



Aldehyde Ether

Sample Problem 13

Classify the following molecules as an aldehyde or ketone



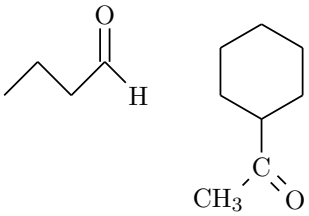
SOLUTION

The left molecule is a ketone as the carbonyl group (C=O) is connected to a CH_3 and a CH_2. Differently, the right molecule is an aldehyde as the carbonyl group is connected to a cycloalkane but also to a hydrogen.

▶Answer: (left) ketone; (right) aldehyde.

STUDY CHECK

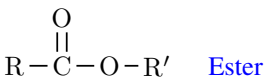
Classify the following molecules as an aldehyde or ketone



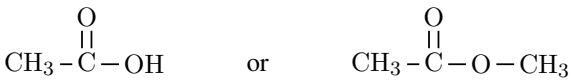
▶Answer: (left) aldehyde; (right) ketone.

Carboxylic acids and esters Carboxylic acids contain a carbonyl group (C=O) connected to an hydrocarbon and also an alcohol group:

Esters have the same C=O group but this time bounded to a carbon (R) and an ether group (–O–R').



Examples of carboxylic acids and esters are:



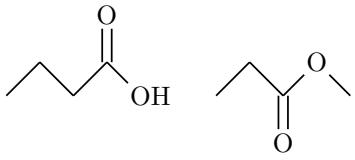
Carboxylic acid Esters

▼Cinnamaldehyde is the aldehyde that gives cinnamon its flavor and odor.

▼Benzyl acetate is an ester that flavors pears.

Sample Problem 14

Classify the following molecules as an carboxylic acid or ester:



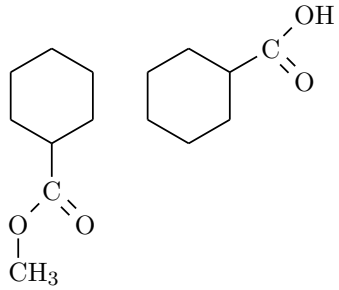
SOLUTION

The molecule in the left is a carboxylic acid as the carbonyl group (C=O) is connected to an alcohol –OH. Differently, the molecule in the right is a ester as the carbonyl group is connected to a $-O-CH_3$ group.

▶Answer: (left) carboxylic acid; (right) ester.

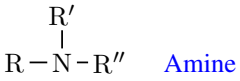
STUDY CHECK

Classify the following molecules as an carboxylic acid or ester:



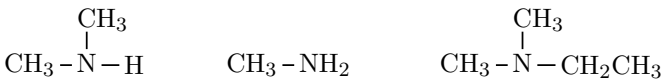
▶Answer: (left) ester; (right) acid.

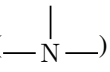
Amines and amides Amines and amides are groups containing nitrogen. Amines are derivative of ammonia (NH_3) with one or more of the hydrogen atoms being replaced by a hydrocarbon

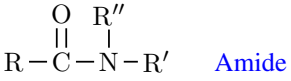


Amine

All these molecules are amines:

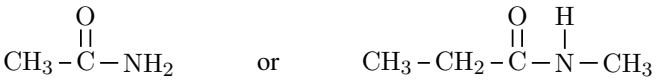


Amides, on the other hand, contain a carbonyl group (C=O) connected to an amine group ()



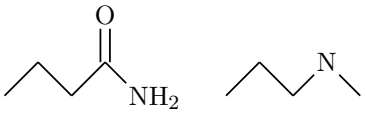
Amide

Examples of amides are:



Sample Problem 15

Classify the following molecules as an amide or amine:



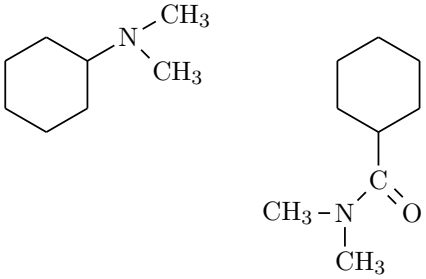
SOLUTION

The molecule in the left is a amide as the carbonyl group (C=O) is connected to a nitrogen atom. Differently, the molecule in the right is an amine as the nitrogen group is not connected to any carbonyl group.

▶Answer: (left) amide; (right) amine.

STUDY CHECK

Classify the following molecules as an amide or amine:



▶Answer: (left) amine; (right) amide.