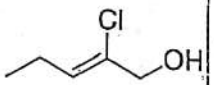
CHAPTER 5
NOMENCLATURE

All molecules have names, and we need to know their names to communicate. Consider the molecule below:



Clearly, it would be inadequate to refer to this compound as "you know, that thing with five carbons and an OH coming off the side with a chlorine on a double bond." First of all, there are too many other compounds that fit that fuzzy description. And even if we could come up with a very adequate description that could only be this one compound, it would take way too long (probably an entire paragraph) to describe. By following the rules of nomenclature, we can unambiguously describe this molecule with just a few letters and numbers: Z-2-chloropent-2-en-1-ol.

It would be impossible to memorize the names of every molecule, because there are too many to even count. It would also be impossible to memorize the name of every compound. Instead, we have a very systematic way of naming molecules. What you need to learn are the rules for how to give a name to a molecule (these rules are referred to as IUPAC nomenclature). This is a much more manageable task than memorizing names, but even these rules can become challenging to master. There are so many of them, that you could study only these rules for an entire semester and still not finish all of them. The larger the molecules get, the more rules you need to account for every kind of possibility. In fact, the list of rules is regularly updated and refined.

Fortunately, you do not need to learn all of these rules, because we deal with very simple molecules in this course. You need to learn only the rules that allow you to name small molecules. This chapter focuses on most of the rules you need to name simple molecules.

There are five parts to every name:

Stereoisomerism	Substituents	Parent	Unsaturation	Functional group

1. *Stereoisomerism* Indicates whether double bonds are cis/trans or E/Z, and indicates stereocenters (R, S), which we will cover in the chapter on configuration.
2. *Substituents* Are groups coming off of the main chain.
3. *Parent* Is the main chain.

4. *Unsaturation* Identifies if there are any double or triple bonds.
5. *Functional group* The functional group after which the compound is named.

Let's use the compound above as an example:

Stereoisomerism	Substituents	Parent	Unsaturation	Functional group
Z	2-chloro	pent	2-en	1-ol

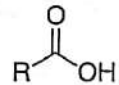
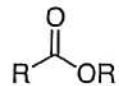
We will systematically go through all five parts to every name, starting at the end (functional group) and working our way backward to the first part of the name (stereoisomerism). It is important to do it backward like this, because the position of the functional group affects which parent chain you choose.

5.1 FUNCTIONAL GROUP

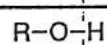
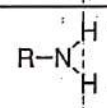
Stereoisomerism	Substituents	Parent	Unsaturation	Functional group

The term *functional group* refers to specific arrangements of atoms that have certain characteristics for reactivity. For example, when an –OH is connected to a compound, we call the molecule an alcohol. Alcohols will display similar reactivity, because alcohols all have the same functional group, the –OH group. In fact, most textbooks have chapters arranged according to functional groups (one chapter on alcohols, one chapter on amines, etc.). Accordingly, many textbooks treat nomenclature as an ongoing learning process: As you work through the course, you slowly add to your list of functional group names. Here we focus on six common functional groups, because you will certainly learn at least these six throughout your course.

When a compound has one of these six groups, we show it in the name of the compound by placing a suffix on the name of the molecule. As we saw, this is the last part of any name. So we need to know the suffixes that we use for each of these groups:

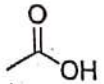
Functional group	Class of compound	Suffix
	Carboxylic acid	-oic acid
	Ester	-oate

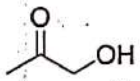
(continued)

Functional group	Class of compound	Suffix
	Aldehyde	-al
	Ketone	-one
	Alcohol	-ol
	Amine	-amine

Halogens (F, Cl, Br, I) are usually not named in the suffix of a compound. They get named as substituents, which we will see later on.

Notice that the carboxylic acid is like a ketone and an alcohol placed next to each other. But be careful, because carboxylic acids are very different from ketones or alcohols. So don't make the mistake of thinking that a carboxylic acid is a ketone and an alcohol:


A carboxylic acid

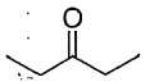

A ketone and an alcohol

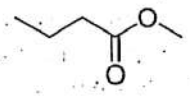
The compound above that is a ketone and an alcohol brings about an important issue: how do you name the functional group when you have two functional groups in a compound? One will go in the suffix of the name and the other will be a prefix in the substituent part of the name. But how do we choose which one goes as the suffix of the name? There is a hierarchy that needs to be followed. The six groups shown above are listed according to their hierarchy, so a carboxylic acid takes precedence over an alcohol. A compound with both of these groups is named as an -oic acid, and we put the term "hydroxy" in the substituent part of the name.

EXERCISE 5.1 Identify what suffix you would use in naming the following compound:

Answer There are two functional groups in this compound, so we have to decide between calling this compound an amine or calling it an alcohol. If we look at the hierarchy above, we see that an alcohol outranks an amine. Therefore, we use the suffix -ol in naming this compound.

PROBLEMS Identify what suffix you would use in naming each of the following compounds.

5.2 
Suffix: _____

5.3 
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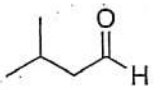
5.4 
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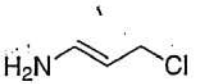
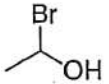
5.5 
Suffix: _____

5.6 
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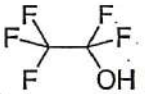
5.7 
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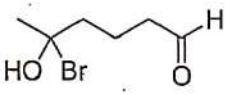
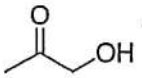
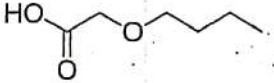
5.8 
Suffix: _____

5.9 
Suffix: _____

5.10 
Suffix: _____

If there is no functional group in the compound, then we put an "e" at the end of the name:


pentanol


pentane

5.2 UNSATURATION

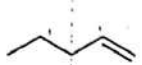
Stereoisomerism	Substituents	Parent	Unsaturation	Functional group

Many molecules have double or triple bonds, often called "unsaturation" because a compound with a double or triple bond has less hydrogen than it would have without the double or triple bond. These double and triple bonds are very easy to see in bond-line drawings:

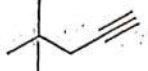

Triple bond


Double bond

Look above at the example of pentane. The "e" told us that there was no functional group. Working our way backward through the name, the "an" tells us that there are no double or triple bonds in the molecule. Double bonds are called "en" (pronounced *een*) and triple bonds are called "yn" (pronounced *ine*). For example,



pentene

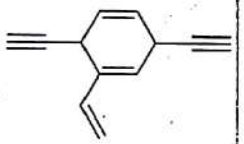


pentyne

If there are two double bonds in a compound, then the unsaturation is "-dien-". Three double bonds is "-trien-". Similarly, two triple bonds is "-diyn-", and three triple bonds is "-triyn-". For multiple double and triple bonds, we use the following terms:

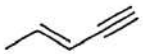
di = 2	penta = 5
tri = 3	hexa = 6
tetra = 4	

You will rarely ever see this many double or triple bonds in one compound, but it is possible to see double and triple bonds in the same molecule. For example,



The compound shown here has three double bonds and two triple bonds. So it is a triendiyne. Double bonds always get listed first.

EXERCISE 5.11 Identify how you would describe the unsaturation in the name of the following compound:

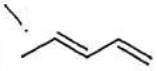


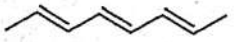
Answer This compound has one double bond and one triple bond. For the double bond, we use the term "en". For the triple bond, we use the term "yn". Double bonds get listed first, so this compound is –enyn-.

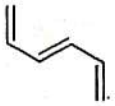
PROBLEMS Identify how you would describe the unsaturation in the name of the following compounds.

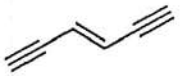
5.12 

5.13 

5.14 

5.15 

5.16 

5.17 

5.3 NAMING THE PARENT CHAIN

Stereoisomerism	Substituents	Parent	Unsaturation	Functional group

When naming the parent of the compound, we are looking for the chain of carbon atoms that is going to be the root of our name. Everything else in the compound is connected to that chain at a specific location, designated by numbers. So we need to know how to choose the parent carbon chain and number it correctly.

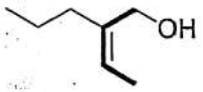
The first step is learning how to say "a chain of three carbons" or "a chain of seven carbons." Here is a table showing the appropriate names:

Number of carbon atoms in the chain	Parent
1	meth
2	eth
3	prop
4	but
5	pent
6	hex
7	hept
8	oct
9	non
10	dec

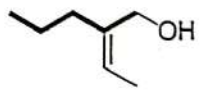
If we have carbon atoms in a ring, we add the term cyclo, so a ring of six carbon atoms is called cyclohex- as the parent and a ring of five carbon atoms is cyclopent-.

You must commit these terms to memory. I am not a big advocate of memorization, but for now, you must memorize these terms. After a while, it will become habitual, like a phone number that you dial all of the time, and you won't have to think about it anymore.

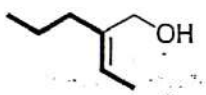
The tricky part comes when you need to figure out which carbon chain to use. Consider the following example, which has three different possibilities for the parent chain:



4-carbon chain



5-carbon chain



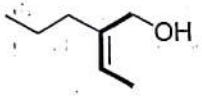
6-carbon chain

So how do we know whether to call this –but- (which is 4) or –pent- (which is 5) or –hex- (which is 6)? There is a hierarchy for this as well. The chain should be as long as possible, making sure to include the following groups, in this order:

Functional group
Double bond
Triple bond

First we need to find the functional group and make sure that the functional group is in the chain. Remember from the last section that if there are two functional groups, one of them gets priority. The functional group that gets priority is the one that needs to be in our parent chain. Of the three possibilities shown above, this rule eliminates the last possibility, because it does not include the functional group on the parent chain.

If there are still more choices of possible parent chains (as there are in this case), then we look for the chain that also includes the double bond (if there is one in the compound). In our case, there is a double bond, and this rule determines for us which chain to use:



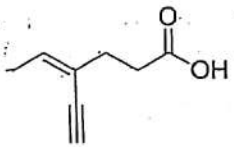
Of the three possibilities, this is the only parent chain containing the functional group and the double bond. "Containing the functional group" means that the OH is connected to a carbon that is part of the chain. We do not count the oxygen itself as part of the chain. It is only attached to the chain. So the chain above is made up of four carbon atoms.

In cases where there is no functional group, then we look for the longest chain that includes the double bond. If there is no double bond, then we look for a triple bond, and choose the longest chain that has the triple bond in it.

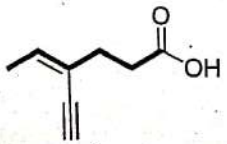
If there are no functional groups, no double bonds, and no triple bonds, then we simply choose the longest chain possible.

Now you can see why we are moving our way backward through the naming process. We cannot name the parent correctly unless we can pick out the highest ranking functional group in the compound. So we start naming a compound by first asking which functional group has priority.

EXERCISE 5.18 Name the parent chain in the following compound:



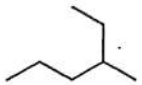
Answer First we look for a functional group. There is only one, so we know the parent chain must include the carboxylic acid group. Next we look for a double bond. The parent chain should include that as well. This gives us our answer. The triple bond will not be included in the parent chain, because the functional group and the double bond are higher priority than a triple bond.



So we count the number of carbons in this chain. There are six (notice that we include the carbon of the carboxylic acid group). Therefore, the parent will be called "hex".

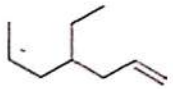
PROBLEMS Name the parent chain in the each of the following compounds.

5.19



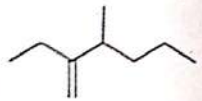
Parent: _____

5.20



Parent: _____

5.21



Parent: _____

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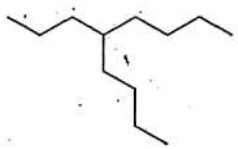

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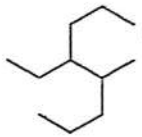
5.23



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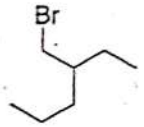
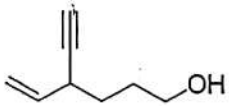
5.24



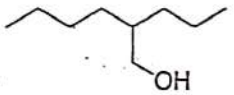
Parent: _____

5.25



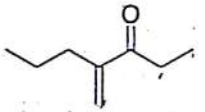
Parent: _____

5.26



Parent: _____

5.27

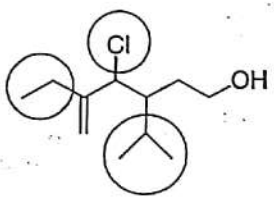


Parent: _____

5.4 NAMING SUBSTITUENTS

Stereoisomerism	Substituents	Parent	Unsaturation	Functional group

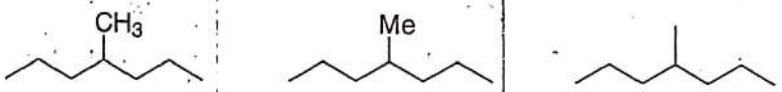
Once we have identified the functional group and the parent chain, then everything else connected to the parent chain is called a substituent. In the following example, all of the circled groups are substituents, because they are not part of the parent chain:



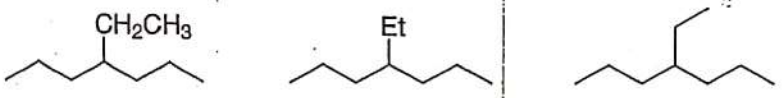
We start by learning how to name the alkyl substituents. These groups are named with the same terminology that parent chains are named, but we add "yl" to the end to imply that it is a substituent:

Number of carbon atoms in the substituent	Substituent
1	methyl
2	ethyl
3	propyl
4	butyl
5	pentyl
6	hexyl
7	heptyl
8	octyl
9	nonyl
10	decyl

Methyl groups can be shown in a number of ways, and all of them are acceptable:

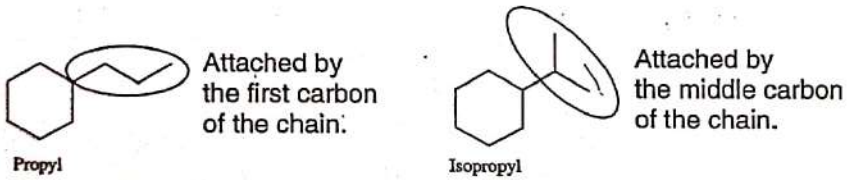


Ethyl groups can also be shown in a number of ways:



Propyl groups are usually just drawn, but sometimes you will see the term Pr (which stands for propyl):

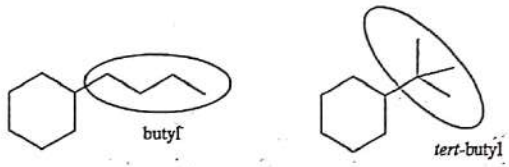
Look at the propyl group above and you will notice that it is a small chain of 3 carbon atoms that is attached to the parent chain by the first carbon of the small chain. But what if it is attached by the middle carbon? Then it is not called propyl anymore:



It is still a chain of three carbon atoms, but it is attached to the parent chain differently than a propyl group is attached, so we call it isopropyl. This is an example of

a branched substituent (branched, because it is not connected in one straight line to the parent chain, like a propyl group is).

Another important branched substituent to be familiar with is the *tert*-butyl group:



The *tert*-butyl group is made up of four carbon atoms, just like a butyl group, but the *tert*-butyl group is not a straight line connected to the parent. Rather, the group has three methyl groups attached to one carbon, which is itself attached to the parent chain. So, we call this group *tert*-butyl.

There are two other ways to attach four carbon atoms to a parent chain (other than butyl and *tert*-butyl). As a small assignment, see if you can find their names in your textbook.

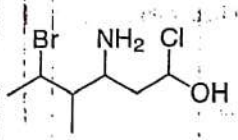
There is another important type of substituent that we need to cover. When we learned about functional groups, we saw that some compounds can have two functional groups. When this happens, we need to choose one of the functional groups to get the suffix, and the other functional group gets named as a substituent. To choose the functional group that gets the priority, go back to the section on functional groups and you will see the list of six functional groups (they are in order of priority, where a carboxylic acid always gets the priority). We need to know how to name any other functional groups in the molecule as substituents. The OH group is named –hydroxy- as a substituent. The NH_2 group is called –amino- if it is named as a substituent. A ketone is called –keto- as a substituent, and an aldehyde is called –aldo- as a substituent. Knowing how to name those four functional groups as substituents will probably cover you for anything you will see in your course.

Halogens are named as substituents in the following way: fluoro, chloro, bromo, and iodo. Essentially, we add the letter "o" at the end to say that they are substituents. If there are multiple substituents of the same kind (for example, if there are five chlorine atoms on the compound), we use the same prefixes that we used earlier when classifying the number of double and triple bonds:

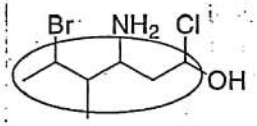
di = 2 penta = 5
tri = 3 hexa = 6
tetra = 4

Each and every substituent needs to be numbered so that we know where it goes on the parent chain, but we will learn about this after we have finished going through the five parts of the name. At that time, we will also discuss in what order to place substituents in the name.

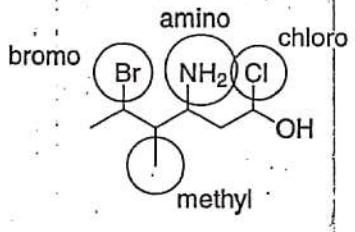
EXERCISE 5.28 In the following compound, identify all groups that would be considered substituents, and then indicate how you would name each substituent:



Answer First we must locate the functional group that gets the priority. Alcohols outrank amines, so the OH group is the priority functional group. Then, we need to locate the parent chain. There are no double or triple bonds, so we choose the longest chain containing the OH group:



Now we know which groups must be substituents, and we name them accordingly:

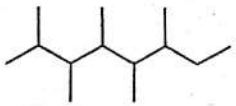


PROBLEMS For each of the following compounds, identify all groups that would be considered substituents, and then indicate how you would name each substituent.

5.29

5.30

5.31



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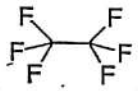

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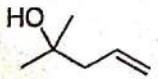

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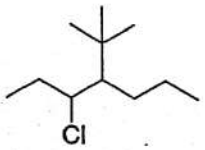

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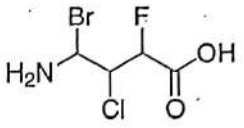

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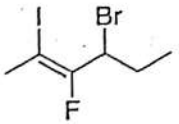

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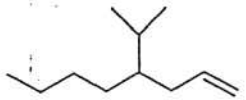
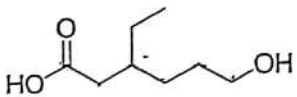


5.38

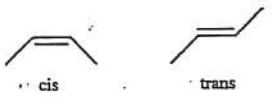


5.5 STEREOISOMERISM

Stereoisomerism	Substituents	Parent	Unsaturation	Functional group

Stereoisomerism is the first part of every name. It identifies the configuration of any double bonds or stereocenters. If there are no double bonds or stereocenters in the molecule, then you don't need to worry about this part of the name. If there are, you must learn how to identify the configuration of each. Identifying the configuration of a stereocenter requires a chapter to itself. You will need to learn what a stereocenter is, how to locate them in molecules, how to draw them, and how to assign a configuration (R or S). These topics will all be covered in detail in Chapter 7. At that time, we will revisit how to appropriately place the configuration in the name of the molecule. For now, you should know that configurations are placed here in the first part of a name.

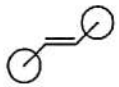
Here we will focus on double bonds, which can often be arranged in two ways:



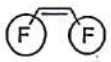
This is very different from the case with single bonds, which are freely rotating all of the time. But a double bond is the result of overlapping p orbitals, and double bonds *cannot* freely rotate (if you had trouble with this concept when you first learned it, you should review the bonding structure of a double bond in your textbook or notes). So there are two ways to arrange the atoms in space: cis and trans. If you compare which atoms are connected to each other in each of the two possibilities, you will notice that all of the atoms are connected in the same order. The difference is how they are connected *in 3D space*. This is why they are called stereoisomers (this type of isomerism stems from a difference of orientation in space—"stereo").

To name a double bond as being cis or trans, you need to have identical groups on *either side* of the double bond that can be compared to each other. If these

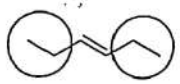
identical groups are on the same side of the double bond, we call them cis. If they are on opposite sides, we call them trans:



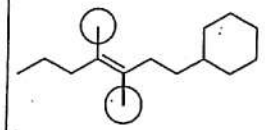
Two methyl groups are trans



Two fluorine atoms are cis

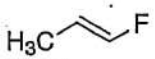


Two ethyl groups are trans

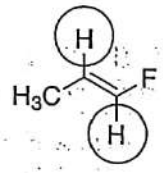


Two methyl groups are trans

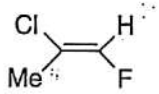
The two groups that we compare can even be hydrogen atoms. For example,



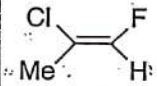
is trans because there are two hydrogen atoms not shown, and they are trans to each other:



But what do you do if you don't have two identical groups to compare? For example,



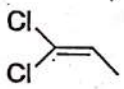
is not the same as



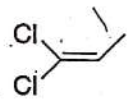
These compounds are clearly not the same. We cannot use cis/trans terminology to differentiate them, because we don't have two identical groups to compare. In situations when all four groups on the double bond are different, we have to use another method for naming them.

The other way of naming double bonds uses rules similar to those used in determining the configuration of a stereocenter (R versus S), so we will wait until the next chapter (when we learn about R and S), and then we will cover this alternative way of naming double bonds. The alternative method is far superior, because it can be used to name any double bond. In contrast, cis/trans nomenclature can be used only when we have two identical groups. The reason that we do not drop the cis/trans terminology altogether is probably based in deep-rooted tradition and usage of these terms.

There is one situation when we don't have to worry about cis/trans or E/Z because there aren't two ways to arrange the double bond. If we have two identical groups connected *to the same atom,* then we cannot have stereoisomers. For example,



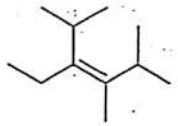
is the same as



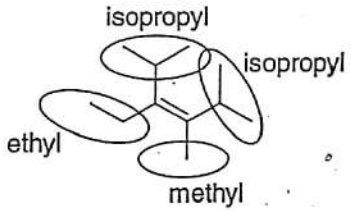
because there are two chlorine atoms connected to one carbon atom on one side of the double bond. Why are the two drawings the same? Remember that the carbon

atoms of the double bond are sp^2 hybridized, and therefore trigonal *planar*. So, if we flip over the first drawing, we get the other drawing. They are the same thing. To see this, take two pieces of paper. Draw one of these compounds on one piece of paper, and draw the other compound on the second piece of paper. Then flip over one of the pieces of paper, and hold it up to the light so that you can see the drawing through the back side of the paper. Compare it to the other drawing and you will see that they are the same. If you try to do the same thing with some of the previous examples (that did have cis and trans stereoisomers), you will find that flipping the page over does not make the two drawings the same. This is a useful exercise, so take a few minutes and do it.

EXERCISE 5.39 Determine whether the double bond below is cis or trans:



Answer Begin by circling the four groups attached to the double bond and try to name them:



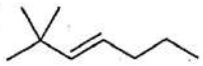
You should always use this technique, because it will help you see when you have two groups that are the same. There are always four groups on the double bond (even if some of them are just hydrogen atoms). In this case, it helps us see that there are two isopropyl groups on the same side of the double bond. Therefore, the double bond is cis.

PROBLEMS For each of the compounds below, determine whether the double bond is cis or trans.

5.40

5.41

5.42



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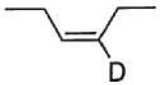
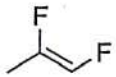
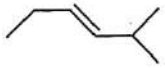
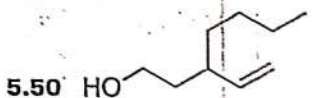


5.44



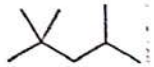
5.45

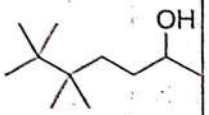


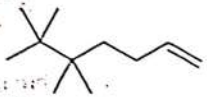
5.50 

5.51 

5.52 

5.53 

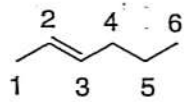
5.54 

5.55 

Now that we know how to number the parent chain, we need to see how to apply those numbers to the various parts of the name.

Functional Group The number generally gets placed directly in front of the suffix (for example, hexan-2-ol). If the functional group appears at the number 1, then the number does not need to be placed in the name (for example, hexanol). It is assumed that the absence of a number means that the functional group is at the number 1 position. When placing a number, it is OK to place the number at the beginning of the name if there are no other numbers in the name (from substituents or anything else). For example, 2-hexanol is the same as hexan-2-ol.

Unsaturation For double and triple bonds, the number indicates the lower number of the two carbon atoms. For example,

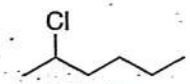


We use the number 2

The double bond is between C2 and C3, so we use C2 to number the double bond. So the example above is hex-2-ene (or 2-hexene, because there are no other numbers in the name, so it is OK to put the number in front). We treat triple bonds the same way.

If there are two double bonds in the molecule, then we must indicate both numbers; for example, hexa-2,4-diene, or 2,4-hexadiene. Every double and triple bond must be numbered.

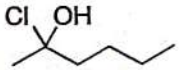
Substituents The number of the substituent goes immediately in front of the substituent. Examples:



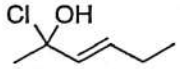
2-chlorohexane

3-methylpentane

This does not change if there are double bonds, triple bonds, or functional groups:

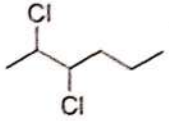


2-chlorohexan-2-ol



2-chlorohex-3-en-2-ol

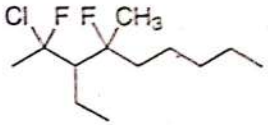
If there are multiple substituents, then every substituent must be numbered:



2,3-dichlorohexane

2,2,4-trimethylpentane

If there are multiple substituents of different types, then we must alphabetize the substituents in the name. Consider the following example:



There are four types of substituents in the example above (chloro, fluoro, ethyl, and methyl). They must be alphabetized (c, e, f, m) (we do not count di, tri, tetra, etc. as part of the alphabetization system). So the compound above is called

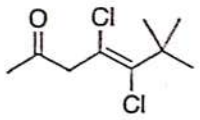
2-chloro-3-ethyl-2,4-difluoro-4-methylnonane

Note that two numbers are always separated by commas (2,4 in example above) but letters and numbers are separated by dashes (2-chloro-3-ethyl . . .).

Stereoisomerism If there are any double bonds, we place the term cis or trans at the beginning of the name. If there is more than one double bond, then we need to indicate cis or trans for each double bond, and we must number accordingly (for example, 2-cis-4-trans . . .). If there are any stereocenters, here is where we would indicate them; for example, (2R,4S). Stereocenters are placed in parentheses. We will see more of this when we learn about stereocenters in the upcoming chapters.

There it is. A lot of rules. No one ever said nomenclature would take 10 minutes to learn, but with enough practice, you should get the hang of it. Let's now take everything we have learned and apply it to solving some problems:

EXERCISE 5.56 Name the following compound:



Answer We go through the five parts of the name backward. So we start by looking for the functional group. We see that there is a ketone. So we know the end of the name will be –one.

Next, we look for unsaturation. There is a double bond here, so there will be –en- in the name.

Next we need to name the parent. We locate the longest chain that includes the functional group and double bond. In this example, it is an obvious choice. The parent has 7 carbon atoms, so the parent is –hept-.

Next we look for substituents. There are two methyl groups and two chlorines. We need to alphabetize, and c comes before m, so it will be dichlorodimethyl.

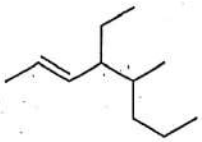
Next we look for stereoisomerism. The double bond in this molecule has two chlorine atoms on opposite sides, so it is trans. This part of the name (*trans*) is generally italicized. So far, we have

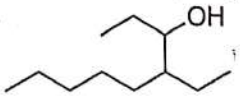
trans-dichlorodimethylheptenone

Now that we have figured out all of the pieces, we must number everything. We need to number the parent to give the functional group the lowest number, so the numbering, in this example, will go from left to right. This puts the functional group at the number 2 position, the double bond at the 4 position, the chlorines at 4 and 5, and the methyls at 6 (both of them). So the name is

trans-4,5-dichloro-6,6-dimethylhept-4-en-2-one

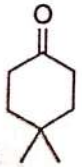
PROBLEMS Name each of the following compounds. (Ignore stereocenters for now. We will focus on stereocenters in the upcoming chapters.)

5.57  Name: _____

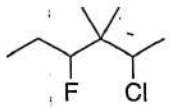
5.58 

Name: _____

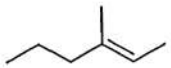
5.59  Name: _____

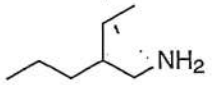
5.60 

Name: _____

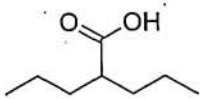
5.61 

Name: _____

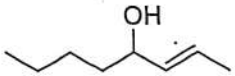
5.62  Name: _____

5.63 

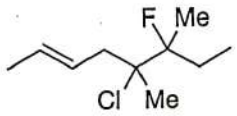
Name: _____

5.64 

Name: _____

5.65 

Name: _____

5.66 

Name: _____

5.7 COMMON NAMES

In addition to the rules for naming compounds, there are also some common names for some simple and common organic compounds. You should be aware of these names to the extent that your course demands this of you. Each course will be

5.6 NUMBERING

Stereoisomerism	Substituents	Parent	Unsaturation	Functional group

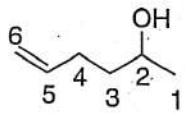
Numbering applies to all parts of the name

We're almost ready to start naming molecules. We finished learning about the individual parts of a name, and now we need to know how to identify where each of those pieces goes. For example, let's say you determine that the functional group is OH (therefore, the suffix is –ol), there is one double bond (-en-), the parent chain is six carbon atoms long (hex), there are four methyl groups attached to the parent chain (tetramethyl), and the double bond is cis. Now you know all of the pieces, but we must find a way to identify where all of the pieces are on the parent chain. Where are all of those methyl groups? (and so on). This is where the numbering system comes in. First we will learn how to number the parent chain, and then we will learn the rules of how to apply those numbers in each part of the name.

Once we have chosen the parent chain, there are only two ways to number it: right to left or left to right. But how do we choose? To number the parent chain properly, we begin with the same hierarchy that we used when choosing the parent in the first place:

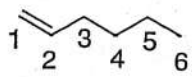
Functional group
Double bond
Triple bond

If there is a functional group, then number the parent chain so that the functional group gets the lower number:



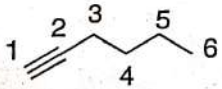
OH gets the number 2 instead of 5

If there is no functional group, then number the chain so that the double bond gets the lower number:



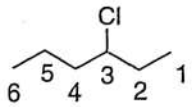
The double bond is 1 instead of 5

If there is no functional group or double bond, then number the chain so that the triple bond gets the lower number:



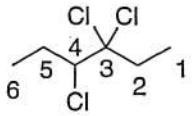
The triple bond is 1 instead of 5

If there is no functional group, double bond, or triple bond, then we should number the chain so that the substituent has the lower number:



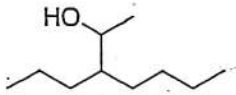
Cl gets the number 3 instead of 4

If there is more than one substituent on the parent chain, then we should number the chain so that the substituents get the lowest numbers possible:

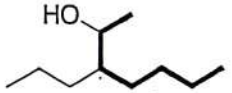


3,3,4-Trichloro instead of 3,4,4-trichloro

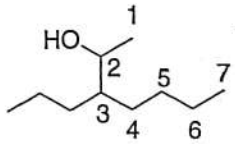
EXERCISE 5.46 For the compound below, choose the parent chain and then number it correctly:



Answer To choose the parent chain, remember that we need to choose the longest chain containing the functional group:

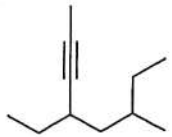


To number it correctly, we need to go in the direction that gives the functional group the lowest number:

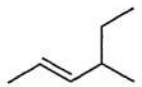


PROBLEMS For each of the compounds below, choose the parent chain and number it correctly.

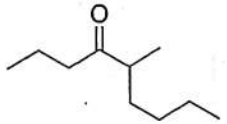
5.47



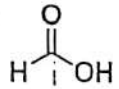
5.48



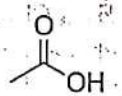
5.49



different in terms of how many of these common names you should be familiar with. Here are some examples:



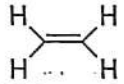
IUPAC name: methanoic acid
Common name: formic acid



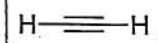
IUPAC name: ethanoic acid
Common name: acetic acid

IUPAC name: methanal
Common name: formaldehyde

IUPAC name: ethanal
Common name: acetaldehyde



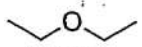
IUPAC name: ethene
Common name: ethylene



IUPAC name: ethyne
Common name: acetylene

Most of these examples are so common, that it is quite rare to hear someone refer to these compounds by their IUPAC names. Their common names are much more "common," which is why we call them common names.

Ethers are typically called by their common names. The group on either side of the oxygen is named as a substituent before the term ether. Examples:



Diethyl ether
(also just ethyl ether)

Dimethyl ether

The IUPAC method would be to treat the oxygen like a carbon and then indicate where the oxygen is with the term oxa-. So diethyl ether would be 3-oxapentane, but no one calls it that. Everyone calls it diethyl ether (or just ethyl ether). It is not a bad idea to familiarize yourself with all of the common names listed in whatever textbook you are using.

5.8 GOING FROM A NAME TO A STRUCTURE

Once you have completed all of the problems in this chapter, you will find that it is much easier to draw a compound when you are given the name than it is to name a compound that is drawn in front of you. It is easier for the following reason: when naming a compound, there are a lot of decisions you need to make (which functional group has priority, what is the parent chain, how the chain should be numbered, in

what order to put the substituents in the name, etc.). But when you have a name in front of you and you need to draw a structure, you do not need to make any of these decisions. Just draw the parent and then start adding everything else to it according to the numbering system provided in the name.

For practice, make a list of the answers to problems 5.57–5.66. This list should just be names. Wait a few days until you cannot remember what the structures looked like and then try to draw them based on the names. You can also use your textbook for more examples.

From this point on, I will assume that I can say words like 2-hexanol and you will know what I mean. That is what your textbook will do as well, so now is the time to master nomenclature.

Stereoisomerism

cis or trans

Substituents

- add "-yl" to end
- change fluorine to "fluoro"
- Change chlorine to chloro
- if more than 1, add di, tri, tetra, penta, hexa
- a, b, c order

Parent Chain

1. meth
2. eth
3. prop
4. but
5. pent
6. hex
7. hept
8. oct
9. non
10. dec

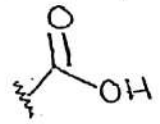
* start # wl func. group

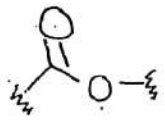
Unsaturation (double/triple bonds)

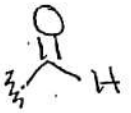
Single - an
double - en
triple - yn

* use smaller # for double/triple bonds

Functional Group

1.)  Carboxylic acid "-oic acid"

2)  ester "-oate"

3.)  aldehyde "-al"

4.)  Ketone "-one"

5.) alcohol "-ol"

6.)  amine "-amine"

No Functional Group: "-e"