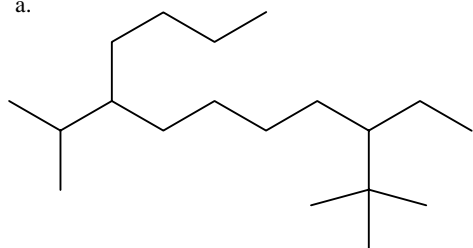


On a separate piece of paper, provide acceptable names for the following structures. After you have named your structures, turn it around and redraw each structure by the name you gave it (for more practice). Clearly number the longest high priority chain in your drawing. Hints are provided just below the structures and answers are provided just below the hints. Use a separate piece of paper to cover those up unless you absolutely need them. There are probably some mistakes. Please let me know when you find them. Thanks. My usual 2 page overview of nomenclature is provided at the end of these problems (repeat found in other documents.)

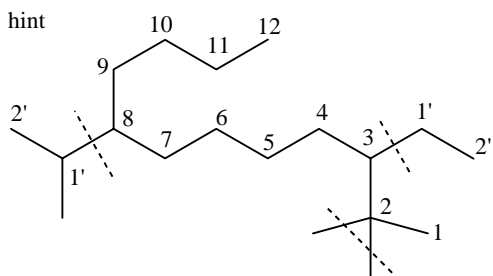
1. Problems - alkanes

a.

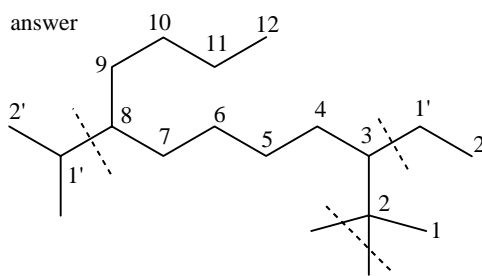


alkanes suffix = -ane prefix = branch names end in "-yl"

hint

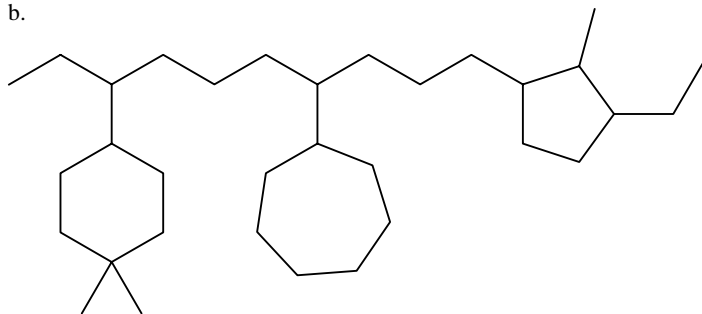


possible answer

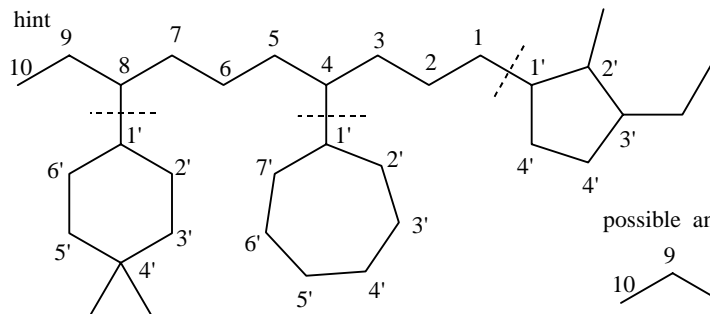


2,2-dimethyl-3-ethyl-8-(1-methylethyl)dodecane

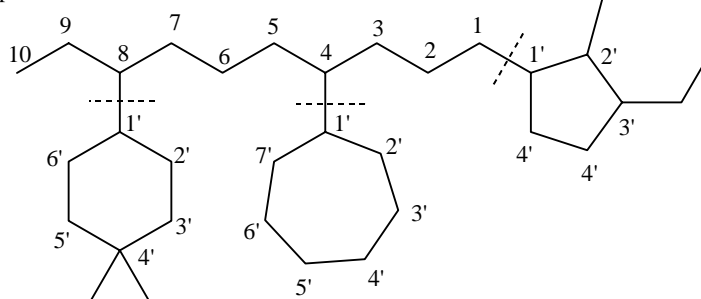
b.



hint

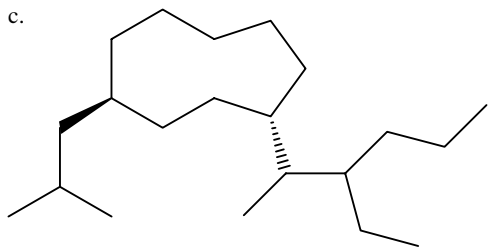


possible answer

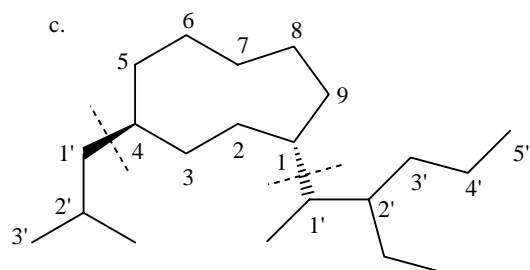


4-cycloheptyl-8-(4,4-dimethylcyclohexyl)-1-(2-methyl-3-ethylcyclopentyl)decane

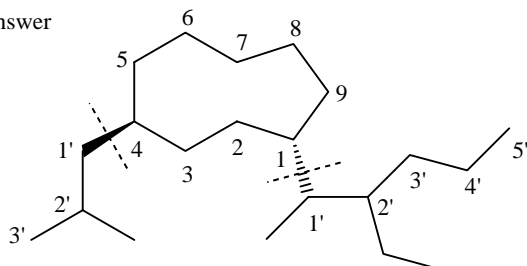
c.



hint



possible answer

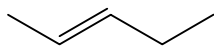


trans-1-(1-methyl-2-ethylpentyl)-4-(2-methylpropyl)cyclononane

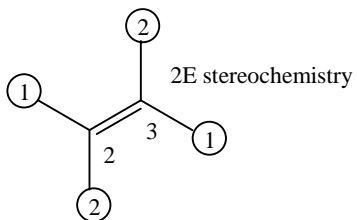
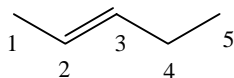
2. Problems – alkenes

a.

alkenes suffix = -ene prefix = branch names end in "-#-enyl"



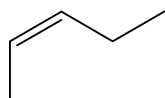
hint



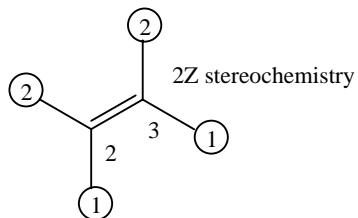
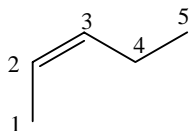
possible answer

older newer
(2E)-2-pentene or (2E)-pent-2-ene
trans-2-pentene

b.



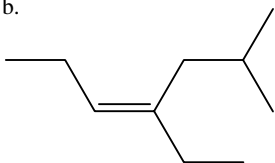
hint



possible answer

older newer
(2Z)-2-pentene or (2Z)-pent-2-ene
cis-2-pentene

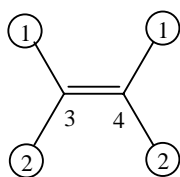
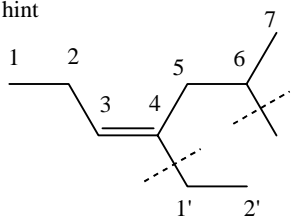
b.



Nomenclature Worksheet

Beauchamp

hint



2Z stereochemistry

possible answer

(3Z)-4-ethyl-6-methyl-3-heptene

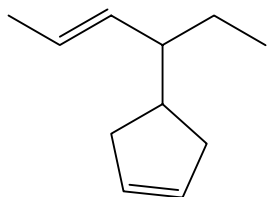
older

or

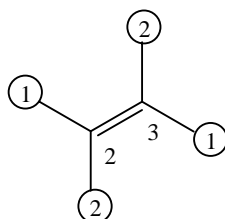
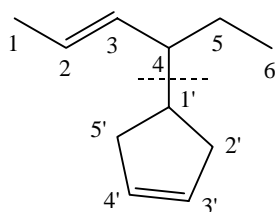
(3Z)-4-ethyl-6-methylhept-3-ene

newer

c.



hint

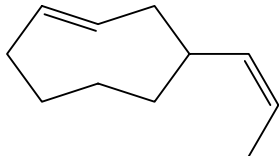


2Z stereochemistry

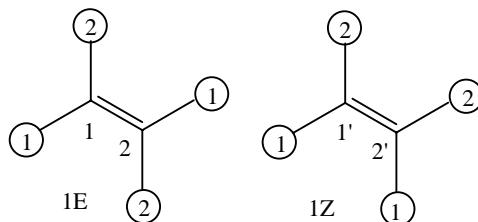
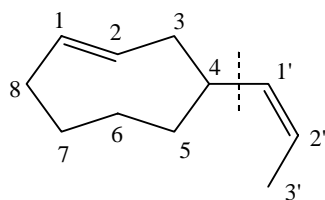
possible answer

(2E)-4-(cyclopent-3-enyl)hex-2-ene

d.



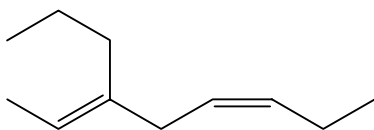
hint



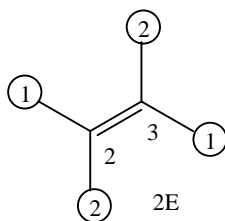
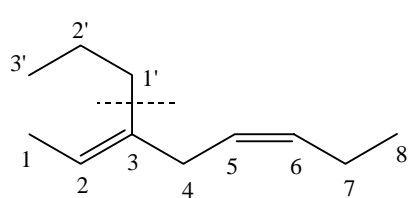
possible answer

(1E)-4-(prop-1Z-enyl)cyclooct-1-ene

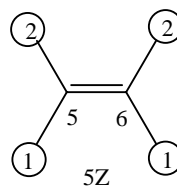
e.



hint



2E



5Z

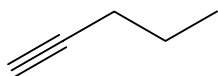
possible answer

(2E,5Z)-3-propylocta-2,5-diene

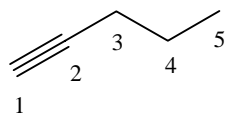
3. Problems – alkynes

a.

alkynes prefix = branch names end in "-#-ynyl" suffix = #-yne



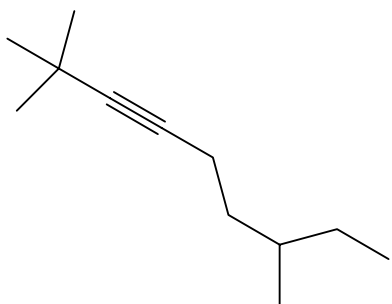
hint



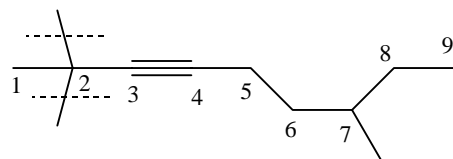
possible answer

 older newer
 1-pentyne or pent-1-yne

b.



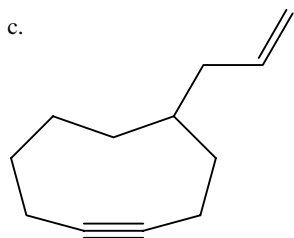
hint



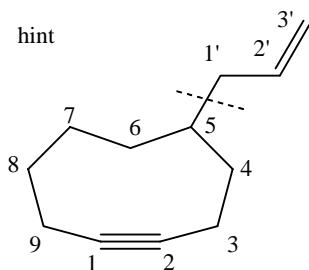
possible answer

2,2,7-trimethylnon-3-yne

c.



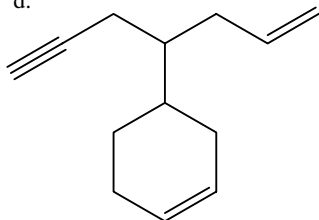
hint



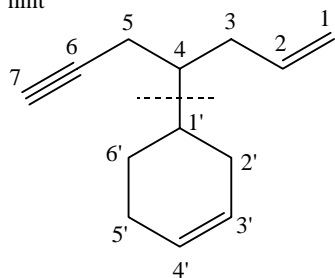
possible answer

5-(prop-2-enyl)cyclonon-1-yne

d.



hint

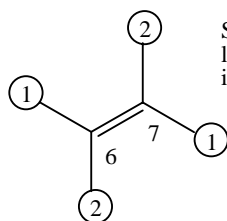
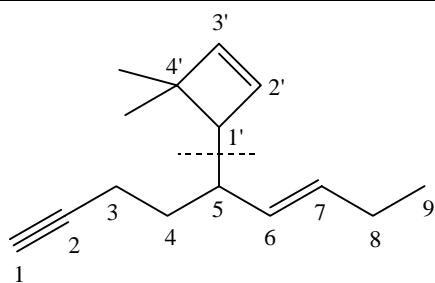
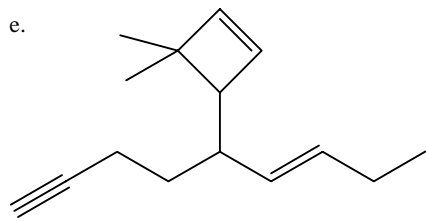


Either the alkene or the alkyne could get #1 based on the lowest possible number at the first point of difference. Since they are similar here, the alkene gets the #1 because it is higher priority when all else is equal.

possible answer

4-(cyclohex-3-enyl)hept-1-en-6-yne

e.



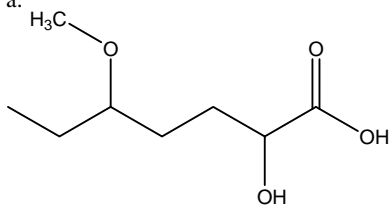
Since the alkyne would get a lower number than the alkene it gets number 1 in this example.

possible answer

5-(4,4-dimethylcyclobut-2-enyl)non-6E-en-1-yne

4. Problems – carboxylic acids

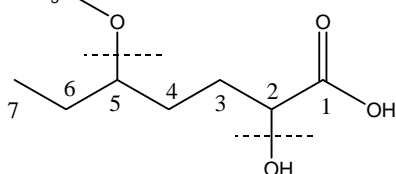
a.



carboxylic acids

prefix = not used in our course (#-carboxy-)

suffix = -oic acid

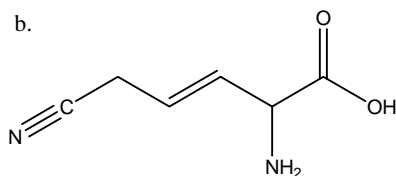
H₃C hint

Functional Groups
1. carboxylic acid
2. alcohol
3. ether

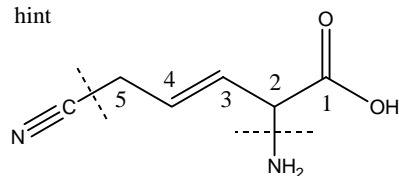
possible answer

2-hydroxy-5-methoxyheptanoic acid

b.



hint

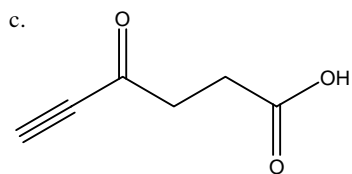


Functional Groups
1. carboxylic acid
2. amine
3. nitrile
4. alkene

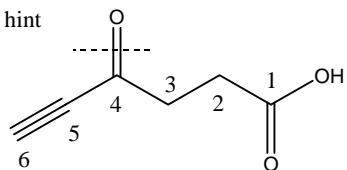
possible answer

Do not count the nitrile carbon in the longest chain when it is a substituent.

2-amino-5-cyanopent-3E-enoic acid



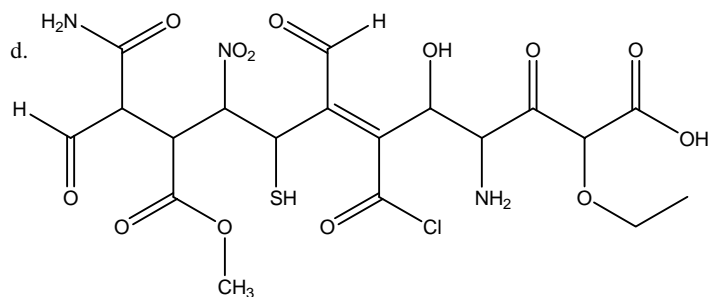
hint

Functional Groups

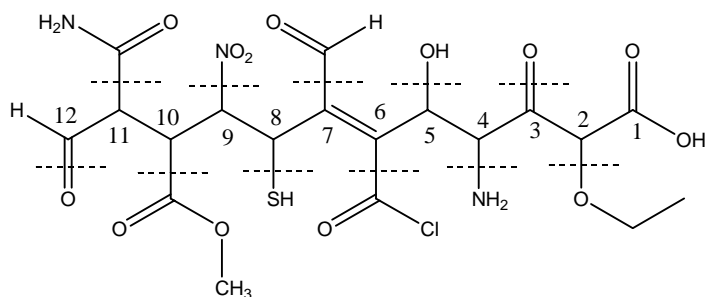
1. carboxylic acid
2. ketone
3. alkyne

possible answer

4-oxohex-5-ynoic acid



hint

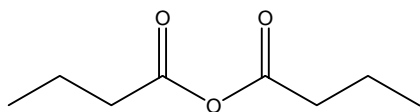
Functional Groups

1. carboxylic acid
2. ether
3. ketone
4. amine
5. alcohol
6. acid chloride
7. aldehyde (branch)
8. thiol
9. nitro
10. methoxy ester
11. 1° amide
12. aldehyde (in longest chain)

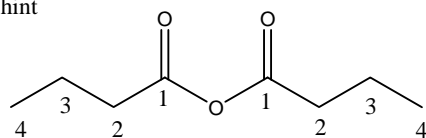
possible answer

2-ethoxy-3,12-dioxo-4-amino-5-hydroxy-6-chloroacetyl-7-formyl-8-mercapto-9-nitro-10-methoxycarbonyl-11-amidodec-6Z-enoic acid

5. Problems –anhydrides

a. **carboxylic anhydrides (we just say "anhydride")** **prefix = not used in our course** **suffix = -oic anhydride**

hint

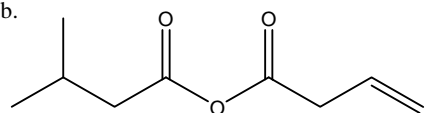


possible answer

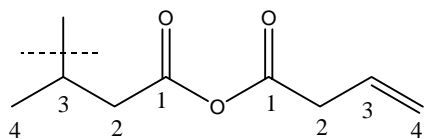
Since both carbon chains are identical you only have to write the name once.

butanoic anhydride

b.



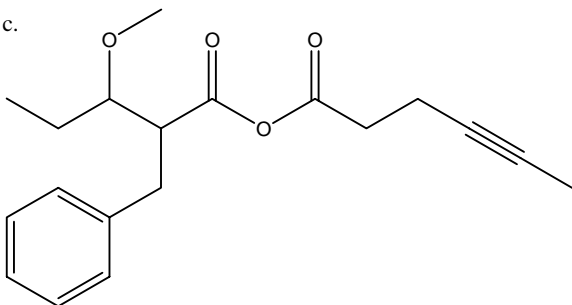
hint



possible answer

3-methylbutanoic but-3-enoic anhydride

c.



possible answer

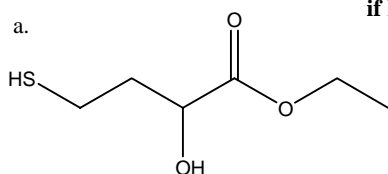
2-benzyl-3-methoxybutanoic hex-4-ynoic anhydride

6. Problems – esters

carboxylic esters (we just say "ester")

if lower priority group name as prefix = #-alkoxycarbonyl-

a.



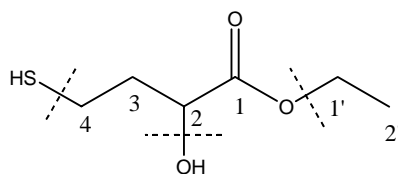
if highest priority group name in two parts: prefix = alkyl part (name as branch) suffix = -oate

hint

Functional Groups

1. ester
2. alcohol
3. thiol

possible answer

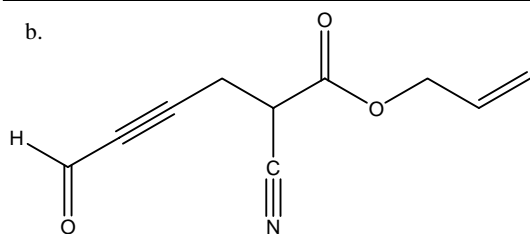


There are two carbon chains to name. The alkoxy side is named in front, as a separate name as though it were a typical branch (-yl ending). It may have its own numbers, but no number is associated with it the way a branch off of the parent chain would have.

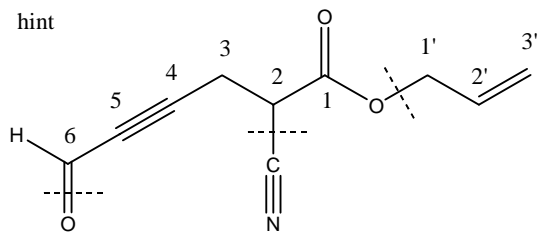
no hyphen,
separate name

↓
ethyl 2-hydroxy-4-mercaptopentanoate

b.



hint



Functional Groups

1. ester
2. nitrile
3. alkyne
4. aldehyde
5. alkene, in front

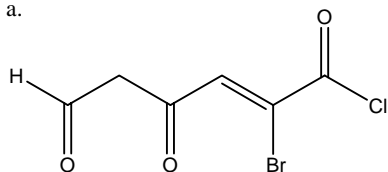
no hyphen,
separate name

possible answer

prop2-enyl 2-cyano-6-oxohex-4-ynoate
or
allyl 2-cyano-6-oxohex-4-ynoate

7. Problems – acid chlorides

a.

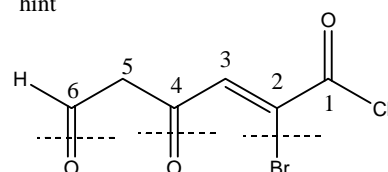


acid chlorides

prefix = chlorocarbonyl-

suffix = -oyl chloride

hint



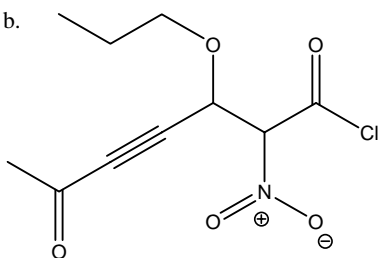
Functional Groups

1. acid chloride
2. bromo
3. alkene
4. ketone
5. aldehyde

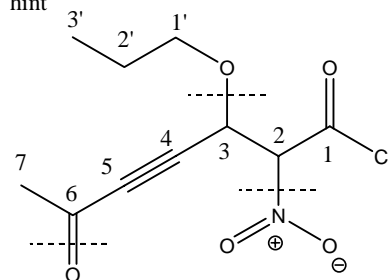
possible answer

2-bromo-4,6-dioxohex-2-enoyl chloride

b.



hint



Functional Groups

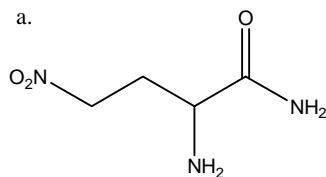
1. acid chloride
2. nitro
3. ether
4. alkyne
5. ketone

possible answer

2-nitro-3-propoxy-6-oxohept-4-ynoyl chloride

8. Problems – amides

a.

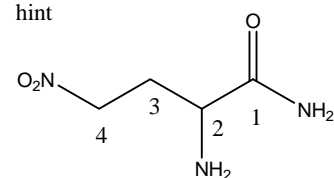


amides

prefix = #-carbamoyl- or #-amido

suffix = -amide

hint



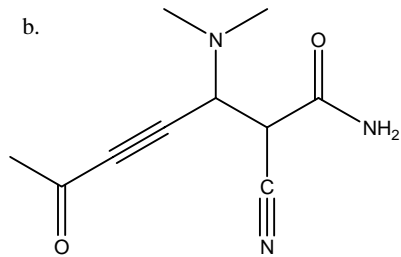
Functional Groups

1. amide
2. amine
3. nitr

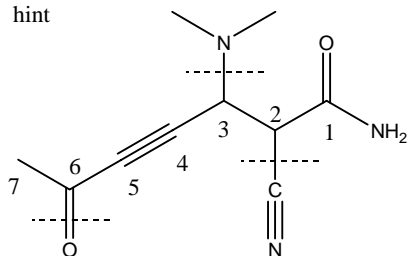
possible answer

2-amino-4-nitrobutanamide

b.



hint

Functional Groups

1. amide
2. nitrile
3. amine
4. alkyne
5. ketone

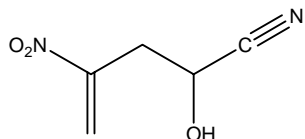
possible answer

2-cyano-3-(N,N-dimethylamino)-6-oxohept-4-ynamide

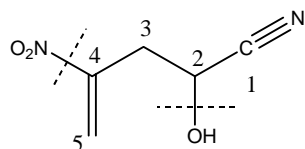
9. Problems – nitriles

a.

nitriles prefix = #-cyano- suffix = -nitrile (don't drop the final "e" before nitrile)



hint

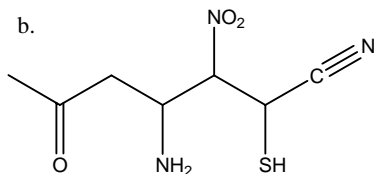
Functional Groups

1. nitrile
2. alcohol
3. nitro
4. alkene

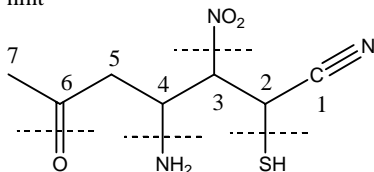
possible answer

2-hydroxy-4-nitropent-4-enitrile

b.



hint

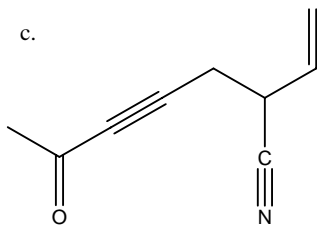
Functional Groups

1. nitrile
2. thiol
3. nitro
4. amine
5. aldehyde

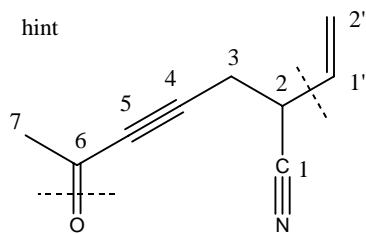
possible answer

2-mercapto-3-nitro-4-amino-6-oxoheptanenitrile

c.



Nomenclature Worksheet



Functional Groups

1. nitrile
2. alkyne
3. ketone
4. alkene

Beauchamp

possible answer

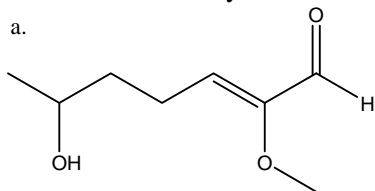
can also call "vinyl"



2-ethenyl-6-oxohept-4-ynenitrile

9. Problems – aldehydes

a.

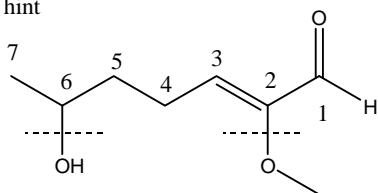


aldehydes

prefix = #-oxo-

suffix = -al

hint



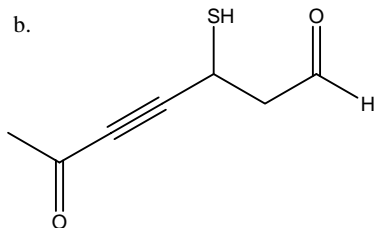
Functional Groups

1. aldehyde
2. ether
3. alcohol
4. alkene

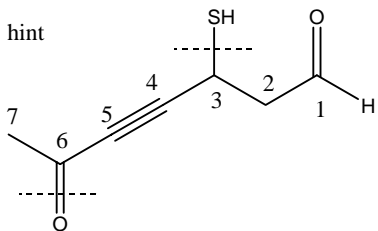
possible answer

2-methoxy-6-hydroxyhept-2Z-enal

b.



hint



Functional Groups

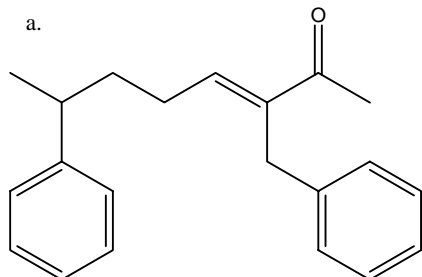
1. aldehyde
2. thiol
3. alkyne
4. ketone

possible answer

3-mercapto-6-oxohept-4-ynal

10. Problems – ketones

a.

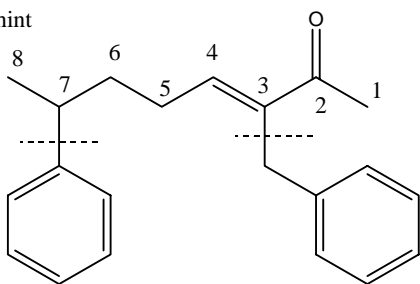


ketones

prefix = #-oxo- (older = #-keto-)

suffix = -one (sounds like "cone")

hint

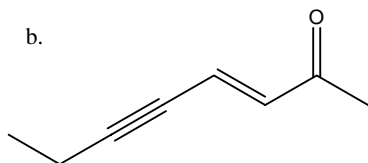
Functional Groups

1. ketone
2. benzyl
3. phenyl
4. alkene

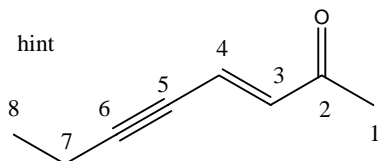
possible answer

3-benzyl-7-phenyloct-3E-en-2-one

b.



hint

Functional Groups

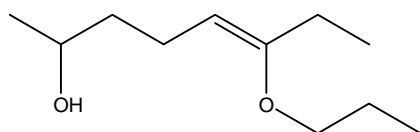
1. ketone
2. alkene
3. alkyne

possible answer

oct-3E-en-5-yn-2-one

11. Problems – alcohols

a.

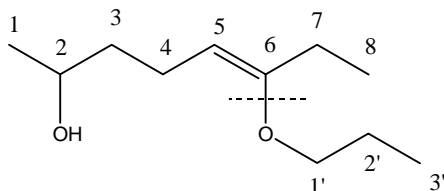


alcohols

prefix = #-hydroxy

suffix = #-ol

hint

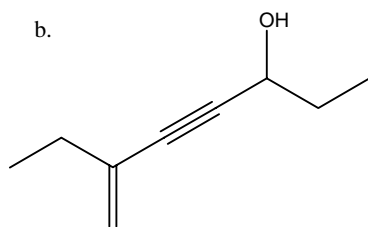
Functional Groups

1. alcohol
2. ether
3. alkene

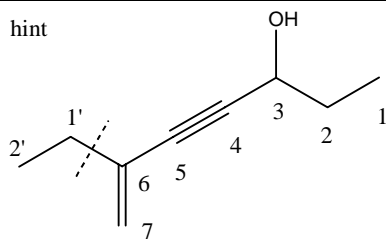
possible answer

6-propoxyoct-5Z-en-2-ol

b.



hint

Functional Groups

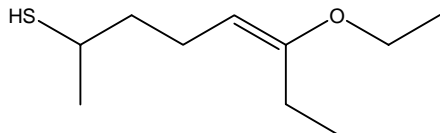
1. alcohol
2. alkyne
3. alkene

possible answer

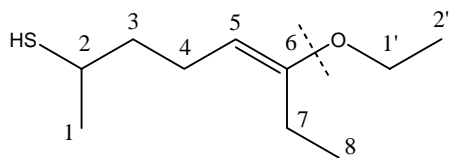
6-ethylhept-6-en-4-yn-3-ol

12. Problems – thiols

a. **thiols** **prefix = #-mercapto-** **suffix = #-thiol** (don't drop the final "e" before thiol)



hint

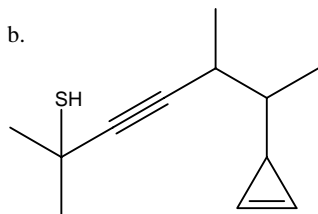
Functional Groups

1. thiol
2. ether
3. alkene

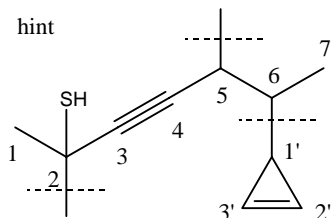
possible answer

6-ethoxyoct-5E-en-2-thiol

b.



hint

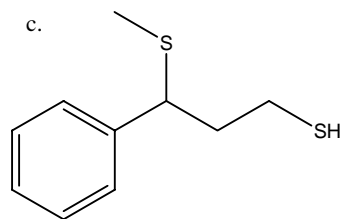
Functional Groups

1. thiol
2. cycloalkene
3. alkyne

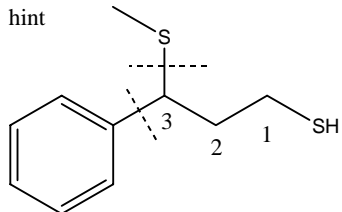
possible answer

2,5-dimethyl-6-(cycloprop-2-enyl)hept-3-yne-2-thiol

c.



hint

Functional Groups

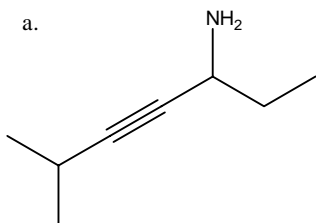
1. thiol
2. sulfide
3. aromatic

possible answer

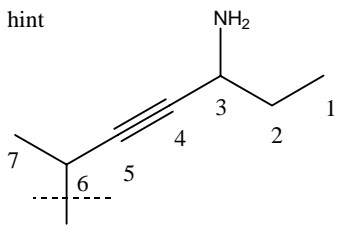
3-phenyl-3-methylthioprop-1-ylthiol

13. Problems – amines

a. **amines** **prefix = #-amino-** **suffix = #-amine**



hint

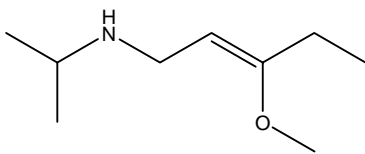
Functional Groups

1. amine
2. alkyne

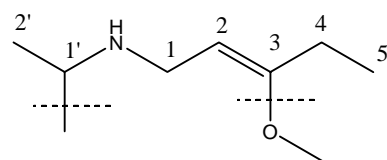
possible answer

6-methylhept-4-yn-3-amine

b.



hint

Functional Groups

1. amine
2. alkene
3. ether

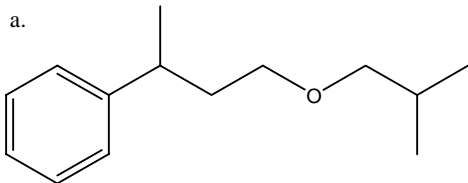
possible answer

N-(1-methylethyl)-3-methoxy-2Z-en-1-amine

↑
can also use "N-isopropyl"

14. Problems – ethers

a.

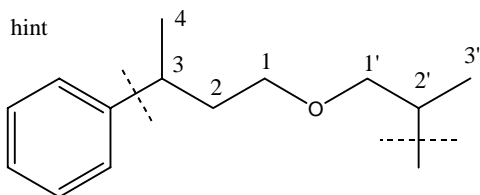


ethers

prefix = (<5C) = alkoxy (≥5C) = alkyloxy

suffix = none

hint

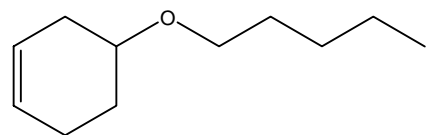
Functional Groups

1. ether
2. aromatic

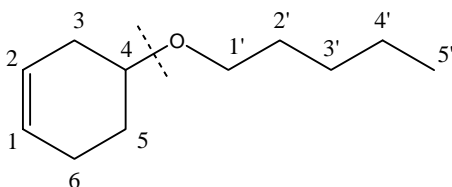
possible answer

1-(2-methylpropoxy)-3-phenylbutane
or
isobutyl 3-phenylbutyl ether

b.



hint

Functional Groups

1. ether
2. cycloalkene

possible answer

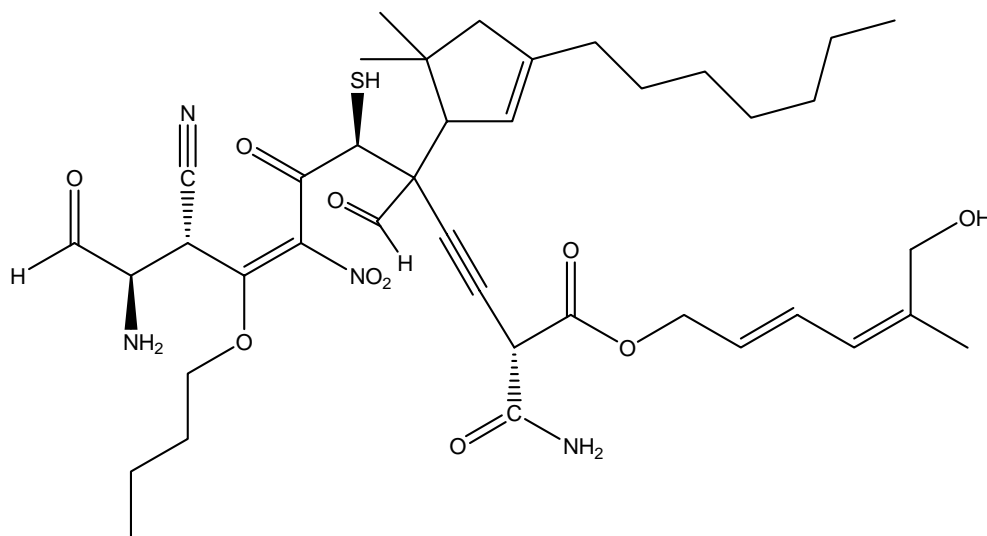
4-pentyloxycyclohex-1-ene

15. Problems – miscellaneous low priority groups

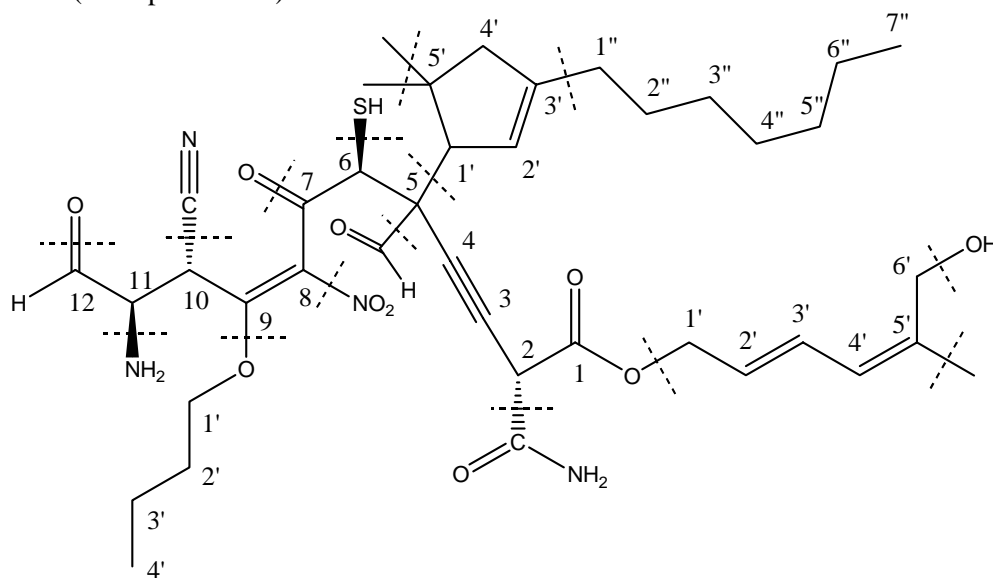
This problem has most of the functional groups you are responsible for in a first year course in organic chemistry. The problem, as difficult as it looks, is doable if you are systematic in your approach. A possible strategy to follow is listed just below.

Some Points to Consider

1. What is the highest priority group present?
2. What is the longest chain with that group?
3. Number that chain (or ring) so that the high priority group gets the lowest number (often this is a 1 and not written).
4. Identify branches and lower priority functionality with their numbers (usually named as prefixes, except “-ene” and “-yne”).
5. Combine everything into one name with proper use of hyphens (between numbers and letters) and commas (between numbers and numbers).



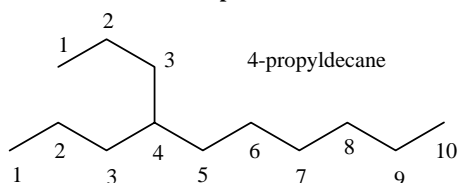
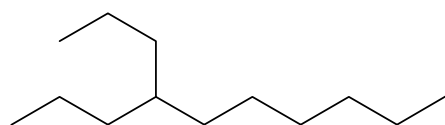
A possible solution (not alphabetized).



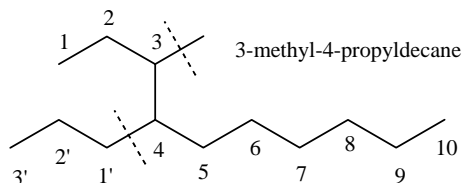
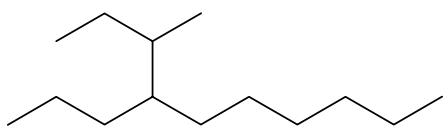
6-hydroxy-5-methylhexa-2E,4Z-dienyl (2S,6S,8Z,10R,11R)-2-carbamoyl-5-formyl-5-(3-heptyl-5,5-dimethylcyclopent-2-enyl)-6-mercapto-7,12-dioxo-8-nitro-9-butoxy-10-cyano-11-aminododec-8-en-3-ynoate

alkane structures

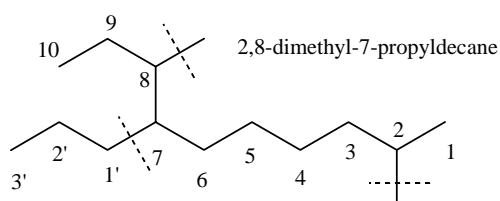
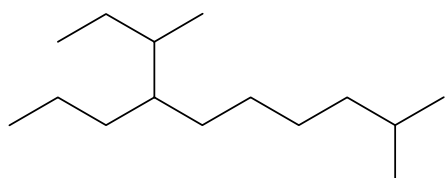
possible answers



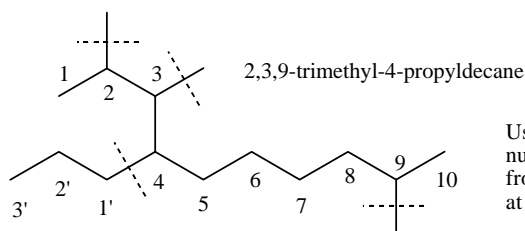
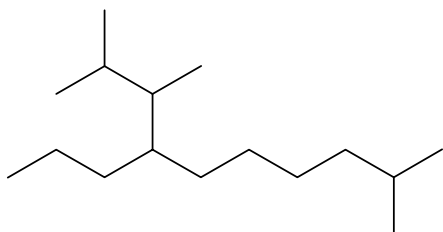
Two equivalent chains. Number from left so lower initial number.



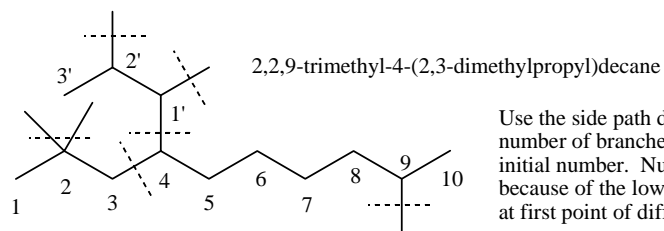
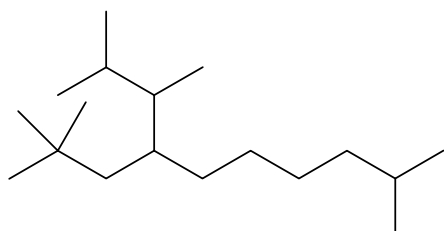
Use the top path due to a greater number of branches. Number from left so lower initial number.



Use the top path due to a greater number of branches. Number from right so lower initial number.

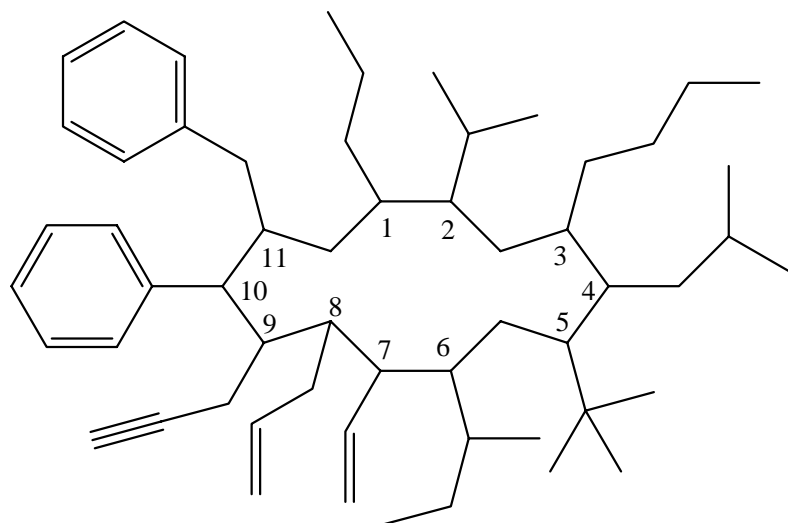


Use the top path due to a greater number of branches. Number from right so lower initial number at first point of difference.



Use the side path due to a similar number of branches, but lower initial number. Number from right because of the lower initial number at first point of difference.

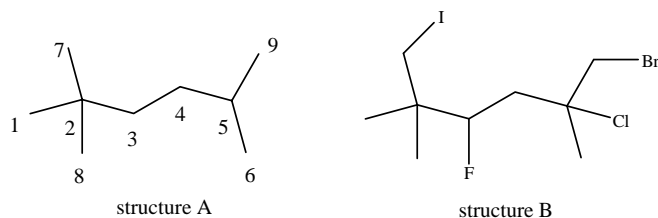
What are the common names of the branches at each number?



Common names of the branches.

1. propyl (or n-propyl)
2. isopropyl
3. butyl (or n-butyl)
4. isobutyl
5. t-butyl
6. sec-butyl
7. vinyl
8. allyl
9. propargyl
10. phenyl
11. benzyl

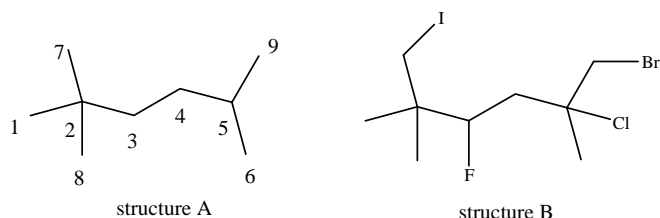
Identify each carbon atom as primary, secondary, tertiary or quaternary.



primary carbon = 1° = 1, 6, 7, 8, 9
 secondary carbon = 2° = 3, 4
 tertiary carbon = 3° = 5
 quaternary carbon = 4° = 2

same answers for either structure A or B

Identify each carbon atom as methyl, methylene or methine.



methyl = 1, 6, 7, 8, 9
 methylene = 3, 4
 methine = 5
 none of the above = 2

answers for structure A

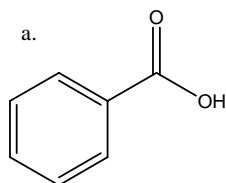
methyl = 1, 6, 8
 methylene = 4, 7, 9
 methine = 3
 none of the above = 2, 5

answers for structure B

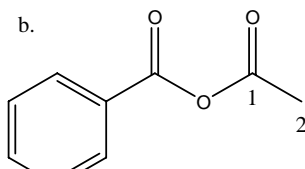
Provide an acceptable structure for each of the following names.

- 2,4-dimethylhexane
- 1,3,5,5-tetramethyl-1-cycloheptene
- trans-5-hepten-1-yne or 5E-hepten-1-yne
- 5-(4-methyl-2-cyclobutenyl)-1-nonene
- trans-3-ethyl-1-isopropylcyclopentane
- cis-1-t-butyl-4-isobutylcyclohexane
- trans-2-cis-4-decadien-6,8-diyne or 2E,4Z-decadien-6,8-diyne
- 1-allyl-3-propargyl-6-vinylcyclodecane or 1-(2-propenyl)-3-(2-propynyl)-6-ethenylcyclodecane
- 1-hepten-6-yne
- 3-allyl-1-sec-butyl-1-cyclopropene or 3-(2-propenyl)-1-(1-methylpropyl)-1-cyclopropene
- 3-propyl-1-trans-6-octadiene or 3-propyl-1E,6-octadiene
- 7-(1,1-dimethylethyl)-4-(1-methylpropyl)-1-cycloundecyne
- 2,9,10-trimethyl-6-butyldodecane
- 1-(1,3-dimethylbutyl)-4-methyl-1,3,5,7-cyclooctatetraene
- 2,9,10-trimethyl-6-butyldodecane
- trans-(3,3-dimethylbutyl)-3-methylcyclooctane
- 7-(1,1-dimethylethyl)-4-(1-methylpropyl)-1-cycloundecyne
- 1-hepten-6-yne
- 1-trans-3-cis-7-cis-cycloundecatriene or 1E,3Z,7Z-cycloundecatriene
- 3-benzyl-6-ethyl-7-phenyl-2Z-octene

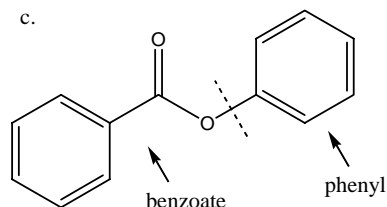
Some aromatic structures and their common names (not required in 314 or 315).



benzoic acid

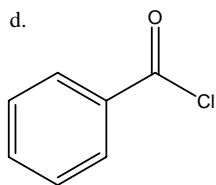


benzoic ethanoic anhydride

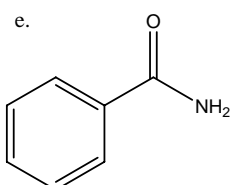


phenyl benzoate

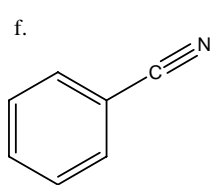
no hyphen,
separate name



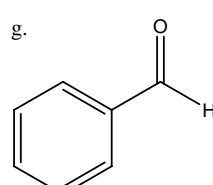
benzoyl chloride



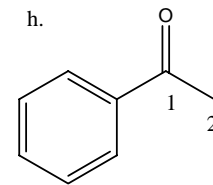
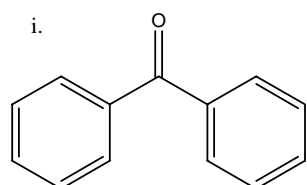
benzamide



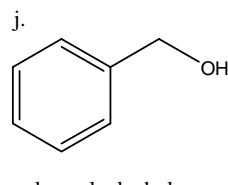
benzonitrile



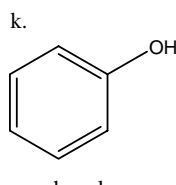
benzaldehyde

acetophenone
or
1-phenylethanone

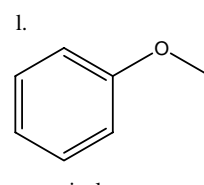
benzophenone



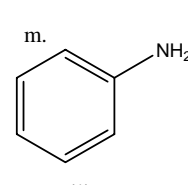
benzyl alcohol



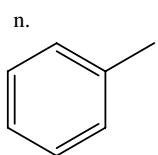
phenol



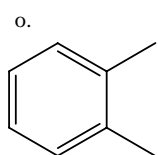
anisole



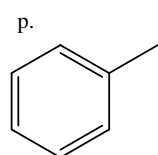
aniline



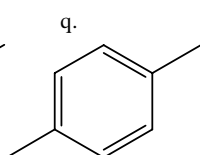
toluene



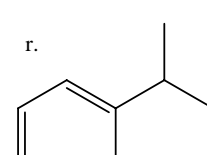
ortho-xylene



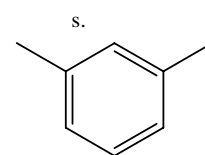
meta-xylene



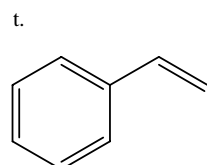
para-xylene



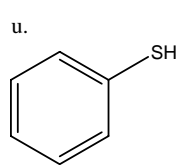
cumene



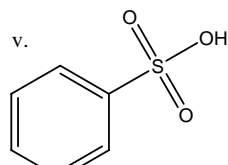
mesitylene



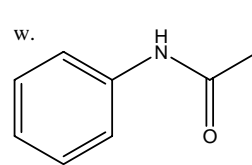
styrene



thiophenol

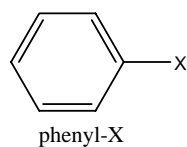


benzenesulfonic acid

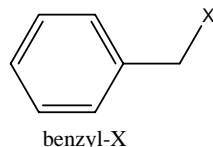


acetanilide

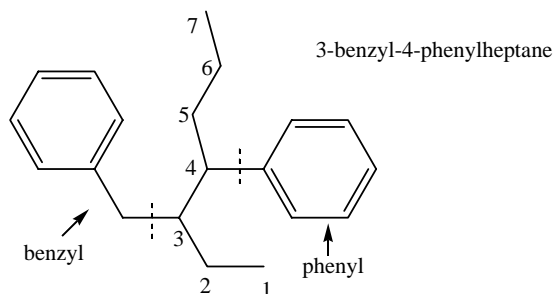
Don't confuse phenyl and benzyl.



phenyl-X



benzyl-X

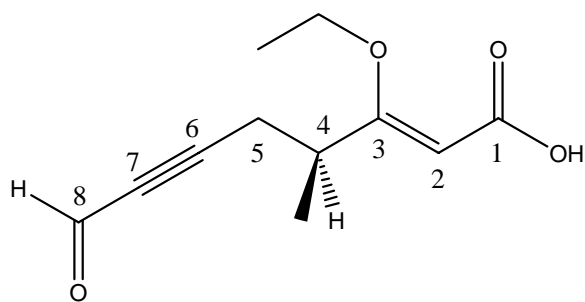


3-benzyl-4-phenylheptane

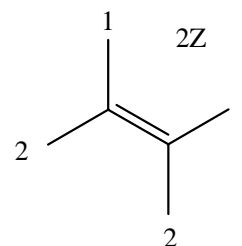
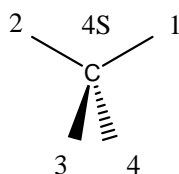
General Strategy For Naming Simple Organic Compounds (Bare bones summary sheets)

1. Find the highest priority group. These are listed in order of priority in the table of functional groups.
2. Find the longest chain containing the highest priority group. You should know carbon chains of length C₁-C₁₂ (listed in the table).
3. Number the longest chain containing the highest priority group to give the highest priority group the lowest number possible in numbering the longest chain. For the first seven groups, the functional group carbon will be number 1 (if it is the highest priority group) and the "1" can be omitted, since it is understood that it has to be this way.
4. Usually the highest priority group is named as a suffix at the end of alkane, alk-#-ene or alk-#-yne. The final e is dropped if the suffix begins with a vowel and it is retained if the suffix begins with a consonant. A number will be present in front of the suffix name unless its position is unambiguously clear (i.e. carboxyl groups aldehydes, nitriles, etc. always = 1, if highest in priority). If there is a C/C pi functional group to identify (alkene or alkyne), the number in front of its part of the name describes its position (see rule 6 below). If both a pi bond and a high priority substituent are present, then two numbers may be necessary, one for each functionality.
5. Lower priority groups are named with their prefix names and their location numbers based on the numbering of the parent chain (always true for substituents numbered 12 on the next page). The lower priority substituents should be listed in alphabetical order. Some parts of prefix names count in this regard and some don't. We will not emphasize this aspect in this course.
6. Double bonds and triple bonds are named as alk-#-ene or alk-#-yne, respectively. If both are present, name as alk-#-en-#-yne. Multiple pi bonds (or other substituents) use the prefixes di, tri, tetra, penta etc. with a number for each occurrence. In such cases, an "a" is added in front of the numerical prefix for better phonetics. (alka-#,#-diene or alka-#,#,#-triyne, alka-#,#-dien-#,#-diyne, etc.)

The essential functional groups to know (for our course) and their prefixes and suffixes are given in the attached table. In this table the term "alkan-#-suffix" is a generic term for any alkane with a functional group suffix, and it must be replaced with the correct parent stem name based on the number of carbons in the longest chain (C₁-C₁₂ for us). If there is a double bond, the name will change to "alk-#-en-#-suffix" and if there is a triple bond, the name will change to "alk-#-yn-#-suffix".

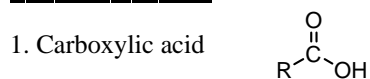


(2Z,4S)-3-ethoxy-4-methyl-8-oxooct-2-en-6-ynoic acid



Notice that no "1" is used for the carboxylic acid group, because it has to be "1" in this structure.

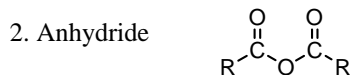
Functional Group



prefix
#-carboxy
not considered

suffix
alkano**ic acid**

The part of each name specific to the functional group is in **bold** and underlined to help you see those features.



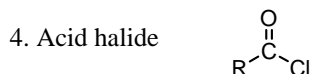
#-acyloxyalkanecarbonyl
not considered

alkano**ic anhydride**
(if symmetrical)



#-**alkoxycarbonyl**

alkyl alkano**ate**
(R') (RCO₂)



#-**chlorocarbonyl**

alkan**oyl chloride**



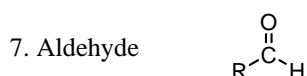
#-**carbamoyl**
#-**amido**

alkan**amide**



#-**cyano**

alkan**e nitrile**



#-**oxo**

alkan**al**



#-**oxo** (older = #-**keto**)

#-alkan**one**



#-**hydroxy**

#-alkan**ol**



#-**mercapto**

#-alkan**ethiol**

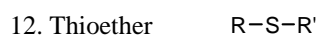


#-**amino**

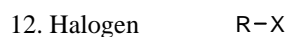
#-alkyl**amine** / #-alkan**amine**



#-**alkoxy** (if more than 5C's, then #-alkoxy) (can also use "#-oxa" prefix and count as carbon in longest chain)



#-alkyl**thio**



#-**fluoro**, #-**chloro**, #-**bromo**, #-**iodo**



#-**azido**



#-**diazo**



#-**nitro**



#-**nitroso**



"R" = carbon chains		
# carbons	alkane chain name	alkyl branch name
1	methane	methyl
2	ethane	ethyl
3	propane	propyl
4	butane	butyl
5	pentane	pentyl
6	hexane	hexyl
7	heptane	heptyl
8	octane	octyl
9	nonane	nonyl
10	decane	decyl
11	undecane	undecyl
12	dodecane	dodecyl
13	tridecane	tridecyl
14	tetradecane	tetradecyl
15	pentadecane	pentadecyl
16	hexadecane	hexadecyl
17	heptadecane	heptadecyl
18	octadecane	octadecyl
19	nonadecane	nonadecyl
20	icosane	icocyl
	etc.	

always prefixes (no suffix names)

* = formal charge is necessary in these Lewis structures and there are two reasonable resonance structures

