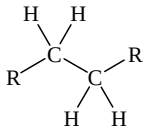
In this handout, all of our functional groups are presented as condensed line formulas, 2D and 3D formulas and with nomenclature prefixes and suffixes (if present). Organic names are built on a foundation of alkanes, alkenes and alkynes. Those examples are presented first and you need to know those rules. The strategies can be found in Chapter 4 of our textbook (alkanes: pages 93-98, cycloalkanes 102-104, alkenes: pages 104-110, alkynes: pages 112-113 and combinations of all of them 113-115). After introducing examples of alkanes, alkenes, alkynes and combinations of them, the functional groups are presented in order of priority. A few nomenclature examples are provided for each of the functional groups. Examples of the various functional groups are presented on pages 115-135 in the textbook. Two overview pages are on pages 136-137. Some functional groups have a suffix name when they are the highest priority functional group and a prefix name when they are not the highest priority group, and these are added to the skeletal names with identifying numbers and stereochemistry terms (E and Z for alkenes, R and S for chiral centers and cis and trans for rings). Several low priority functional groups only have a prefix name. A few additional special patterns are shown on pages 98-102. The only way to learn this topic is practice (over and over). The best practice approach is to actually write out the names (on an extra piece of paper or on a white board, and then do it again). The same functional groups are used throughout the entire course. Once you know them, it's like shuffling a deck of cards. The queen of hearts is always the queen of hearts, and an ester is always an ester. The main variables for a functional group are highest priority (suffix) or lower priority (prefix) and what number identifies it.

**Alkanes** **prefix = none** **suffix = -ane**

alkanes - try to draw 3D structures in a zig-zag shape



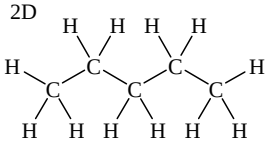
suffix: #-ane

prefix: none

$CH_3CH_2CH_2CH_2CH_3$

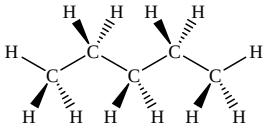
condensed line formula

2D

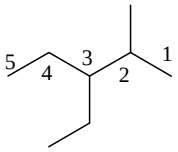


IUPAC: pentane

3D



IUPAC: pentane




3-ethyl-2-methylpentane

---

alkanes Add 2 to "n" to include the end methyl groups (total chain length in parentheses)

$CH_4$ = methane (1C)

$H_3C-(CH_2)_n-CH_3$

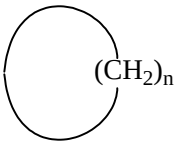
chain length = n + 2

n = 0 = ethane (2C)
n = 1 = propane (3C)
n = 2 = butane (4C)
n = 3 = pentane (5C)
n = 4 = hexane (6C)
n = 5 = heptane (7C)
n = 6 = octane (8C)
n = 7 = nonane (9C)
n = 8 = decane (10C)
n = 9 = undecane (11C)
n = 10 = dodecane (12C)
n = 11 = tridecane (13C)
n = 12 = tetradecane (14C)
n = 13 = pentadecane (15C)
n = 14 = hexadecane (16C)
n = 15 = heptadecane (17C)
n = 16 = octadecane (18C)
n = 17 = nonadecane (19C)

branch names
1C methyl
2C ethyl
3C propyl
4C butyl
5C pentyl
6C hexyl
7C heptyl
8C octyl
9C nonyl
10C decyl

---

cycloalkanes

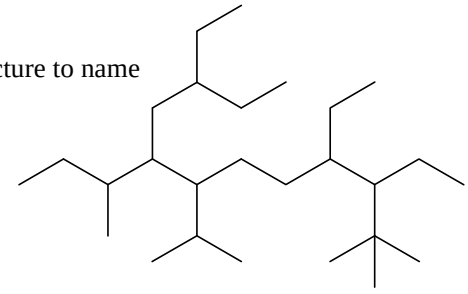



ring size = n

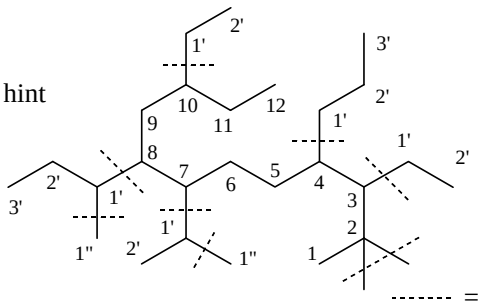
n = 3 = cyclopropane
n = 4 = cyclobutane
n = 5 = cyclopentane
n = 6 = cyclohexane
n = 7 = cycloheptane
n = 8 = cyclooctane
n = 9 = cyclononane
n = 10 = cyclodecane
n = 11 = cycloundecane
n = 12 = cyclododecane
n = 13 = cyclotridecane
n = 14 = cyclotetradecane

a.

structure to name



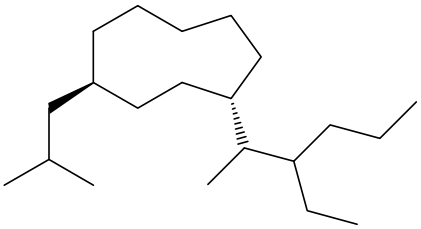
hint



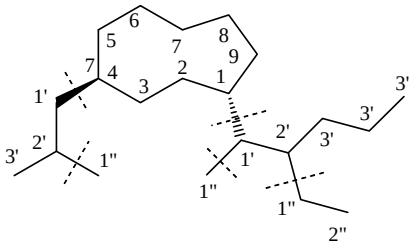

------ = a branch point

b.

structure to name

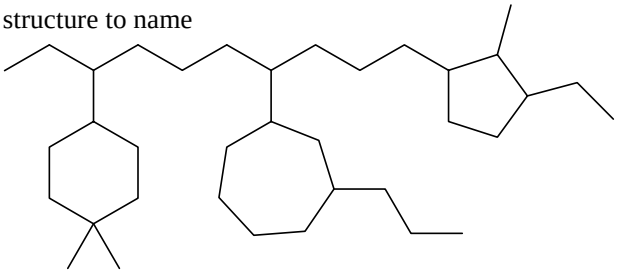


hint

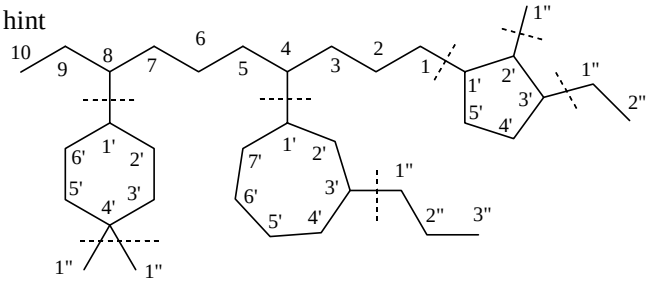


c.

structure to name



hint



answers

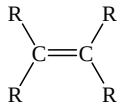
a. 2,2-dimethyl-3,10-diethyl-4-propyl-7-(1-methylethyl)-8-(1-methylpropyl)dodecane

b. t rans-1-(1-methyl-2-ethylpentyl)-4-(2-methylpropyl)cyclononane

c. 1-(2-methyl-3-ethylcyclopentyl)-4-(3-propylcycloheptyl)-8-(4,4-dimethylcyclohexyl)decane

**Alkenes** **prefix = none** **suffix = -ene**

alkenes (always a suffix on the stem name)

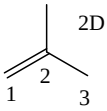


suffix: #-ene

prefix: none

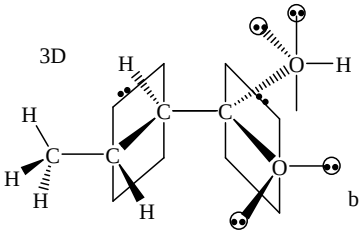
Condensed line formula

$CH_2C(CH_3)_2$



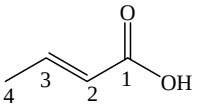
IUPAC: methylprop-2-ene

common: isobutylene

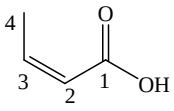


but-2E-enoic acid

$CH_3CHCHCO_2H$



but-2Z-enoic acid



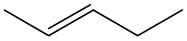
E = high priority opposite side

Z = high priority same side

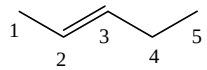
**Alkenes**

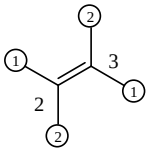
a.

structure to name



hint

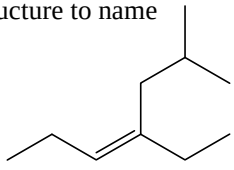




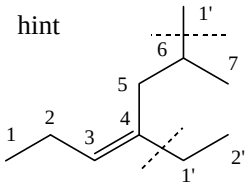
2E stereochemistry

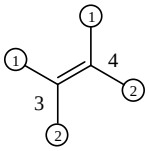
b.

structure to name



hint

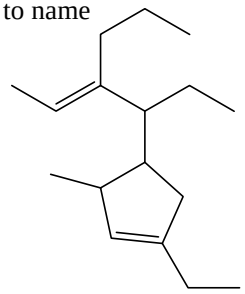




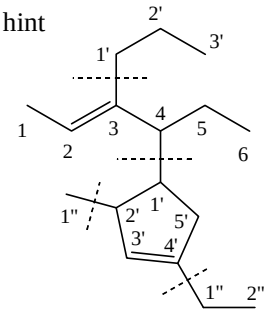
3Z stereochemistry

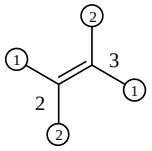
c.

structure to name



hint



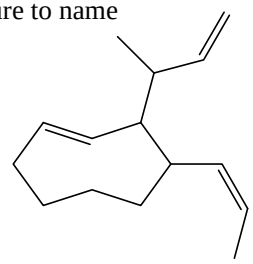


3E stereochemistry

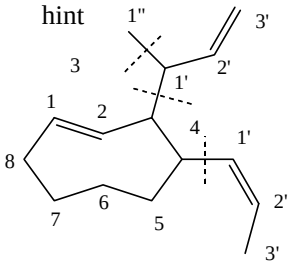
---

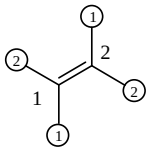
d.

structure to name

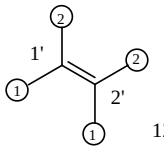


hint





1E stereochemistry

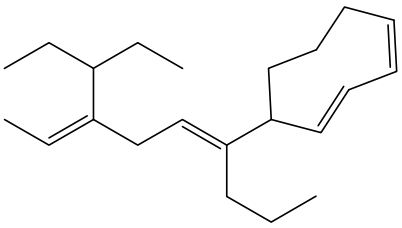


1Z stereochemistry

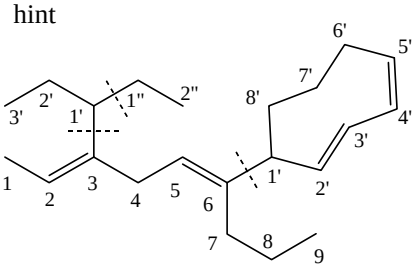
---

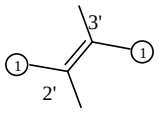
e.

structure to name

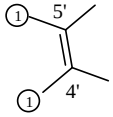


hint

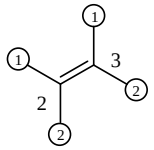




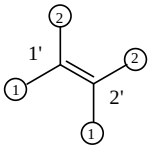
2E stereochemistry



4Z stereochemistry



2Z stereochemistry



5E stereochemistry

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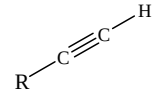
**answers**

a. pent-2E-ene
b. 4-ethyl-6-methylhept-3Z-ene
c. 3-propyl-4-(2-methyl-4-ethylcyclopent-3-enyl)hex-3E-ene
d. 3-(1-methylprop-2-enyl)-4-(prop-1Z-enyl)cyclooct-1E-ene
e. 3-(1-ethylpropyl)-6-(cycloocta-2E,4Z-dienyl)nona-2Z,5E-diene

**Alkynes** **prefix = none** **suffix = -yne**

alkynes (always a suffix on the stem name)



suffix: #-yne

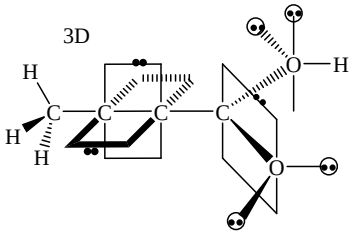
prefix: none

2D

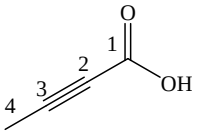
IUPAC: ethyne

common: acetylene

3D

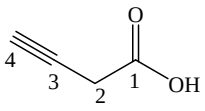


$CH_3CCCO_2H$



but-2-ynoic acid

$HCCCH_2CO_2H$



but-3-ynoic acid

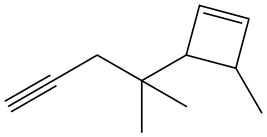
E/Z is not possible with alkynes

---

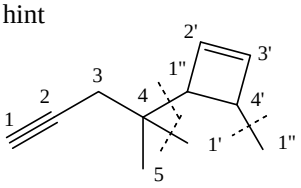
**Alkynes**

a.

structure to name



hint

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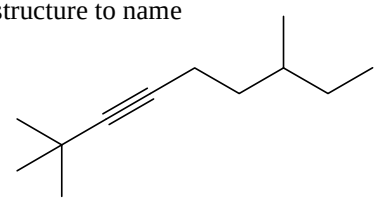
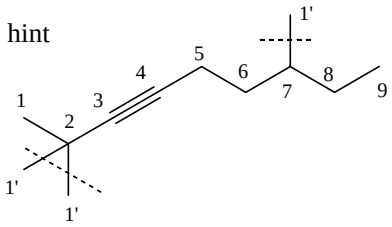
b.

structure to name



hint

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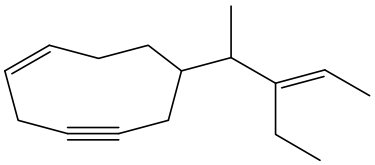
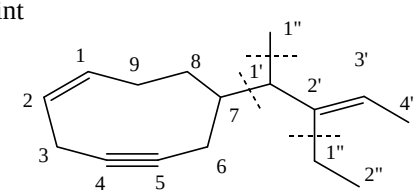
c.

structure to name



hint

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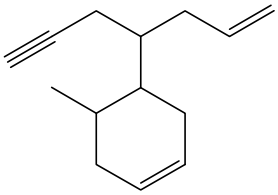
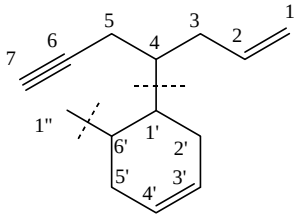
d.

structure to name



hint

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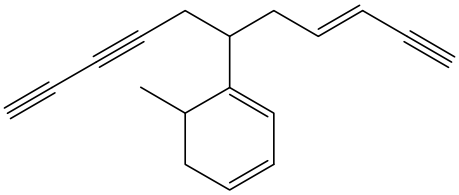
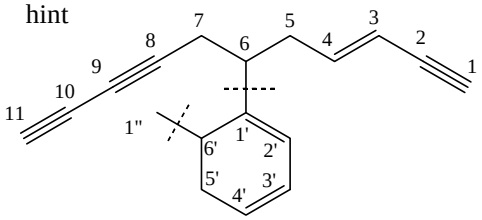
e.

structure to name



hint



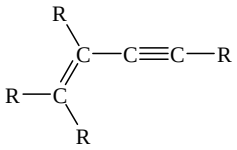

---

**answers:**

a. 4-(4-methylcyclobut-2-enyl)-4-methylpent-1-yne
b. 2,2,7-trimethylnon-3-yne
c. 7-(-1-methyl-2-ethylbut-2E-enyl)cyclonon-1Z-en-4-yne
d. 4-(6-methylcyclohex-3-enyl)hept-1-en-6-yne
e. 6-(6-methylcyclohexa-1,3-dienyl)undec-3E-en-1,8,10-triyne

## Combinations of alkenes and alkynes  prefix = none  suffix = -#-en-#-yne

alkenes and alkynes (always a suffix on the stem name, -#-en-#-yne)



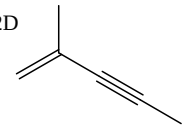
suffix: #-en-#-yne

prefix: none

Condensed line formula

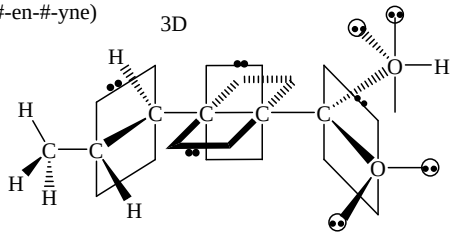
$H_2CC(CH_3)CCCH_3$

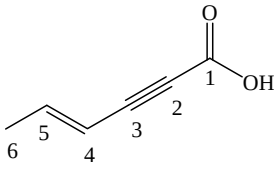
2D



IUPAC: 2-methylpent-1-en-3-yne

3D



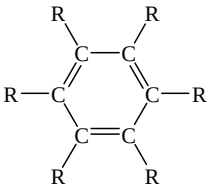


hex-4Z-en-2-ynoic acid

---

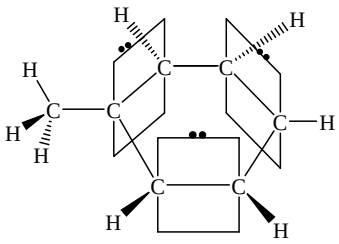
## Aromatics have many special names, for now we will only use phenyl and benzyl prefixes

aromatics (2D)



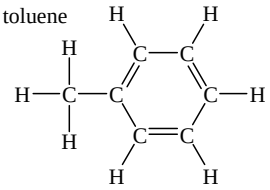
many special names

3D aromatic

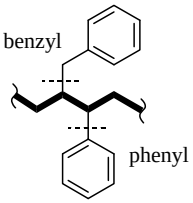


IUPAC: methylbenzene

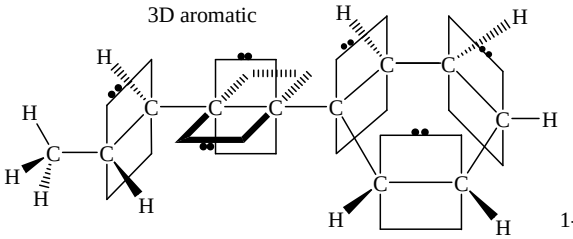
common: toluene



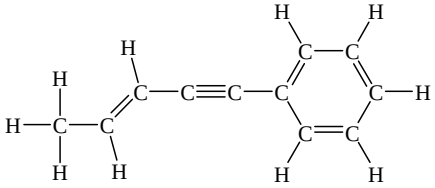
branches



3D aromatic



(2D)



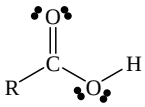
1-phenylpent-3E-en-1-yne

---

## Carboxylic Acids  prefix = carboxy (we won't use this one)  suffix = -oic acid

| Generic Functional Group Pattern in ordero of nomenclature priority in our course. | Specific Example Using Suffix (2D and 3D) when highest priority FG | Specific Example Using Prefix when lower priority FG |
|---|---|---|

1. carboxylic acid (2D)



suffix: -oic acid

prefix: #-carboxy

Condensed line formula

$RCO_2H$ or $HO_2CR$

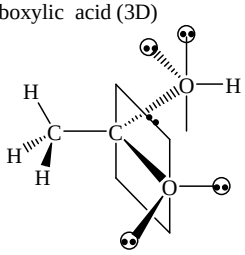
$RCH(CO_2H)R'$

FG on the right

FG in the middle

FG on the left

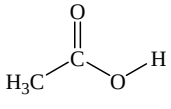
carboxylic acid (3D)



carbonyl resonance (C=O) is possible

IUPAC: ethanoic acid

common: acetic acid



(2D)

prefix example

#-carboxy

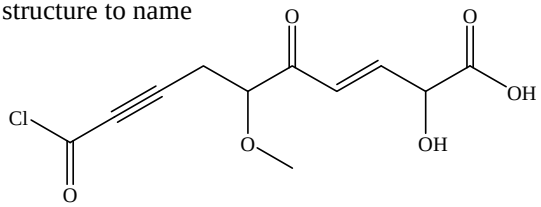
not used in our course (acids are the highest priority group that we use)

---

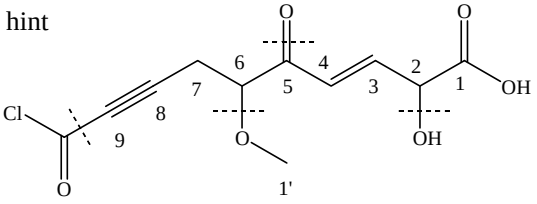
## Carboxylic acids

a.

structure to name



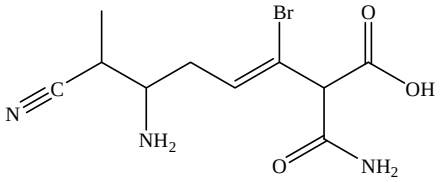
hint



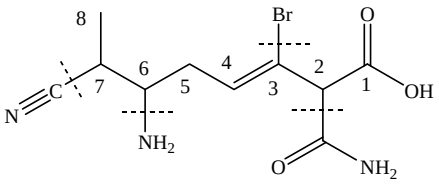
Functional groups
1. carboxylic acid
2. alcohol
3. alkene
4. ketone
5. ether
6. alkyne
7. acid chloride

b.

structure to name



hint

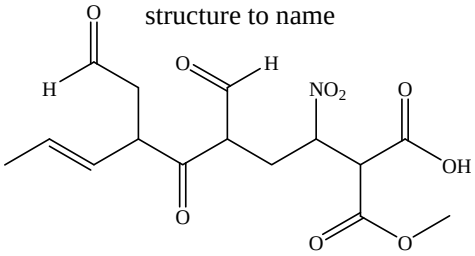


Functional groups
1. carboxylic acid
2. amide
3. bromo
4. alkene
5. amine
6. nitrile

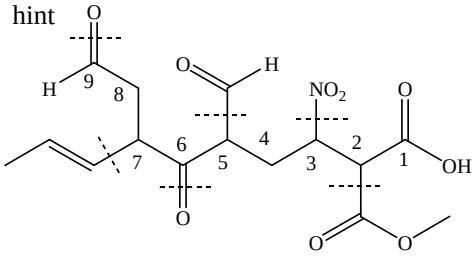
---

c.

structure to name



hint

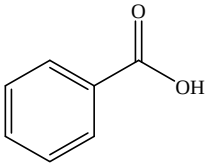


Functional groups
1. carboxylic acid
2. ester
3. nitro
4. aldehyde
5. ketone
6. alkene
7. aldehyde

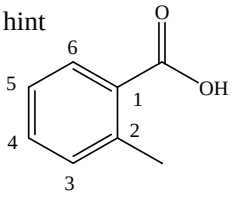
---

d.

structure to name



hint



---

answers:

a. 2-hydroxy-5-oxo-6-methoxy-9-chlorocarbonylnon-3E-en-8-ynoic acid

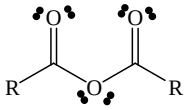
b. 2-amido-3-bromo-6-amino-7-cyanooct-3Z-enoic acid

c. 2-methoxycarbonyl-3-nitro-5-formyl-6,9-dioxo-7-(prop-1E-enyl)nonanoic acid

d. benzoic acid 2-methylbenzoic acid

**Anhydrides** **prefix = too complicated for us** **suffix = -oic -oic anhydride**

2. anhydride (2D)



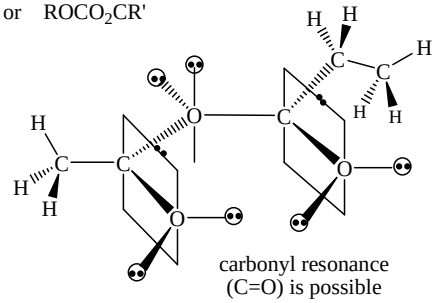
suffix: -oic -oic anhydride
(just one -oic anhydride,
if symmetrical)

prefix: #-acyloxyalkanecarbonyl
(prefix not required for us)

Condensed line formula

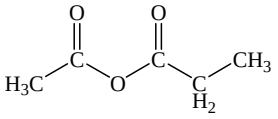
$RCO_2COR'$ or $ROCO_2CR'$

anhydride (3D)



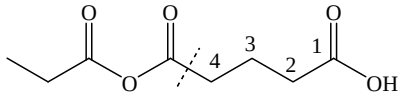
carbonyl resonance
(C=O) is possible

IUPAC: ethanoic propanoic anhydride



(2D)

prefix example



4-acyloxyethanecarbonylbutanoic acid

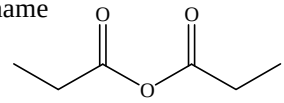
(prefix not required for us - too difficult)

---

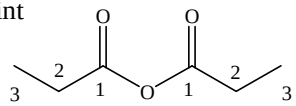
**Anhydrides**

a.

structure to name



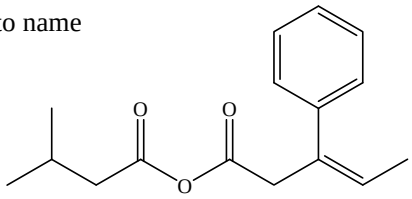
hint



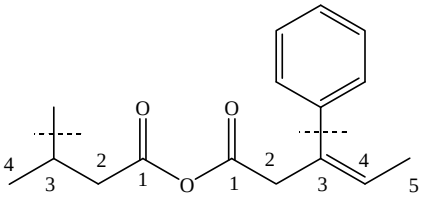
---

b.

structure to name



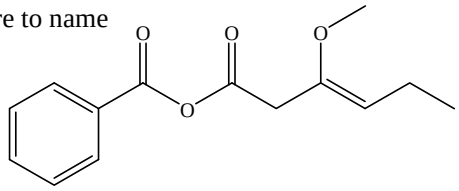
hint



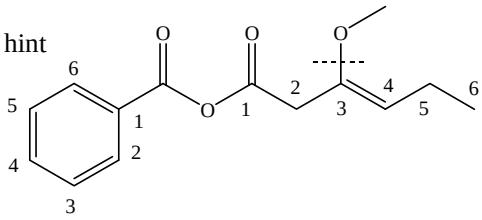
Functional groups
1. anhydride
2. phenyl
3. alkene

c.

structure to name



hint



Functional groups
1. anhydride
2. ether
3. alkene
4. aromatic

answers:

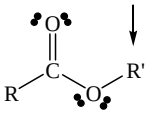
a. propanoic anhydride (since it is symmetrical you only have to write the name one time)

b. 3-methylbutanoic 3-phenylpent-3Z-enoic anhydride

c. benzoic 3-methoxyhex-3Z-enoic anhydride

**Esters** **prefix = #-alkoxycarbonyl** **prefix: "alkyl branch" on oxygen** **suffix = -oate**

3. ester (2D)



alkyl name (goes in front as separate word)

Condensed line formula

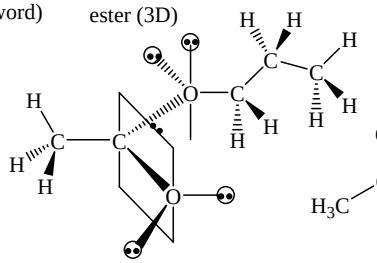
$RCO_2R'$ or $R'O_2CR$

$RCH(CO_2CH_3)R'$

prefix: alkyl suffix: -oate (in longest chain)

prefix: #-alkoxycarbonyl (as a branch)

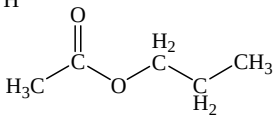
ester (3D)



carbonyl resonance
(C=O) is possible

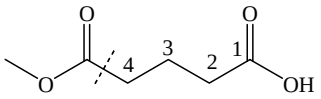
IUPAC: propyl ethanoate

common: propyl acetate



(2D)

prefix example

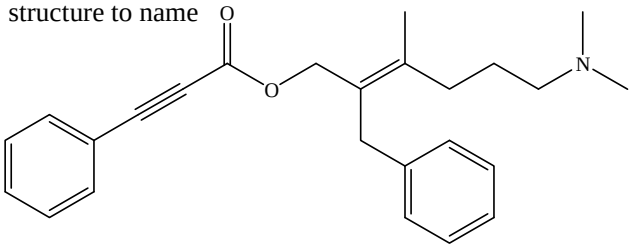


4-methoxycarbonylbutanoic acid

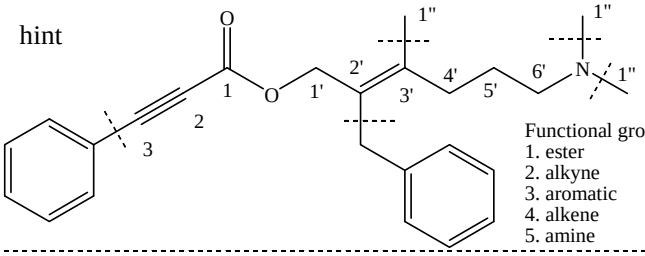
esters

a.

structure to name



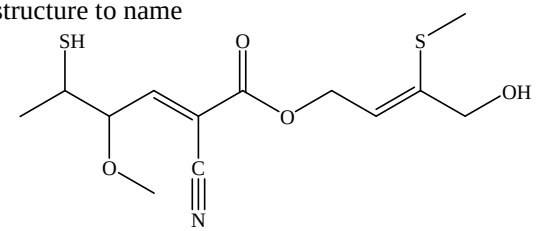
hint



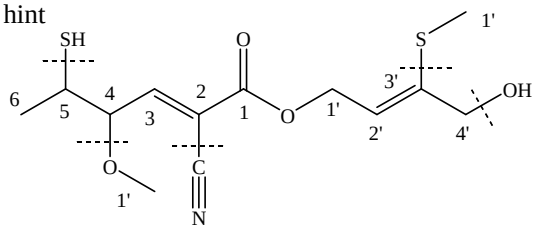
Functional groups
1. ester
2. alkyne
3. aromatic
4. alkene
5. amine

b.

structure to name



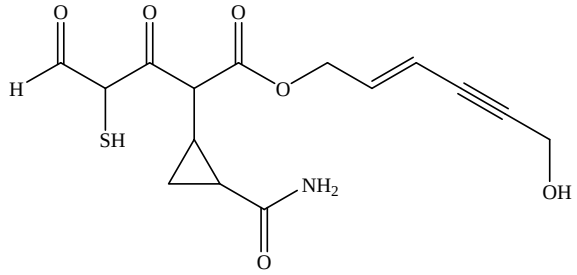
hint



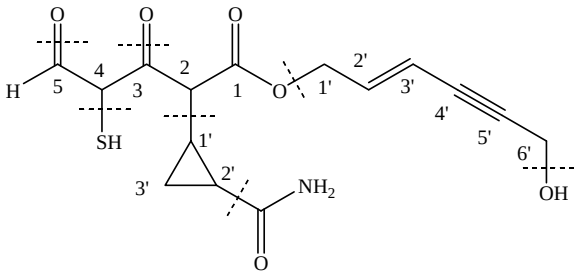
Functional groups
1. ester
2. alkene
3. nitrile
4. ether
5. thiol
6. alkene
7. sulfide
8. alcohol

c.

structure to name



hint

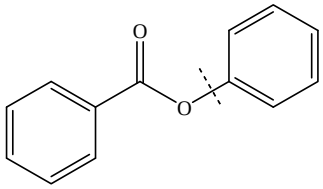


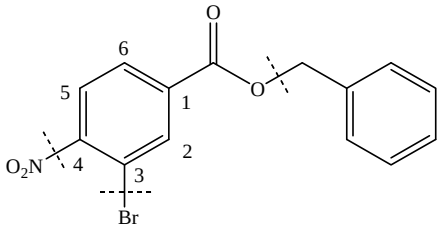
Functional groups
1. ester
2. cycloalkane
3. amide
4. ketone
5. thiol
6. aldehyde
7. alkene
8. alkyne
9. alcohol

---

d.

structure to name





Functional groups
1. ester
2. aromatic
3. bromo
4. nitro

---

answers:

a. 2-benzyl-3-methyl-6-(N,N-dimethylamino)hex-2E-enyl 3-phenylprop-2-ynoate

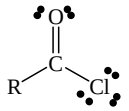
b. 3-methylthio-4-hydroxybut-2Z-enyl 2-cyano-4-methoxy-5-mercaptohex-2E-enoate

c. 6-hydroxyhex-2E-en-4-ynyl 2-(2-amidecyclopropyl)-3,5-dioxo-4-mercaptopentanoate

d. phenyl benzoate benzyl 3-bromo-4-nitrobenzoate

**Acid Chlorides** **prefix = #-chlorocarbonyl** **suffix = -oyl chloride**

4. acid chloride (2D)



suffix: -oyl chloride

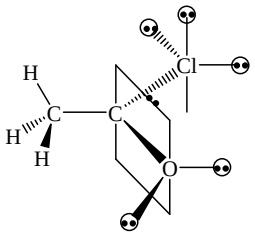
prefix: #-chlorocarbonyl

Condensed line formula

RCOCl or ClOCR

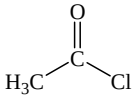
RCH(COCl)R'

carboxylic acid (3D)



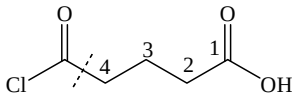
IUPAC: ethanoyl chloride

common: acetylchloride



(2D)

prefix example



4-chlorocarbonylbutanoic acid

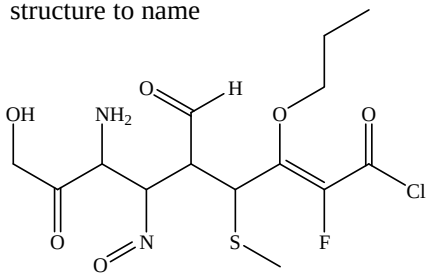
carbonyl resonance (C=O) is possible, but weak because of the poor overlap of the chlorine 3p orbital with the carbon 2p orbital

---

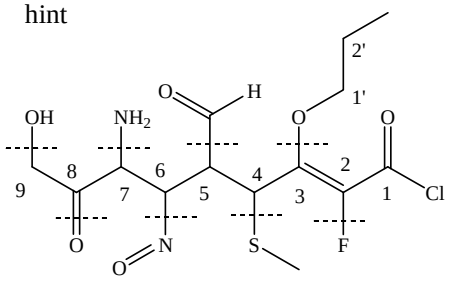
**Acid chlorides**

a.

structure to name



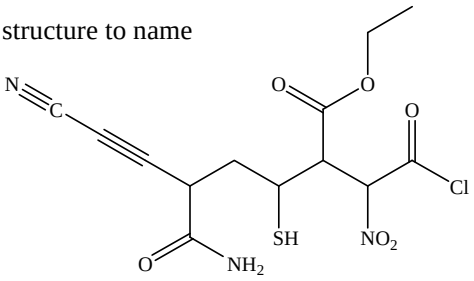
hint



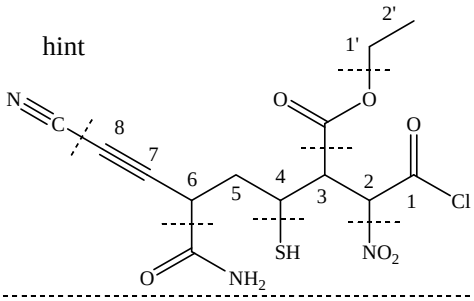
Functional groups
1. acid chloride
2. fluoro
3. alkene
4. ether
5. sulfide / thioether
6. aldehyde
7. nitroso
8. amine
9. ketone
10. alcohol

b.

structure to name



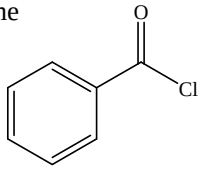
hint

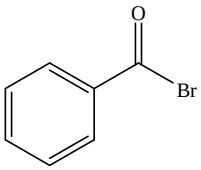


Functional groups
1. acid chloride
2. nitro
3. ester
4. thiol
5. amide
6. alkyne
7. nitrile

c.

structure to name





answers:

a. 2-fluoro-3-(propoxy)-4-methylthio-5-formyl-6-nitroso-7-amino-8-oxo-9-hydroxynon-2E-enoyl chloride

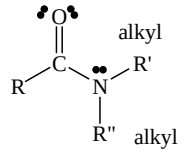
b. 2-nitro-3-ethyoxycarbonyl-4-sulfanyl-6-carbamoyl-8 –cyanooct-7-ynoyl chloride
(sulfanyl = mercapto) (carbamoyl = amido))

c. benzyol chloride benzyol bromide

d.

**Amides** **prefix = #-amido or #-carbamoyl** **suffix = -amide**
**Nitrogen substituents use "N" prefix instead of a number**

5. amides ($1^o$,$2^o$,$3^o$) (2D)



Condensed line formula

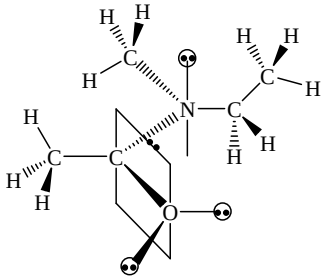
$RCONR_2$ or $R_2NOCR$

$RCH(CONH_2)R'$

when highest priority functional group
$1^o$ amides: suffix: -amide
$2^o$ amides: prefix: N-alkyl suffix: -amide
$3^o$ amides: prefix: N-alkyl-N-alkyl suffix: -amide

prefix when lower priority functional group:
$1^o$ amides: prefix: #-amido or #-carbamoyl
$2^o$ amides: prefix: #-(N-alkylamido) or #-(N-alkylcarbamoyl)
$3^o$ amides: prefix: #-(N-allkyl-N-alkylamido) or #-(N-alkyl-N-alkylcarbamoyl)

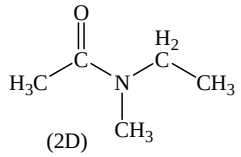
$3^o$ amide (3D)



carbonyl resonance (C=O) is possible, it is especially strong in amides

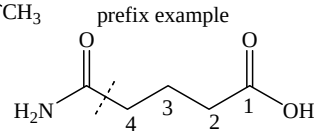
IUPAC: N-ethyl-N-methylethanamide

common: N-ethyl-N-methylacetamide



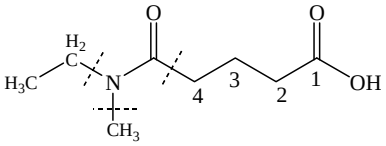
(2D)

prefix example



4-amidobutanoic acid
or
4-carbamoylbutanoic acid

prefix example

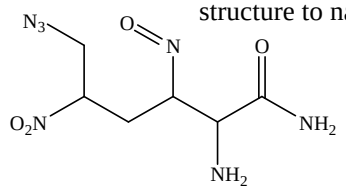


4-(N-ethyl-N-methylamido)butanoic acid

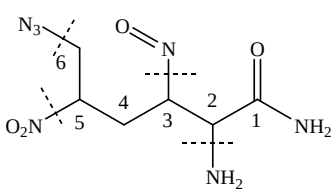
**Amides**

a.

structure to name



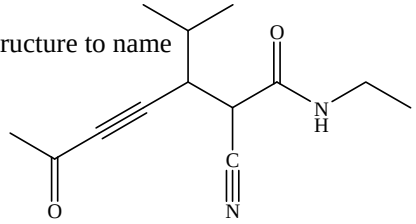
hint



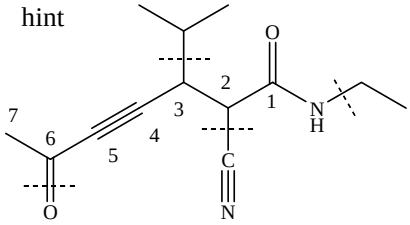
Functional groups
1. amide
2. amine
3. nitroso
4. nitro
5. azide

b.

structure to name



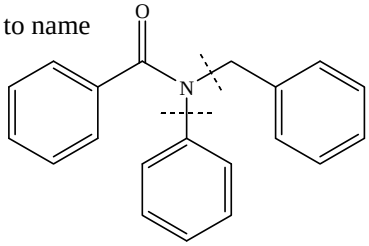
hint



Functional groups
1. amide
2. nitrile
3. alkyl branch
4. alkyne
5. ketone

c.

structure to name



hint

benzyl
phenyl

answers:

a. 2-amino-3-nitroso-5-nitro-6-azidohexanamide

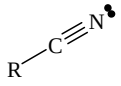
b. N-ethyl-2-cyano-3-(1-methylethyl)-6-oxohept-4-ynamide

c. N-benzyl-N-phenylbenzamide

d.

**Nitriles** **prefix = #-cyano** **suffix = -nitrile (retain the final "e")**

6. nitrile (2D)



suffix: nitrile
(don't drop the final "e" of the stem name)

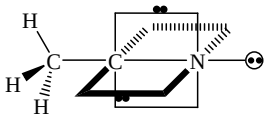
prefix: #-cyano

Condensed line formula

RCN or NCR

RCH(CN)R'

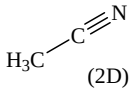
nitrile (3D)



nitrile resonance
(C$^{\ominus}$N) is possible

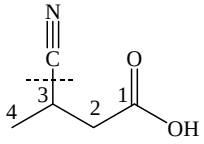
IUPAC: ethanenitrile

common: acetonitrile



(2D)

prefix example

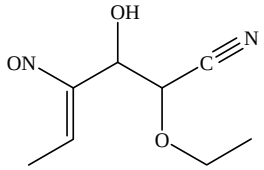


3-cyanobutanoic acid

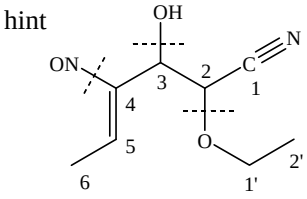
**Nitriles**

a.

structure to name



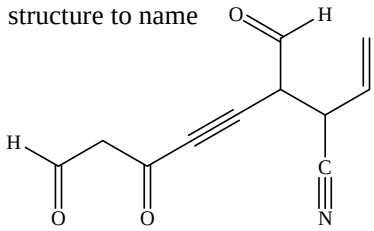
hint



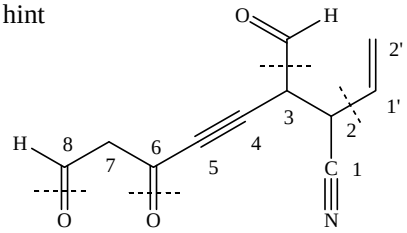
Functional groups
1. nitrile
2. ether
3. alcohol
4. nitoso
5. alkene

b.

structure to name



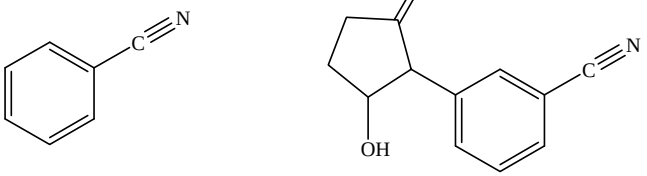
hint



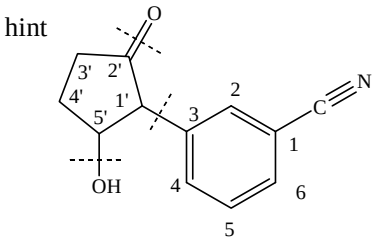
Functional groups
1. nitrile
2. alkene branch
3. aldehyde
4. alkyne
5. ketone
6. aldehyde in chain

c.

structure to name



hint



Functional groups
1. nitrile
2. cycloalkane
3. ketone
4. alcohol

---

answers:

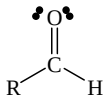
a. 2-ethoxy-3-hydroxy-4-nitrosohex-4Z-enenitrile (don't drop the final "e" because nitrile starts with a consonant)

b. 2-ethenyl-3-formyl-6,8-dioxooct-4-ynenitrile

c. benzonitrile 3-(2-oxo-5-hydroxycyclopentyl)benzonitrile

**Aldehydes** **prefix = #-oxo (if at the end of the longest chain)** **suffix = -al**
**#-formyl (if a side branch on the longest chain)**

7. aldehyde (2D)



Condensed line formula

RCHO or OHCR

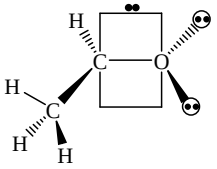
RCH(CHO)R'

suffix: -al

prefix: #-oxo (if part of longest chain)

#-formyl (if branch off of longest chain)

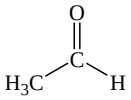
aldehyde (3D)



carbonyl resonance
(C=O) possible

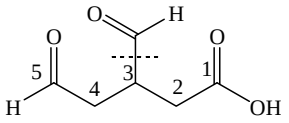
IUPAC: ethanal

common: acetaldehyde



(2D)

prefix examples



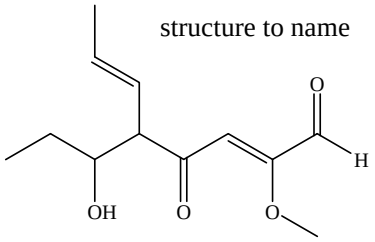
3-formyl-5-oxopentanoic acid

---

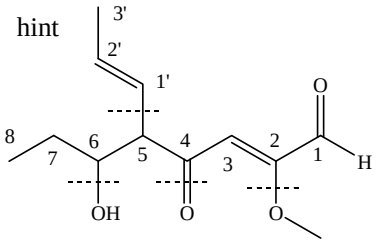
**Anhydrides**

a.

structure to name



hint

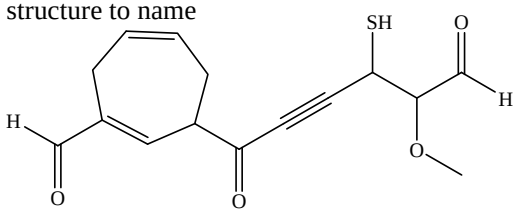


Functional groups
1. aldehyde
2. etheer
3. ketone
4. alkene side chain
5. alcohol

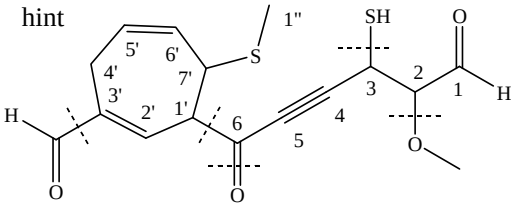
---

b.

structure to name



hint

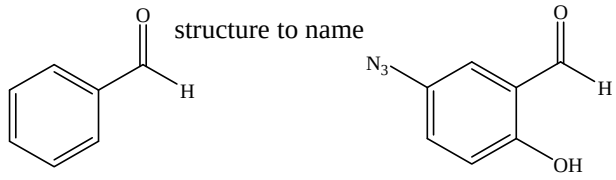


Functional groups
1. aldehyde
2. etheer
3. thiol
4. alkyne
5. ketone
6. cycloalkadiene
7. aldehyde side group
8. sulfide / thioether

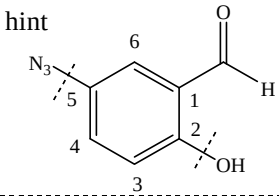
---

c.

structure to name



hint



Functional groups
1. aldehyde
2. aromatic alcohol (phenol)
3. azide

---

answers:

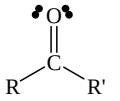
a. 2-methoxy-4-oxo-5-(prop-1E-enyl)-6-hydroxyoct-2Z-enal

b. 2-methoxy-3-mercapto—6-oxo-6-(3-formyl-7-methylthiocyclohepta-2E,5Z-dienyl)hex-4-ynal

c. benzaldehyde 2-hydroxy-5-azidobenzaldehyde

**Ketones** **prefix = #-oxo** **suffix = -#-one (sounds like cone)**

8. ketone (2D)



suffix: -#-one

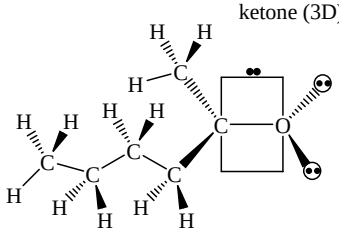
prefix: #-oxo (older = #-keto)

Condensed line formula

$R_1COR_2$ or $R_2OCR_1$

$RCH(COCH_3)R'$

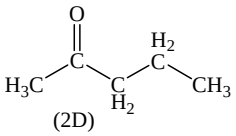
ketone (3D)



carbonyl resonance (C=O) possible

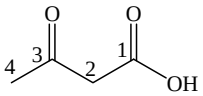
IUPAC: pentan-2-one

former: 2-pentanone



(2D)

prefix example



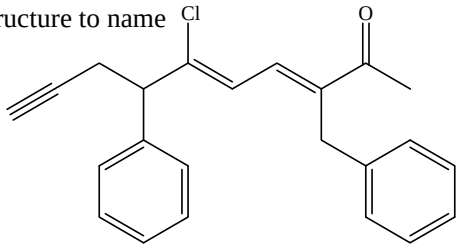
3-oxobutanoic acid

---

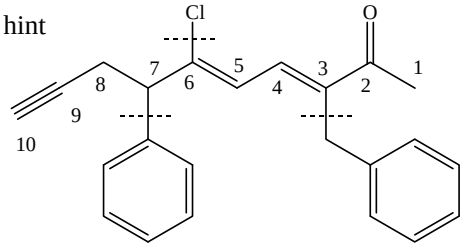
**Ketones**

a.

structure to name



hint

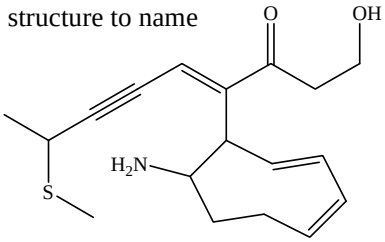


Functional groups
1. ketone
2. diene
3. benzyl
4. chloro
5. phenyl
6. alkyne

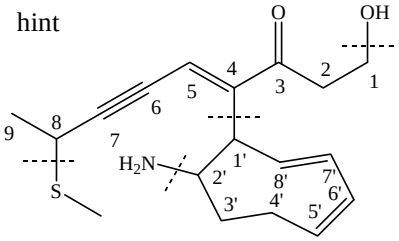
---

b.

structure to name



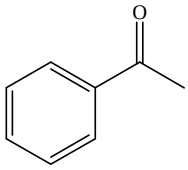
hint



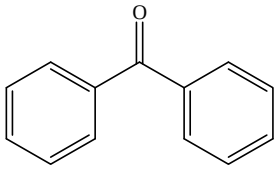
Functional groupsketone
1. alcohol
2. ketone
3. cycloalkadiene
4. amine
5 alkene
6. alkyne
7. sulfide / thioether

---

c.



structure to name



---

answers:

a. 2-benzyl-6-chloro-7-phenyldeca-3E,5Z-dien-9-yn-2-one

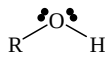
b. 1-hydroxy-4-(2-aminocycloocta-5Z,7E-dienyl)-8-methylthionon-4E-en-6-yn-3-one

c. acetophenone (1-phenylethan-1-one) benzophenone

d.

**Alcohols** **prefix = #-hydroxy** **suffix = -#-ol**

9. alcohol (2D)



suffix: -#-ol

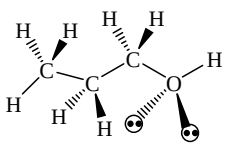
prefix: #-hydroxy

Condensed line formula

$RCH_2OH$ or $HOH_2CR$

RCHOHR'

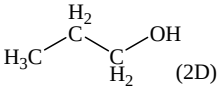
alcohol (3D)



IUPAC: propan-1-ol

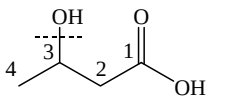
former: 1-propanol

common: n-propyl alcohol



(2D)

prefix example



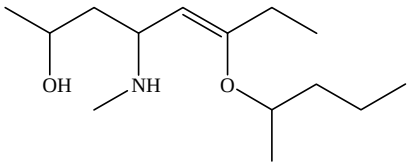
3-hydroxybutanoic acid

---

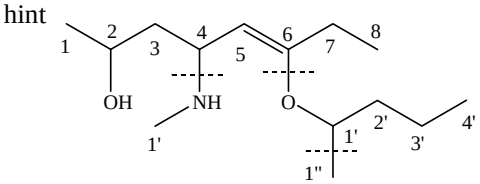
**Alcohols**

a.

structure to name




hint

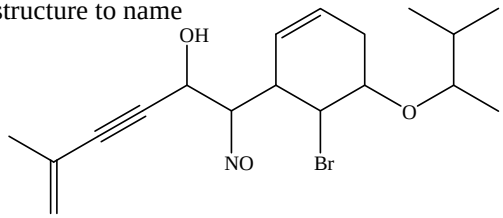



Functional groups
1. alcohol
2. 2o amine
3. alkene
4. ether

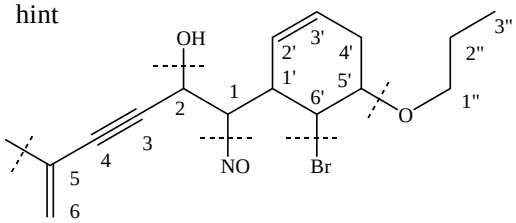
---

b.

structure to name



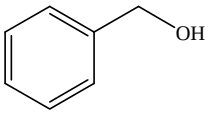

hint



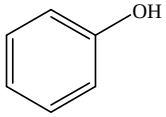

Functional groups
1. alcohol
2. nitroso
3. alkyne
4. alkene
5. cycloalkene
6. bromo
7. ether

---

c.




structure to name




---

answers:

a. 4-(N-methylamino)-6-(1-methylbutoxy)oct-5Z-en-2-ol

b. 1-nitroso-1-(5-propoxy-6-bromocyclohex-2-enyl)-5-methylhex-5-en-3-yn-2-ol

c. benzyl alcohol phenol

d.

**Thiols** **prefix = #-mercapto or #-sulfanyl** **suffix = -#-thiol**

10. thiol (2D)


suffix: -#-thiol
(don't drop the final "e" of the stem name)

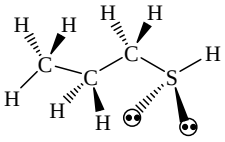
prefix: #-mercapto
#-sulfanyl

Condensed line formula

$R_1CH_2SH$ or $HSH_2CR_1$

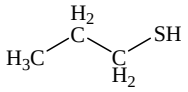
$R_1CHSHR_2$

thiol (3D)



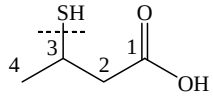

IUPAC: propan-1-thiol

common: propyl mercaptan




(2D)

prefix example




3-mercaptobutanoic acid

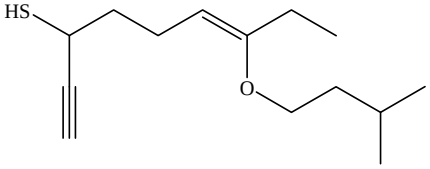
3-sulfanylbutanoic acid

---

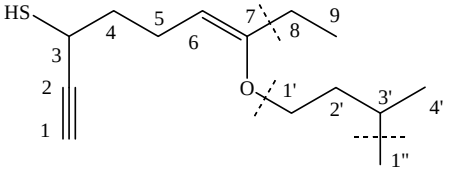
**Thiols**

a.

structure to name




hint

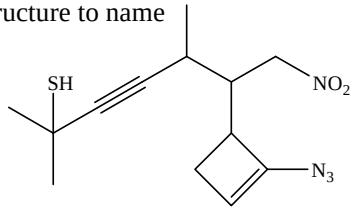



Functional groups
1. alkyne
2. thiol
3. alkene
4. ether

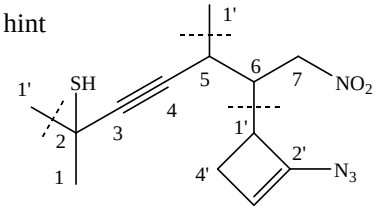
---

b.

structure to name




hint

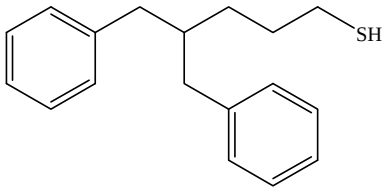



Functional groups
1. thiol
2. alkyne
3. alkene
4. alkyl branch
5. cycloalkene branch
6. azide
7. nitro

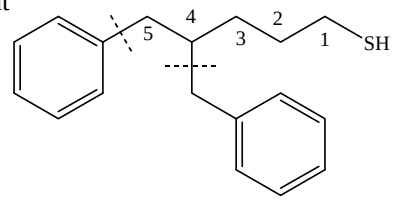
---

c.

structure to name




hint




Functional groups
1. thiol
2. benzyl
3. phenyl

---

answers:

a. 7-(3-methylbutoxy)non-6Z-en-1-ynethiol (retain the "e" because thiol starts with a consonant)

b. 2,5-dimethyl-6-(2-azidocyclobut-2-enyl)-7-nitrohept-3-ynethiol

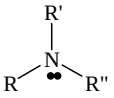
c. 4-benzyl-5-phenylpentanethiol

d.

**Amines** **prefix = #-amino** **suffix = -#-amine**

**(if additional alkyl groups are on the nitrogen, use an "N" prefix)**

11. amines ($1^o$, $2^o$, $3^o$) (2D) Condensed line formula

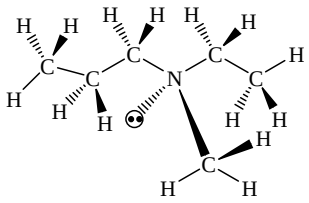


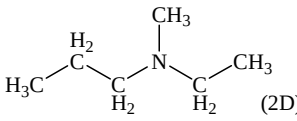

$RNH_2$ $H_2NR$
$R(NR'_2)R''$
$RCH(NH_2)R'$

when highest priority functional group
$1^o$ amines: suffix: -amine
$2^o$ amines: prefix: N-alkyl suffix: -amine
$3^o$ amines: prefix: N-alkyl-N-alkyl suffix: -amine

prefix when lower priority functional group:
$1^o$ amines: prefix: #-amino
$2^o$ amines: prefix: #-(N-alkylamino)
$3^o$ amines: prefix: #-(N-allkyl-N-alkylamino)

$3^o$ amine (3D)



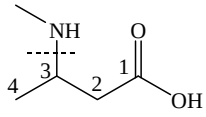



(2D)

IUPAC: N-ethyl-N-methylpropan-1-amine

former: ethylmethylpropylamine

prefix example



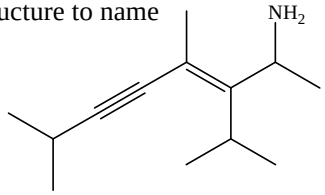

3-(N-methylamino)butanoic acid

---

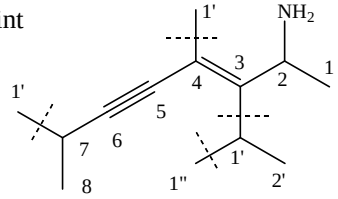
**Amines**

a.

structure to name




hint

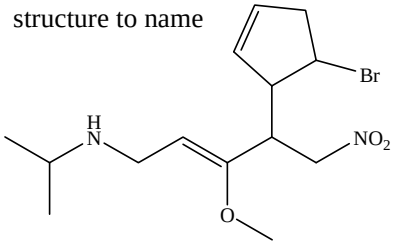



Functional groups
1. amine
2. alkyl branches
3. alkene
4. alkyne

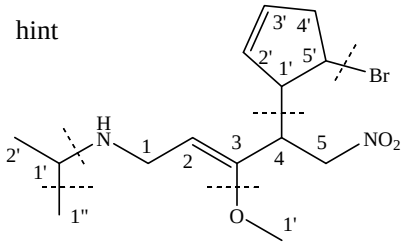
---

b.

structure to name




hint

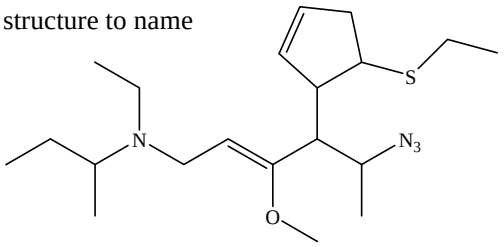



Functional groups
1. amine
2. alkyl branch
3. alkene
4. ether
5. cycloalkene branch
6. bromo
7. nitro

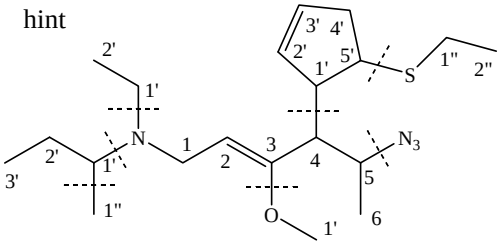
---

c.

structure to name



hint



Functional groups
1. amine
2. alkyl branches
3. alkene
4. ether
5. cycloalkene branch
6. sulfide / thioether
7. azide

---

answers:

a. 3-(1-methylethyl)-4,7-dimethyloct-3E-en-5-yn-2-amime

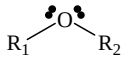
b. N-(1-methylethyl)-3-methoxy-4-(5-bromocyclopent-2-enyl)-5-nitropent-2Z-enamine

c. N-ethyl-N-(1-methylethyl)-3-methoxy-4-(5-ethylthiocyclopent-2-enyl)-5-azidohex-2Z-enamine

d.

**Ethers** **prefix = #-alkoxy** **suffix = none**

12. ether (2D)



suffix: none

prefix: #-alkoxy (< 5C)

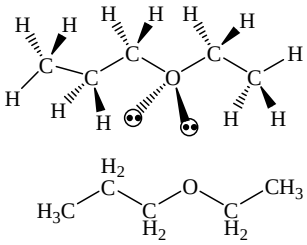
#-alkyloxy (≥ 5C)

Condensed line formula

ROR'

$RCH(OCH_3)R'$

ether (3D)



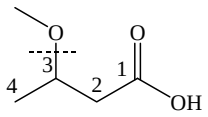
IUPAC: 1-ethoxypropane

common: ethyl propyl ether

(2D)



prefix example



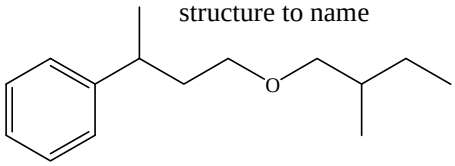
3-methoxybutanoic acid

---

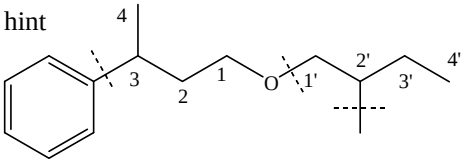
**Ethers**

a.

structure to name



hint

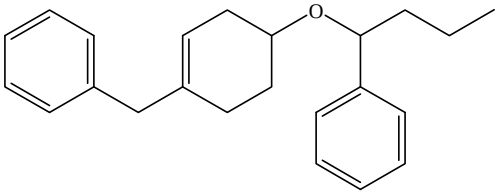


Functional groups
1. ether
2. phenyl
3. alkyl branches

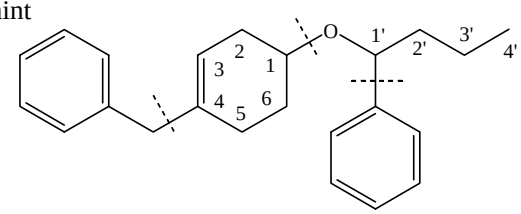
---

b.

structure to name



hint

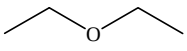


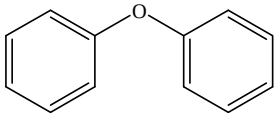
Functional groups
1. ether
2. phenyl
3. benzyl

---

c.

structures to name





---

answers:

a. 1-(2-methylbutoxy)-3-phenylbutane or (2-methylbutyl 3-phenylbutyl ether)

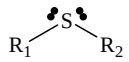
b. 1-(1-phenylbutoxy)-4-benzylcyclohex-3-ene

c. ethoxyethane / diethyl ether / ethyl ether / ether tetrahydrofuran / THF diphenyl ether

d.

**Thioethers** **prefix = #-alkylthio** **suffix = none**

12. sulfide (2D)



suffix: none

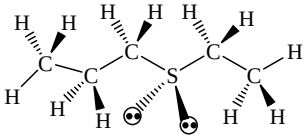
prefix: #-alkylthio

Condensed line formula

RSR'

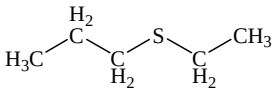
$RCH(SCH_3)R'$

thioether or sulfide (3D)



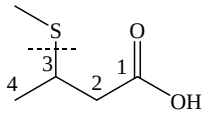
IUPAC: 1-ethylthiopropane

former: ethyl propyl sulfide



(2D)

prefix example

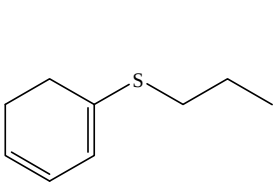


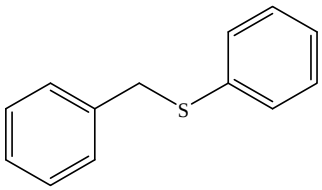
3-methylthiobutanoic acid

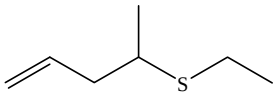
---

**Thioethers**

a. , b. , c.







---

answers:

a. 1-propylthiocyclohexa-1,3-diene

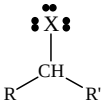
b. benzyl phenyl sulfide

c. 2-ethylthiopent-4-ene

d.

**Halogens** **prefix = #-fluoro, chloro, bromo or iodo** **suffix = none**

12. haloalkane (2D)



X = -F = fluoro
X = Cl = chloro
X = Br = bromo
X = I = iodo

suffix: none

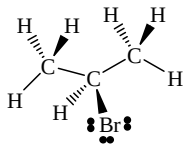
prefix: #-halo

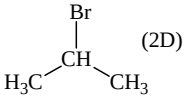
Condensed line formula

$RCH_2Cl$ or $ClH_2CR$

RCHClR'

bromoalkane (3D)



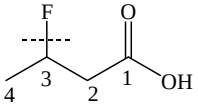


(2D)

IUPAC: 2-bromopropane

common: isopropyl bromide

prefix example



3-fluorobutanoic acid

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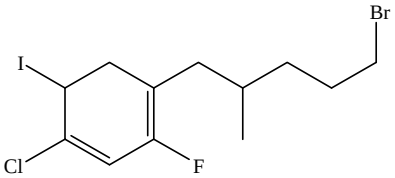
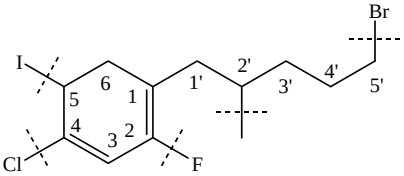
**Halogens**

a.





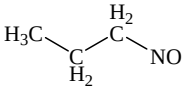
---

answers:

a. 1-(2-methyl-5-bromopentyl)-2-fluoro-4-chloro-5-iodocyclohexa-1,3-diene

**Nitroso** **prefix = #-nitroso** **suffix = none**

12. nitroso (2D)



suffix: none

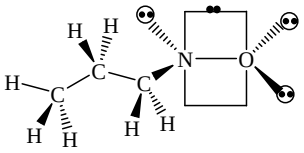
prefix: #-nitroso

Condensed line formula

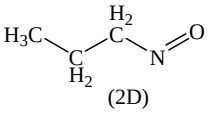
$RCH_2NO$ or $ONH_2CR$

$RCH(NO)R'$

nitroso (3D)

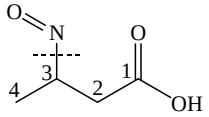


IUPAC: 1-nitrosopropane



(2D)

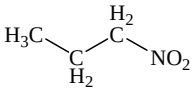
prefix example



3-nitrosobutanoic acid

**Nitro** **prefix = #-nitro** **suffix = none**

12. nitro (2D)



suffix: none

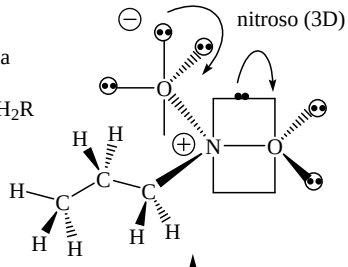
prefix: #-nitro

Condensed line formula

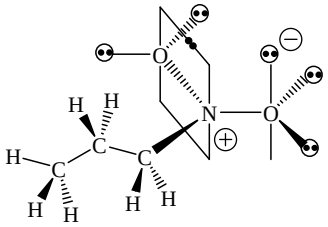
$RCH_2NO_2$ or $O_2NCH_2R$

$RCH(NO_2)R'$

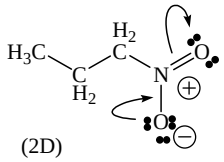
nitroso (3D)



resonance

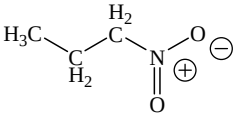


IUPAC: 1-nitropropane

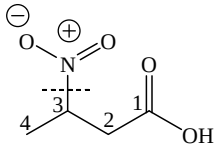


(2D)

resonance



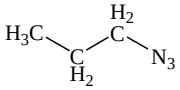
prefix example



3-nitrobutanoic acid

**azides** **prefix = #-azido** **suffix = none**

12. azides (2D)



suffix: none

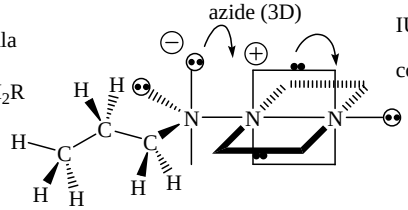
prefix: #-azido

Condensed line formula

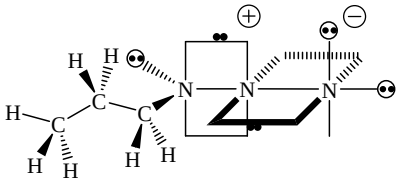
$RCH_2N_3$ or $N_3CH_2R$

$RCHN_3R'$

azide (3D)

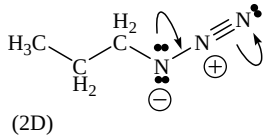


resonance



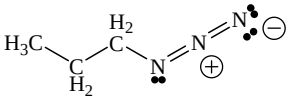
IUPAC: 1-azidopropane

common: propyl azide

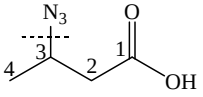


(2D)

resonance

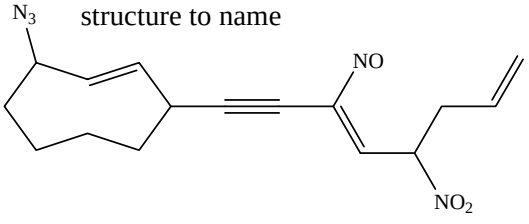


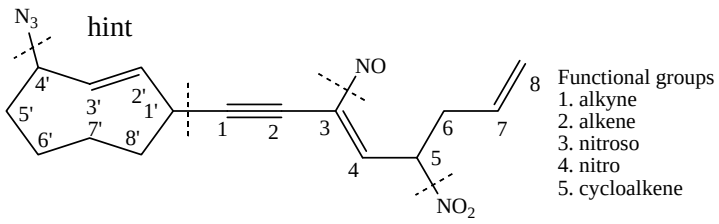
prefix example



3-azidobutanoic acid

a.



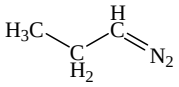




answers:

a. 1-(4-azidocyclooct-2E-enyl)-3-nitroso-5-nitrooct-3Z,7-dien-2-yne

**Diazo** **prefix = #-diazo** **suffix = none** (not used in our course)

12. diazo (2D)



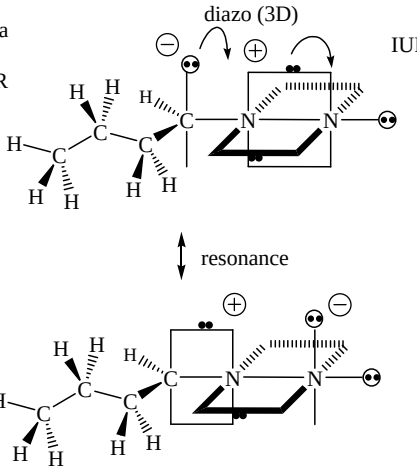
suffix: none

prefix: #-diazo

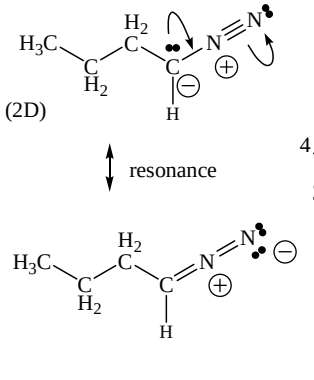
Condensed line formula

$RCHN_2$ or $N_2CHR$

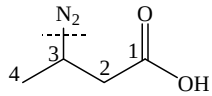
$RC(N_2)R'$




IUPAC: 1-diazobutane




prefix example



3-diazobutanoic acid

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**Nomenclature Strategy**

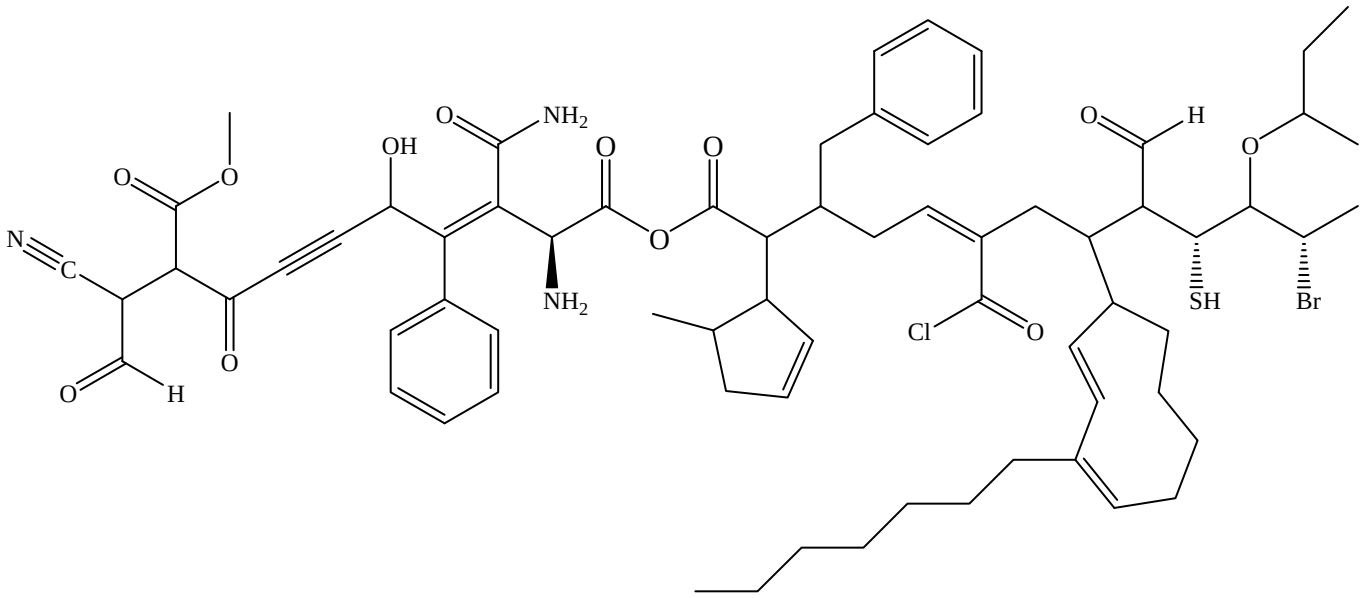
Points to Consider

1. What is the highest priority group present?
2. What is the longest chain with that group?
3. Number that chain (ring) so that the high priority group gets the lowest number.
4. Identify branches and other functionality with those numbers. (Usually named as prefixes.)
5. Combine everything into one name with proper use of hyphens (between numbers and letters) and commas (between numbers and numbers).
6. Identify stereocenters as E/Z for alkenes and R/S for chiral centers. Combine with the number which refers to each center, with the number written first. (3E, 5Z, 4S, 9R, etc.)

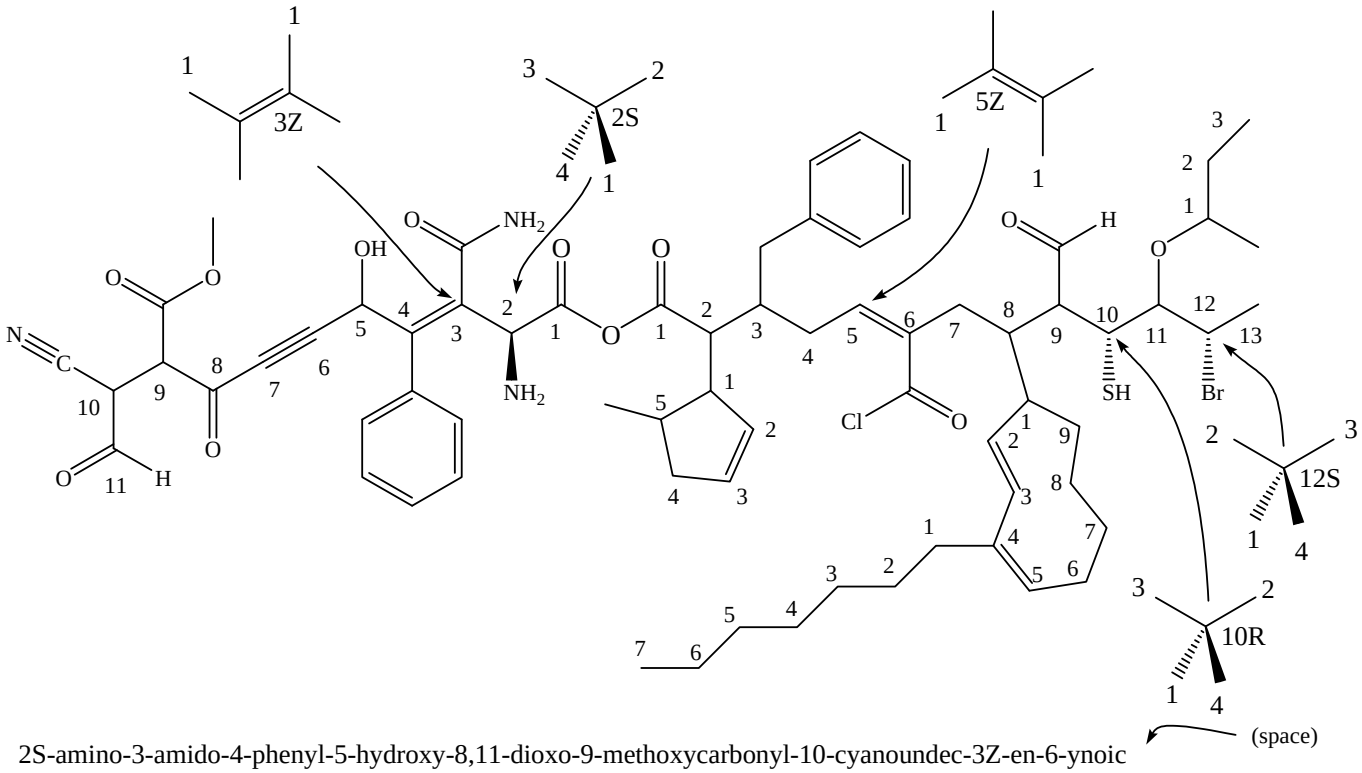
Here are a few names that can be written out as structures, opposite to the way we do it.

a. 2,4-dimethylhexane
b. 1,3,5,5-tetramethyl-1-cycloheptene
c. trans-5-hepten-1-yne or 5E-hepten-1-yne
d. 5-(4-methyl-2-cyclobutenyl)-1-nonene
e. trans-3-ethyl-1-isoproplycyclopentane
f. cis-1-t-butyl-4-isobutylcyclohexane
g. trans-2-cis-4-decadien-6,8-diyne or 2E,4Z-decadien-6,8-diyne
h. 1-allyl-3-propargyl-6-vinylcyclodecane or 1-(2-propenyl)-3-(2-propynyl)-6-ethenylcyclodecane
i. 1-hepten-6-yne
j. 3-allyl-1-sec-butyl-1-cyclopropene or 3-(2-propenyl)-1-(1-methylpropyl)-1-cyclopropene
k. 3-propyl-1-trans-6-octadiene or 3-propyl-1E,6-octadiene
l. 7-(1,1-dimethylethyl)-4-(1-methylpropyl)-1-cycloundecyne
m. 2,9 ,10-trimethyl-6-butyldodecane
n. 1-(1,3-dimethylbutyl)-4-methyl-1,3,5,7-cyclooctatetraene
o. 2,9,10-trimethyl-6-butyldodecane
p. trans-(3,3-dimethylbutyl)-3-methylcyclooctane
q. 7-(1,1-dimethylethyl)-4-(1-methylpropyl)-1-cycloundecyne
r. 1-hepten-6-yne
s. 1-trans-3-cis-7-cis-cycloundecatriene or 1E,3Z,7Z-cycloundecatriene
t. 3-benzyl-6-ethyl-7-phenyl-2Z-octene

More Complicated Functional Group Combinations



Possible answer (each side is a separate word because this is an anhydride = 2 x “-oic” + anhydride)

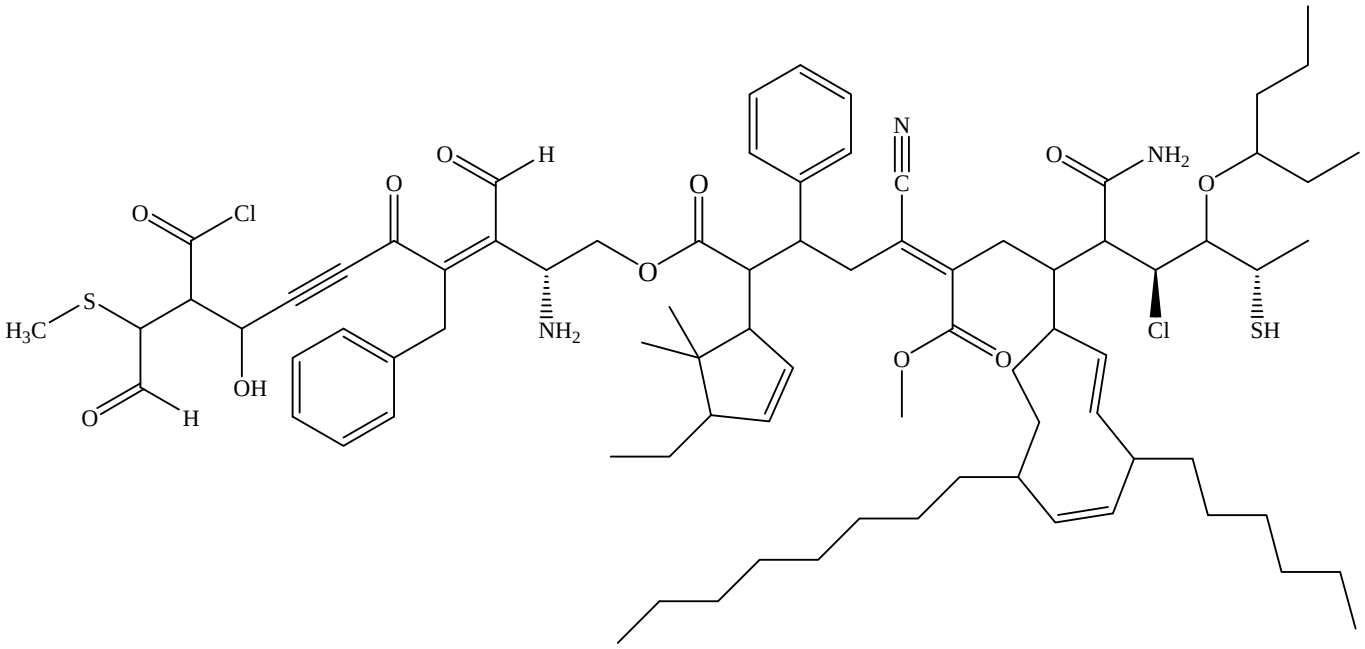


2S-amino-3-amido-4-phenyl-5-hydroxy-8,11-dioxo-9-methoxycarbonyl-10-cyanoundec-3Z-en-6-ynoic

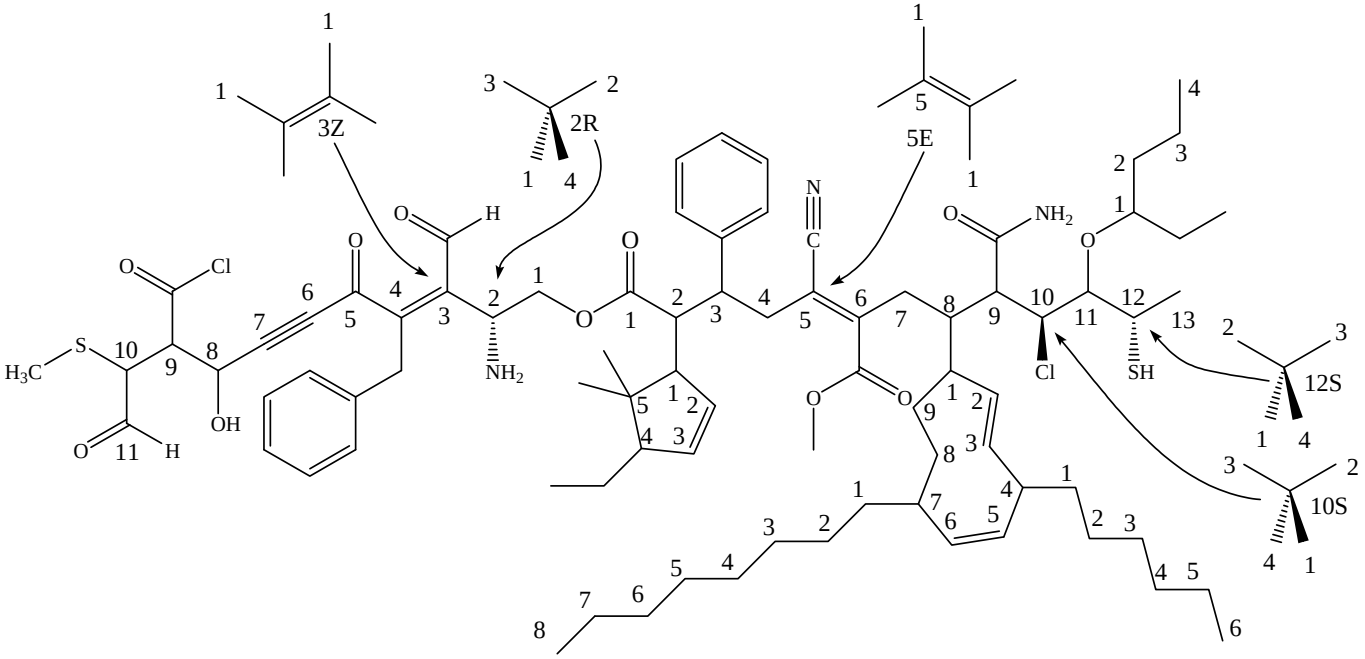
2-(5-methylcyclopent-2-enyl)-3-benzyl-6-chlorocarbonyl-8-(4-heptylcyclonona-2E,4Z-dienyl)-9-formyl-

10R-mercapto-11-(1-methylpropoxy)-12S-bromotridec-5Z-enoic anhydride

More Complicated Functional Group Combinations



Possible answer (each side is a separate word, the first word is the name of the "alkyl" branch attached to the ester oxygen on the left side and the second part is the name of the branch with the carbonyl group on the right side).



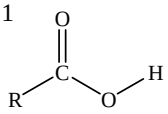
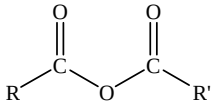
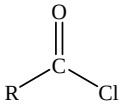
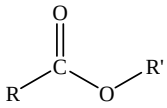
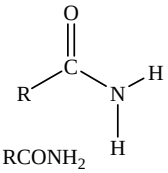
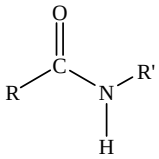
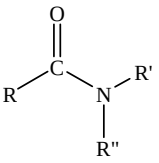
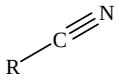
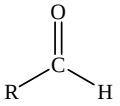
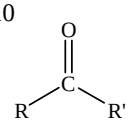
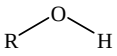
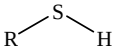
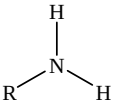
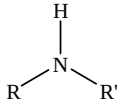
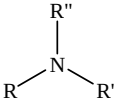
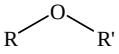
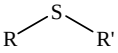
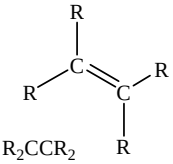
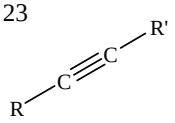
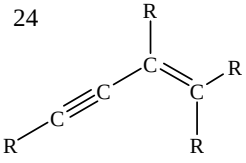
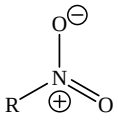
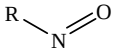
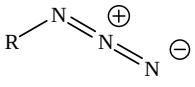
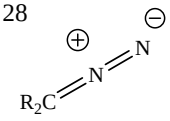
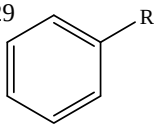
(space)

2R-amino-3-formyl-4-benzyl-5,11-dioxo-8-hydroxy-9-chlorocarbonyl-10-methylthioundec-3Z-en-6-ynyl

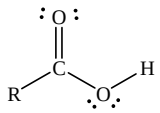
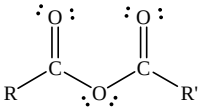
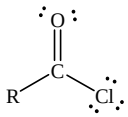
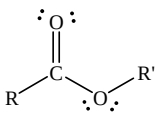
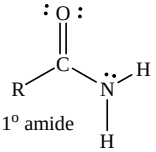
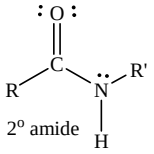
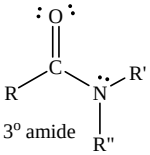
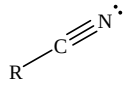
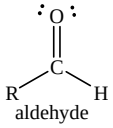
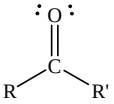
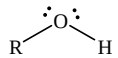
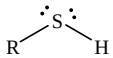
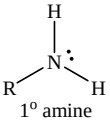
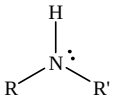
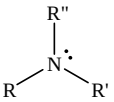
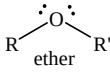
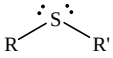
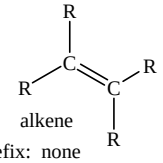
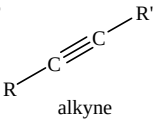
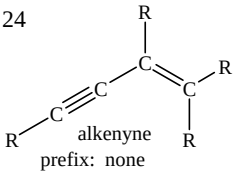
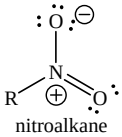
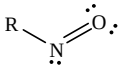
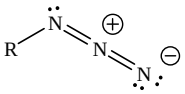
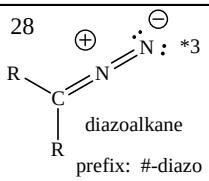
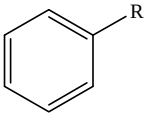
2-(4-ethyl-5,5-dimethylcyclopent-2-enyl)3-phenyl-5-cyano-6-methoxycarbonyl-8-(4-hexyl-7-octylcyclonona-2E,5Z-dienyl)-

9-amido-10S-chloro-11-(1-ethylbutoxy)-12S-mercaptotridec-5E-enoate

Match each functional group with its name.
2D and condensed line formulas.

| | | | | |
|---|---|---|---|---|
| 1  $RCO_2H$ | 2  $RCO_2COR$ | 3  RCOCl | 4  $RCO_2R'$ | 5  $RCONH_2$ |
| 6  RCONHR' | 7  RCONR'R" $(R \neq R' \neq R")$ $RCONR'_2$ $(R' = R")$ | 8  RCN | 9  RCHO | 10  RCOR' |
| 11  ROH | 12  RSH | 13  $RNH_2$ | 14  RNHR' | 15  RNR'R" |
| 16  ROR' | 17  RSR' | 18  RBr | 19  RCl | 20  RF |
| 21  RI | 22  $R_2CCR_2$ | 23  RCCR' | 24  $RCCCRCR_2$ | 25  $RNO_2$ |
| 26  RNO | 27  $RN_3$ | 28  $R_2CN_2$ | 29  $RC_6H_5$ | 30  RH |

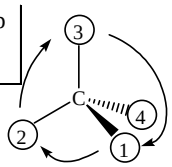
a. aromatic
b. fluoro
c. carboxylic acid
d. 1° amine
e. 2° amide
f. nitrile
g. thiol
h. ether
i. bromo
j. acid chloride
k. ketone
l. sulfide
m. alkane
n. nitro
o. 3° amide
p. alkene
q. aldehyde
r. nitroso
s. alcohol
t. iodo
u. 2° amine
v. alkyne
w. chloro
x. 3° amine
y. azido
z. anhydride
aa. 1° amide
bb. diazo
cc. ester
dd. alkene/alkyne

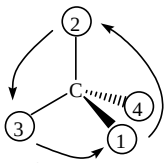
| | | | | |
|---|---|---|---|---|
| 1  carboxylic acid<br>prefix: #-carboxy[*1]<br>suffix: -oic acid | 2  anhydride<br>prefix: #-acyloxyalkylcarbonyl[*2]<br>suffix: -oic anhydride (R = R')<br>-oic -oic anhydride (R ≠ R') | 3  acid chloride<br>prefix: #-chlorocarbonyl<br>suffix: -oyl chloride | 4  ester<br>prefix: #-alkoxycarbonyl<br>suffix: -oate<br>(R' name as branch at front) | 5  1° amide<br>prefix: #-amido<br>or #-carbamoyl<br>suffix: -amide |
| 6  2° amide<br>prefix: #-(N-alkylamido)<br>#-(N-alkylcarbamoyl)<br>suffix: -amide<br>name R' as N-alkyl in front | 7  3° amide<br>prefix: #-(N-alkyl-N-alkylamido)<br>#-(N-alkyl-N-alkylcarbamoyl)<br>suffix: -amide<br>name R',R" as N-alkyl-N-alkyl in front | 8  nitrile<br>prefix: #-cyano<br>suffix: -nitrile | 9  aldehyde<br>prefix: #-oxo- (in chain)<br>or #-formyl (as branch)<br>suffix: #-al | 10  ketone<br>prefix: #-oxo<br>suffix: -#-one |
| 11  alcohol<br>prefix: #-hydroxy<br>suffix: -#-ol | 12  thiol<br>prefix: #-mercapto<br>or #-sulfanyl<br>suffix: -#-thiol | 13  1° amine<br>prefix: #-amino<br>suffix: -#-amine | 14  2° amine<br>prefix: #-(N-alkylamino)<br>suffix: -#-amine | 15  3° amine<br>prefix: #-(N-alkyl-N-alkylamino)-<br>suffix: -#-amine |
| 16  ether<br>prefix: #-alkoxy (≤ 5C)<br>#-alkyloxy (> 5C)<br>suffix: none | 17  sulfide<br>prefix: #-alkylthio<br>suffix: none | 18  bromoalkane<br>prefix: #-bromo<br>suffix: none | 19  chloroalkane<br>prefix: #-chloro<br>suffix: none | 20  fluoroalkane<br>prefix: #-fluoro<br>suffix: none |
| 21  iodoalkane<br>prefix: #-iodo<br>suffix: none | 22  alkene<br>prefix: none<br>suffix: -#-ene | 23  alkyne<br>prefix: none<br>suffix: -#-yne | 24  alkenyne<br>prefix: none<br>suffix: -#-en-#-yne | 25  *3<br>nitroalkane<br>prefix: #-nitro<br>suffix: none |
| 26  nitrosoalkane<br>prefix: #-nitroso<br>suffix: none | 27  *3<br>azidoalkane<br>prefix: #-azido<br>suffix: none | 28  *3<br>diazoalkane<br>prefix: #-diazo<br>suffix: none | 29  aromatic<br>many special<br>names | 30  alkane<br>prefix: #-alkyl<br>suffix: -ane |

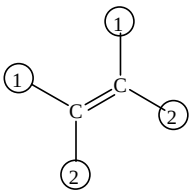
*1: not used because we don't use any higher priority group
*2: not used because it is too complicated for our level
*3: formal charge and resonance is always present.

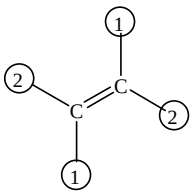
Possible stereochemical features include chiral centers, "R and S" and pi bond configurations, "E and Z".

Numbers (1,2,3,4) indicate priority of groups based on atomic numbers.

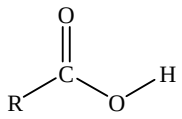
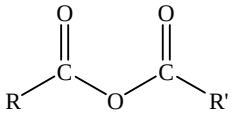
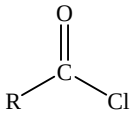
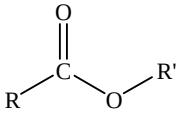
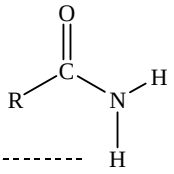
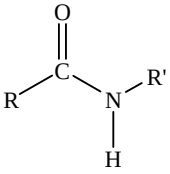
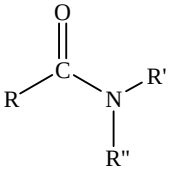
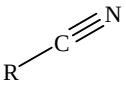
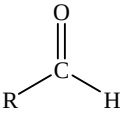
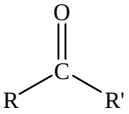
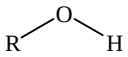
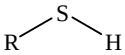
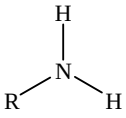
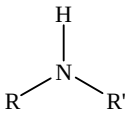
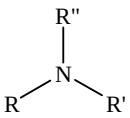
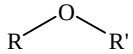
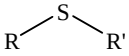
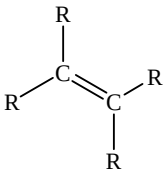
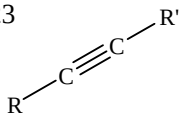
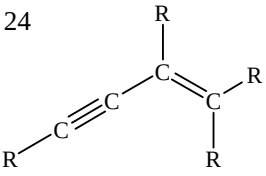
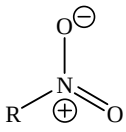
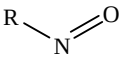
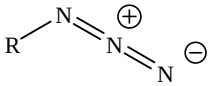
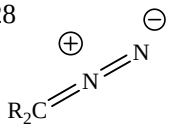
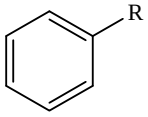

R = rectus (clockwise)


S = sinister (counter clockwise)


Z = zussamen (both "1"s on same side)


E = entgegen ("1"s on opposite side)

2D structures and condensed line formulas

| | | | | |
|---|---|---|---|---|
| 1  | 2  | 3  | 4  | 5  |
| $RCO_2H$ carboxylic acid | $RCO_2COR$ anhydride | RCOCl acid chloride | $RCO_2R'$ ester | $RCONH_2$ $1^o$ amide |
| 6  | 7  | 8  | 9  | 10  |
| RCONHR' $2^o$ amide | RCONR'R" $3^o$ amide | RCN nitrile | RCHO aldehyde | RCOR' ketone |
| 11  | 12  | 13  | 14  | 15  |
| ROH alcohol | RSH thiol | $RNH_2$ $1^o$ amine | RNHR' $2^o$ amine | RNR'R" $3^o$ amine |
| 16  | 17  | 18  | 19  | 20  |
| ROR' ether | RSR' sulfide | RBr bromoalkane | RCl chloroalkane | RF fluoroalkane |
| 21  | 22  | 23  | 24  | 25  |
| RI iodoalkane | $R_2CCR_2$ alkene | RCCR' alkyne | $RCCCRCR_2$ alkenyne | $RNO_2$ nitroalkane |
| 26  | 27  | 28  | 29  | 30  |
| RNO nitrosoalkane | $RN_3$ azidoalkane | $R_2CN_2$ diazoalkane | $RC_6H_5$ aromatic | RH alkane |