

CM1501 Nomenclature

Alkane

Cycloalkane

Alkenes / Alkynes

Alk-(num)-ene or Alk-(num)-yne

Cycloalkenes

Alkyl Halides

Alcohols, Ketons, Amines

Alkan-(num)-ol, Alkan-(num)-one, Alkan-(num)-amine

Ethers

Aldehydes, Carboxylic Acids, Nitriles

Alkanal, Alcanoic acid, Alkanenitrile

Acid Derivatives

Acid halides (RCOX)

Acid anhydrides (RCO₂COR')

Esters (RCOOR')

Thioesters (RCOSR')

Amides (RCONH₂)

Benzene & Derivatives

Arenes – alkyl substituted benzenes

≥ 2 Functional groups

Functional Groups attached to Cycloalkanes

Functional Groups attached to COOH

Substituted Amines

Functional group	Prefix	Suffix	Examples	Name of Example
carboxylic acid	carboxy	-oic acid -carboxylic acid		pentanoic acid
acid anhydride	—	-oic anhydride -carboxylic anhydride		ethanoic anhydride
carboxylic ester	alkoxycarbonyl	-oate -carboxylate		methyl propanoate
amide	amido	-amide -carboxamide		N-propylethanamide
nitrile	cyano	-nitrile (keep "e") -carbonitrile		butanenitrile
aldehyde	oxo	-al -carbaldehyde		4-bromo-pentanal
ketone	oxo	-one		3-hexanone
alcohol	hydroxy	-ol		3-methyl-2-butanol
amine	amino	-amine		butylamine (common name)
alkene	enyl	-ene		2-pentene
alkyne	ynyl	-yne		1-hexyne
alkyl	yl	-ane		2,2-dimethylbutane

Functional group	Structure	Prefix	Suffix
alkyl halide	R—X (X: F, Br, Cl, I)	halo (fluoro, bromo, chloro, iodo)	—
ether	R—O—R	oxy	ether
sulfide	R—S—R	alkylthio	sulfide
nitro	—NO ₂	nitro	—
benzene		phenyl	benzene

Alkane

1. Find the parent hydrocarbon

- a. longest continuing chain of carbon atoms
- b. 2 chains of equal length → choose the one with more branch points



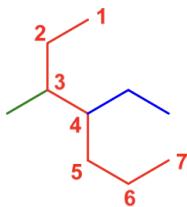
2. Number the atoms in the parent chain

- a. begin at the end nearer to the 1st branch point
- b. if branching point are equal → begin at the end nearer to the 2nd branch

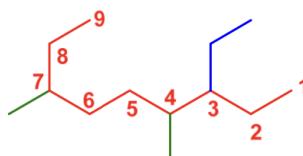
3. Identify and number the substituents

4. Write the name as a single word

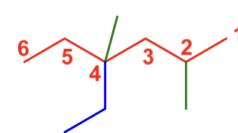
- a. If two or more different substituents are present write them in alphabetical order
- b. use the multiplier prefixes di-, tri-, tetra- ...
- c. prefixes are not counted when alphabetising



4-Ethyl-3-methylhepane



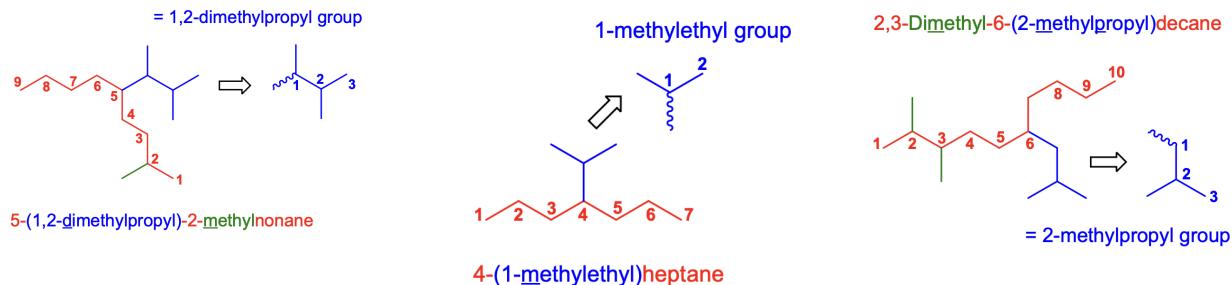
3-Ethyl-4,7-dimethylnonane



4-Ethyl-2,4-dimethylhepane

5. Name a branched substituent as though it were itself a compound

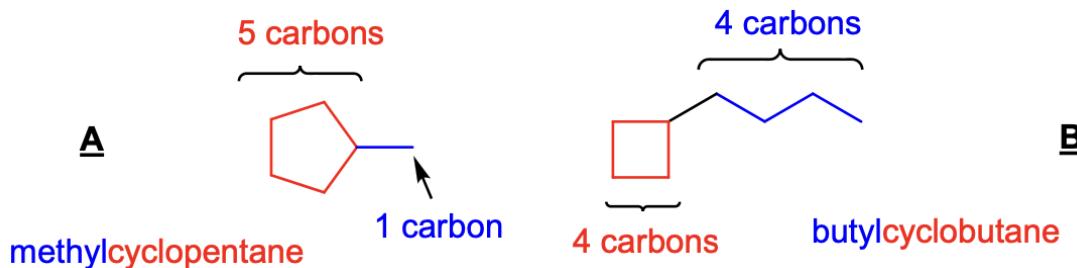
- Begin numbering at point of attachment to the main chain
- Alphabetised according to first letter of its complete name, **including any numerical prefixes**, and is set off in parentheses when naming the entire molecule



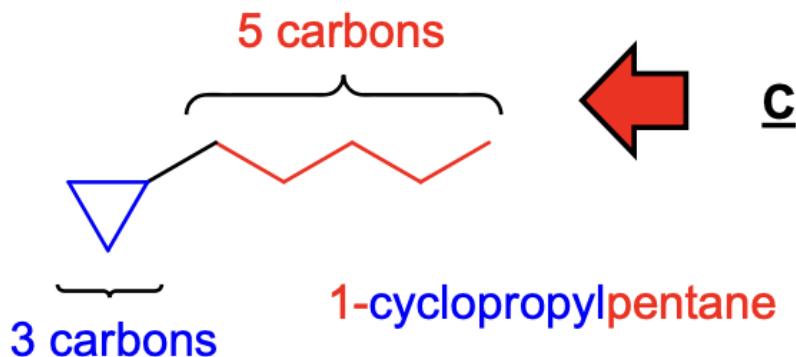
Cycloalkane

1. Find the parent HC

- Named as alkyl-substituted cycloalkane: the number of carbon atoms in the ring is equal to or greater than the number in the alkyl chain

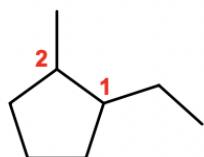


- Name as cycloalkyl-substituted alkane: the number of carbon atoms in the ring is equal to or smaller than the number in the alkyl chain:



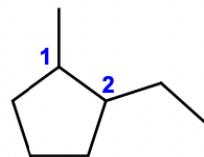
2. Number the substituents

- Choose attachment point as C1 and number the C atoms s.t. the 2nd substituent has the lower number
- if ambiguity exists, number carbon atoms so that third or fourth substituent has lowest number possible.
- When two or more substituents could potentially receive the same numbers, number by alphabetical priority



1-Ethyl-2-methylcyclopentane

NOT

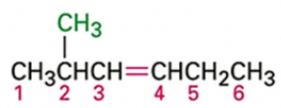


2-Ethyl-1-methylcyclopentane

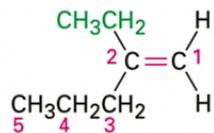
Alkenes / Alkynes

Alk-(num)-ene or Alk-(num)-yne

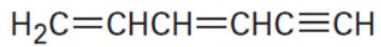
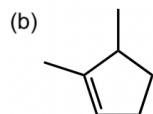
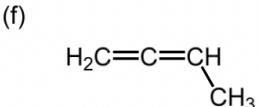
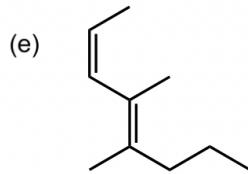
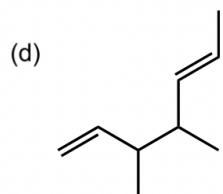
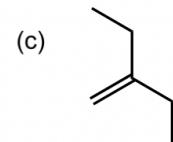
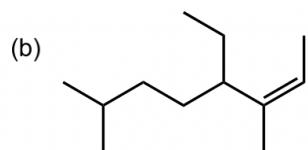
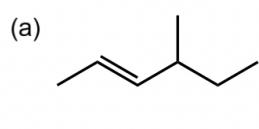
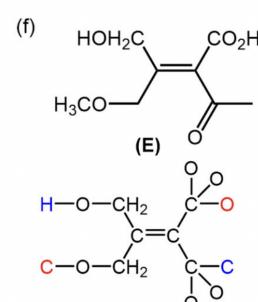
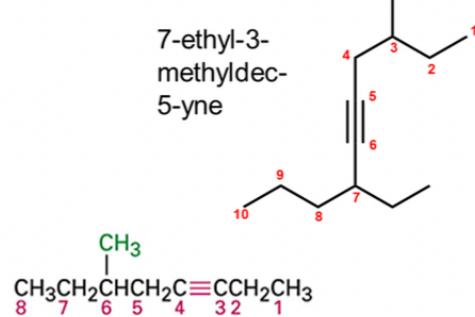
1. Find the parent chain: longest carbon chain containing C=C or triple bond
2. Number the atoms
 - a. begin at the end where C=C receives lowest possible number
 - b. equidistant C=C → end nearer the first branching point
3. Note E/Z

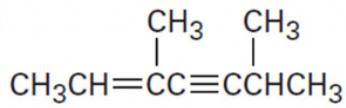
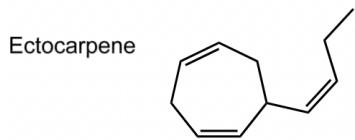


2-Methylhex-3-ene



2-Ethylpent-1-ene



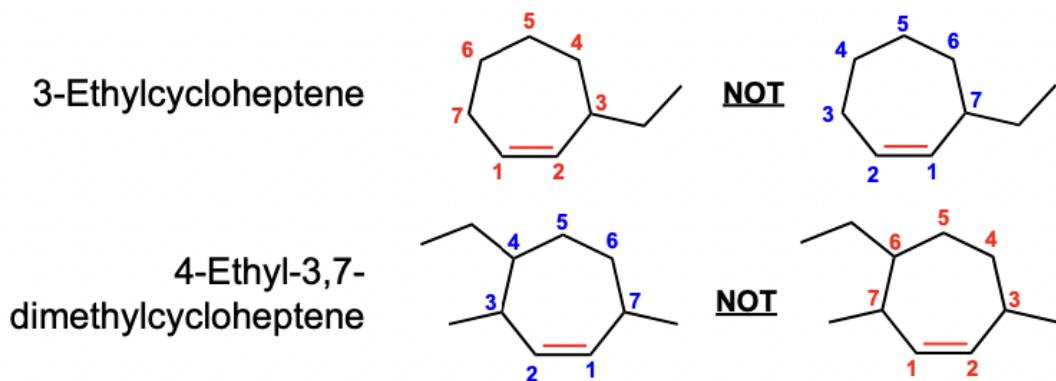


▼ Nomenclature (rmb to add E/Z or cis/trans)

1. (E)-4-methyl-hex-2-ene or (E)-4-methyl-2-hexene
[or trans instead of (E)]
2. (Z)-4-ethyl-3,7-dimethyoct-2-ene or (Z)-4-ethyl-3,7-dimethyl-2-octene
[or cis instead of (Z)]
3. 2-Ethylbut-1-ene or 2-ethyl-1-butene
4. (5E)-3,4-Dimethyl-1,5-heptadiene or (5E)-3,4-Dimethylhepta-1,5-diene [or trans instead of (E)]
5. (2Z,4E)-4,5-Dimethyl-2,4-octadiene or (2Z,4E)-4,5-Dimethylocta-2,4-diene [better to use (Z,E) and not cis,trans]
6. 1,2-Butadiene
7. 1,5-Dimethylcyclopentene
 - a. Either one of C=C is to be numbered C1.
 - b. Give the lowest number to the first substituent
8. 6-[(Z)-but-1-enyl]cyclohepta-1,4-diene
 - a. if the ring has more carbon atoms than a substituent chain, then the ring is the parent.
 - b. name parent ring first to have the diene receiving lowest numbers: cyclohepta-1,4-diene
 - c. the substituent is: 6-(but-1- enyl) [alkenyl in this case is butenyl]
9. 3,6-Dimethylhept-2-en-4-yne or 3,6-Dimethyl-2-hepten-4-yne
10. 1,3-Hexadien-5-yne or Hexa-1,3-dien-5-yne

Cycloalkenes

1. Find the parent chain
 - a. The cycloalkene is treated as the parent ring
 - b. double bond numbered as C1 C2
 - c. ambiguity → minimise branch point numbers



Alkyl Halides

1. Find parent
2. Number atoms
 - a. Number each C in the parent chain beginning at the end nearer the 1st subst
 - b. halo has no priority

Alcohols, Ketons, Amines

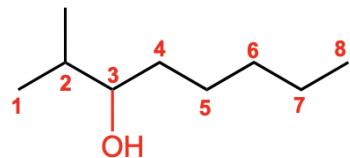
Alkan-(num)-ol, Alkan-(num)-one, Alkan-(num)-amine

1. Find the parent chain with hydroxyl (-OH), carbonyl (C=O) or amino (-NH₂) group

2. Number the C atoms

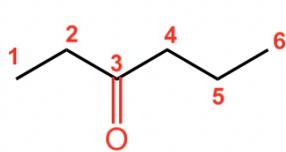
- prioritise -OH, C=O, -NH₂
- consider 1st substituent number

Alkan-(number)-ol



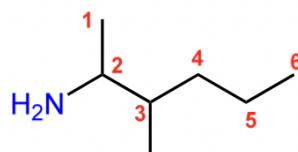
2-Methyloctan-3-ol

Alkan-(number)-one

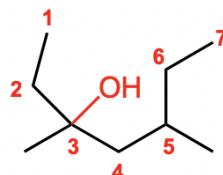


Hexan-3-one

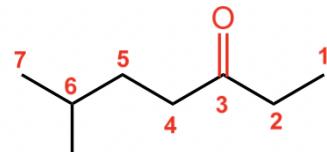
Alkan-(number)-amine



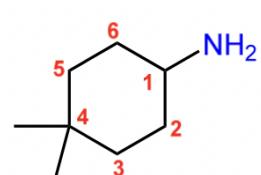
3-Methylhexan-2-amine



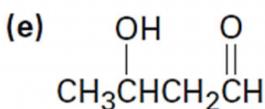
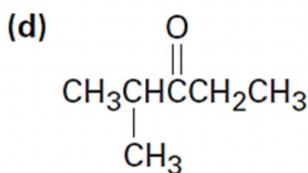
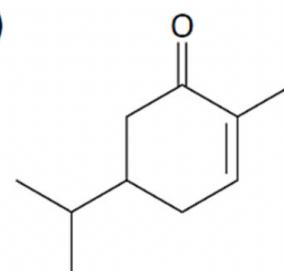
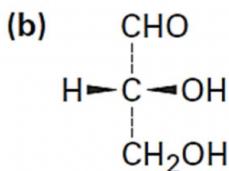
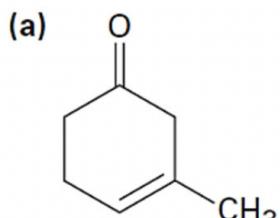
3,5-Dimethylheptan-3-ol



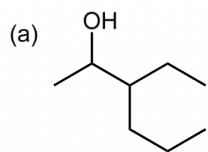
6-Methylheptan-3-one



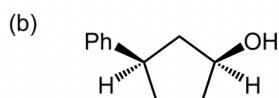
4-Dimethylcyclohexanamine



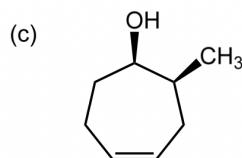
- 3-Methylcyclohex-3-enone
- (R)-2,3-Dihydroxypropanal
- 5-Isopropyl-2-methylcyclohex-2-enone or 2-methyl-5-(methylethyl)cyclohex-2-enone
- 2-Methylpentan-3-one
- 3-Hydroxybutanal



3-ethylhexan-2-ol



cis-3-phenylcyclopentanol
(the two identical hydrogens are cis)

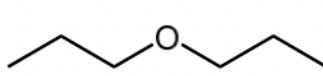


cis-2-methylcyclohept-4-en-1-ol
(the two identical hidden hydrogens are cis)

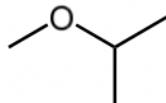
Ethers

1. Simple ethers with no other functional groups are named by identifying the two organic substituents and adding the word ether.

- The two organic substituents are named following the steps for naming alkanes, the prefix di- is used for identical substituents.



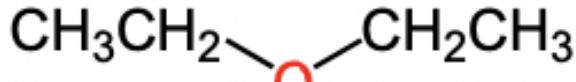
Dipropyl ether



Methyl 1-methylethyl ether

- In alphabetical order if the two substituents are different.

2. Common ethers: diethyl ether (or ether) and THF (tetrahydrofuran)

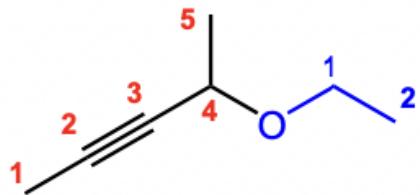


“Ether”

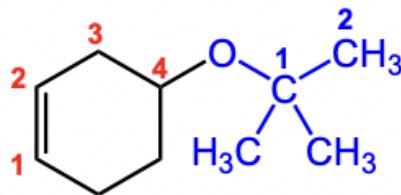


THF

3. If other functional groups are present, the ether part is considered an alkoxy substituent (ethyl to ethoxy, pentyl to pentoxy, etc).



4-ethoxypent-2-yne



4-(1,1-Dimethylethoxy)cyclohexene

Aldehydes, Carboxylic Acids, Nitriles

Alkanal, Alkanoic acid, Alkanenitrile

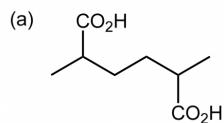
1. Find the parent hydrocarbon

a. Find the longest carbon chain containing the CHO, COOH or CN group.

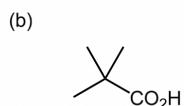
b. The CHO, COOH or CN group is always at the terminal of the chain.

2. Number the atoms

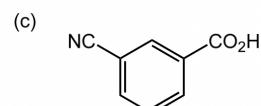
a. begin at the terminal CHO, COOH or CN group and labelling its carbon atom C1.



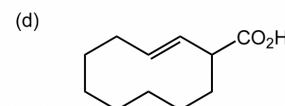
2,5-dimethylhexanedioic acid



2,2-dimethylpropanoic acid



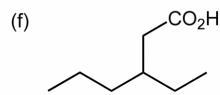
m-cyanobenzoic acid
(3-cyanobenzoic acid)



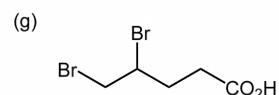
(E)-cyclodec-2-enecarboxylic acid



2,2-dimethylpropanenitrile



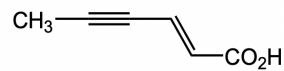
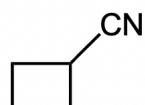
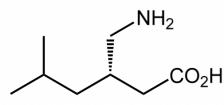
3-ethylhexanoic acid



4,5-dibromopentanoic acid



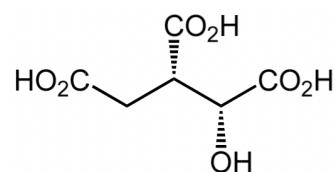
cyclopent-2-enecarbonitrile



(S)-3-(aminomethyl)-5-methylhexanoic acid

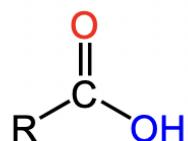
Cyclobut-2-enecarbonitrile

(E)-Hex-2-en-4-yneic acid

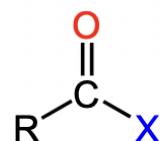


(2R,3S)-3-carboxy-2-hydroxypentanedioic acid

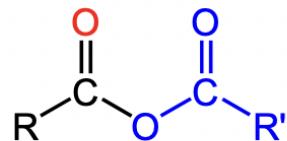
Acid Derivatives



Carboxylic acid



Acid halide
(X = Cl, Br)

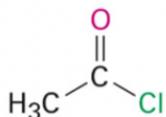


Acid anhydride

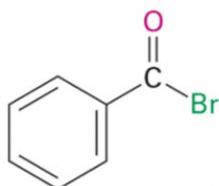
Acid halides (RCOX)

- Derive from carboxylic acid name by replacing the **-ic acid** or **-oic acid** ending with **-yl** or **-oyl halide**.
- If COX is on a ring, derive from carboxylic acid by replacing **-carboxylic acid** with **-carbonyl halide**.

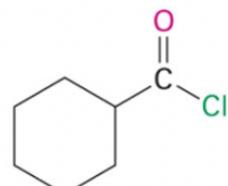
halide.



(ethanoyl chloride)



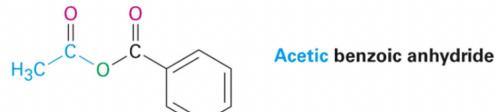
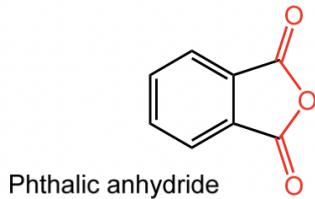
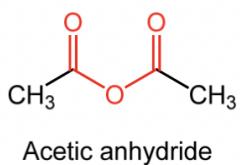
Benzoyl bromide



Cyclohexanecarbonyl chloride

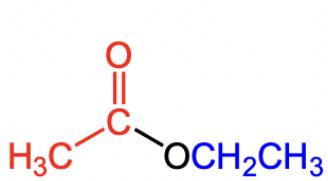
Acid anhydrides (RCO2COR')

1. Symmetrical anhydrides of unsubstituted monocarboxylic acids and cyclic anhydrides of dicarboxylic acids, replacing acid with **anhydride**.
2. Unsymmetrical anhydrides, listing the two acids alphabetically and then adding anhydride.

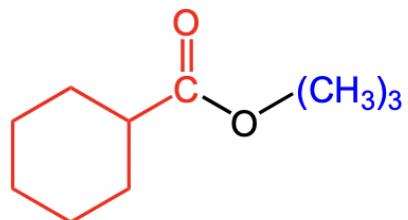


Esters (RCOOR')

1. Identifying **alkyl group** (in blue) attached to oxygen and the **carboxylic acid** (in red), replacing –ic or –oic acid with **–ate**.



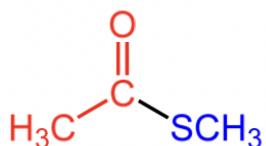
Ethyl acetate



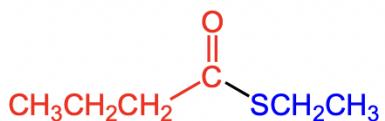
t-Butyl cyclohexanecarboxylate

Thioesters (RCOSR')

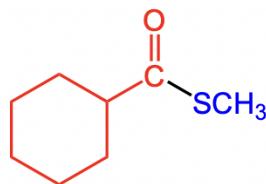
1. Similar to esters
2. Prefix **thio-** is added to carboxylate if ester has a common name.
3. –oate or carboxylate is replaced by –thioate or carbothioate if ester has a systematic name.



methyl thioacetate



Ethyl butanethioate

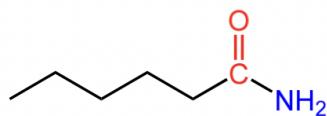
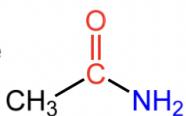


Methyl cyclohexane carbothioate

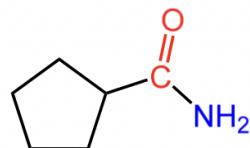
Amides (RCONH₂)

1. With unsubstituted –NH₂ group, –ic acid or –oic acid is replaced with **–amide**.
2. If the NH₂ group is attached to a ring, –carboxylic acid is replaced with **–carboxamide**.
3. If the N is further substituted, identify the substituent group and add prefix "N"

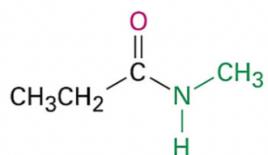
Acetamide



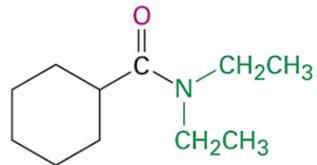
Hexanamide



cyclopentanecarboxamide



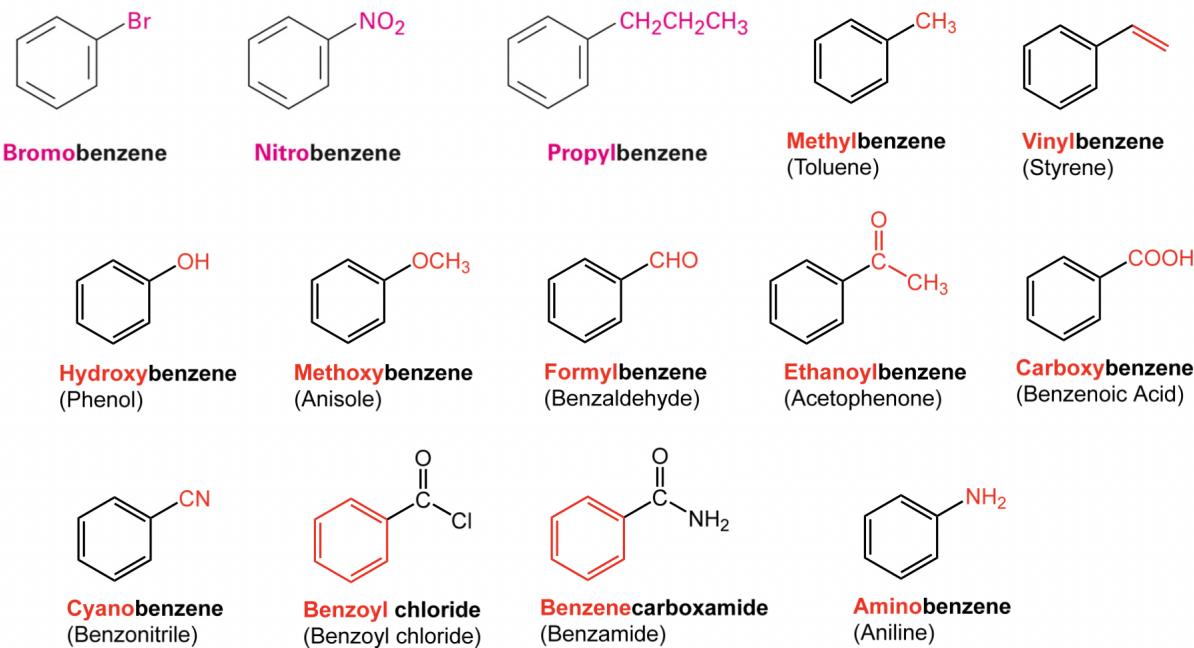
N-Methylpropanamide



N,N-Diethylcyclohexanecarboxamide

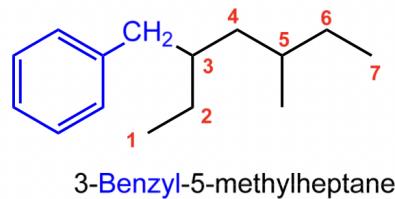
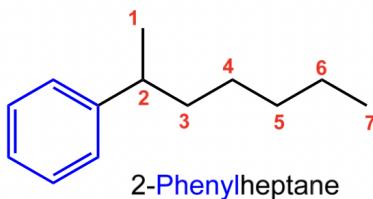
Benzene & Derivatives

1. Mono-substituted benzene: IUPAC and common names are both important

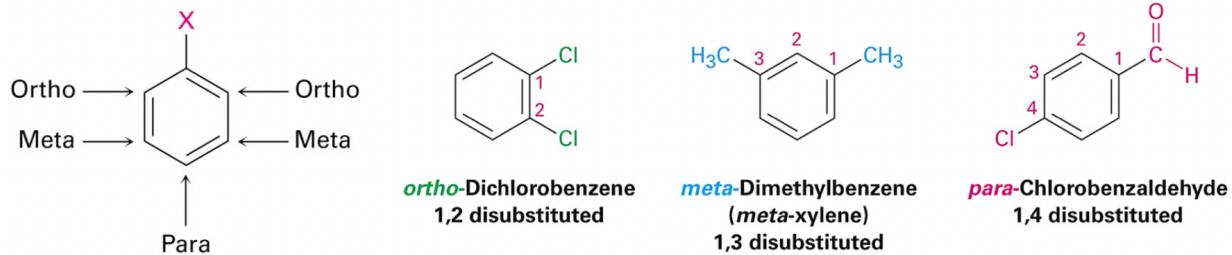


Arenes – alkyl substituted benzenes

- Based on the size of the alkyl substituents, they are termed alkyl-substituted or phenyl-substituted benzene
 - phenyl** (Ph or Φ) is used in cases of a substituent benzene ring in the $-C_6H_5$
 - benzyl** is used for the $C_6H_5CH_2-$ group

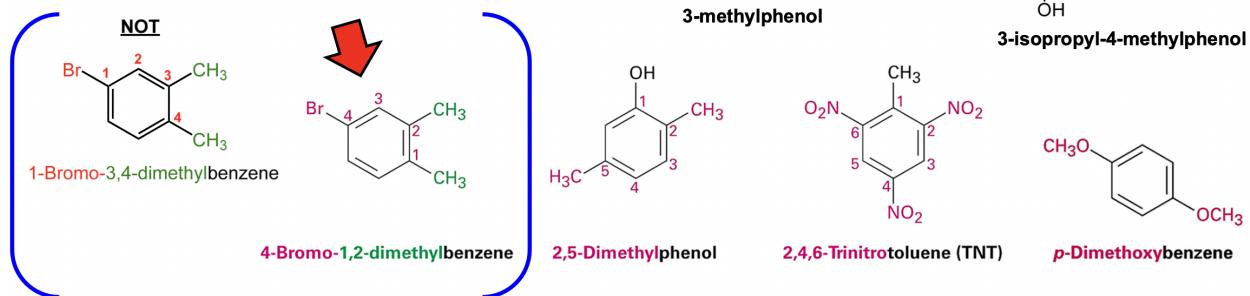


- ortho (o), meta (m), and para (p) with reference to the following figures with relative positions of two substituents

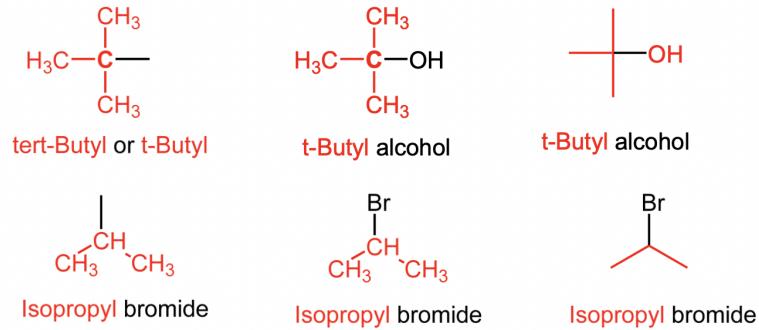


b) If two substituents are different, identify the main functional group and start numbering from its attached carbon in the benzene ring.

→ c) IUPAC: numbers with the lowest possible values are chosen
• Common names can be used as root name.

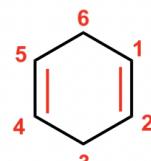


Alkyl	
CH_3-	Methyl (Me)
CH_3CH_2-	Ethyl (Et)
$\text{CH}_3\text{CH}_2\text{CH}_2-$	Propyl (Pr)
$\text{CH}_3(\text{CH}_2)_2\text{CH}_2-$	Butyl (Bu)
$\text{CH}_3(\text{CH}_2)_3\text{CH}_2-$	Pentyl

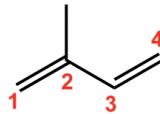


≥ 2 Functional groups

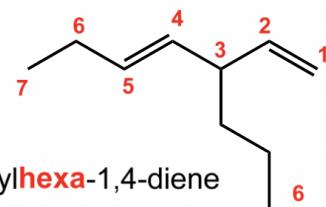
- If >1 double-bond or triple-bond, use suffixes -diene, -triene, and so on.
 - alkane part of the name is “alka-”



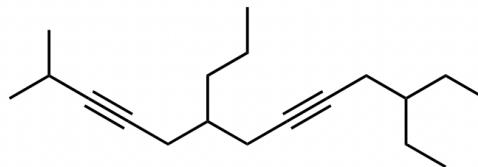
Cyclohexa-1,4-diene



2-Methylbuta-1,3-diene

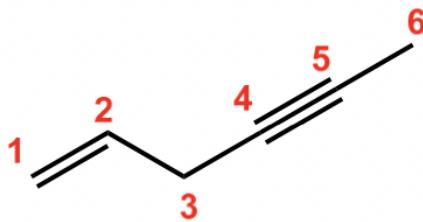


3-propylhexa-1,4-diene

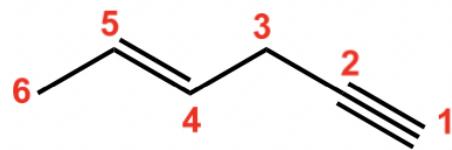


11-ethyl-2-methyl-6-propyltrideca-3,8-diyne

- If both alkene and alkyne are present in the molecule.
 - Number from the end to give lowest number to first functional group, alkene or alkyne.
 - The full name is a single word, with –ene and –yne in alphabetical order.

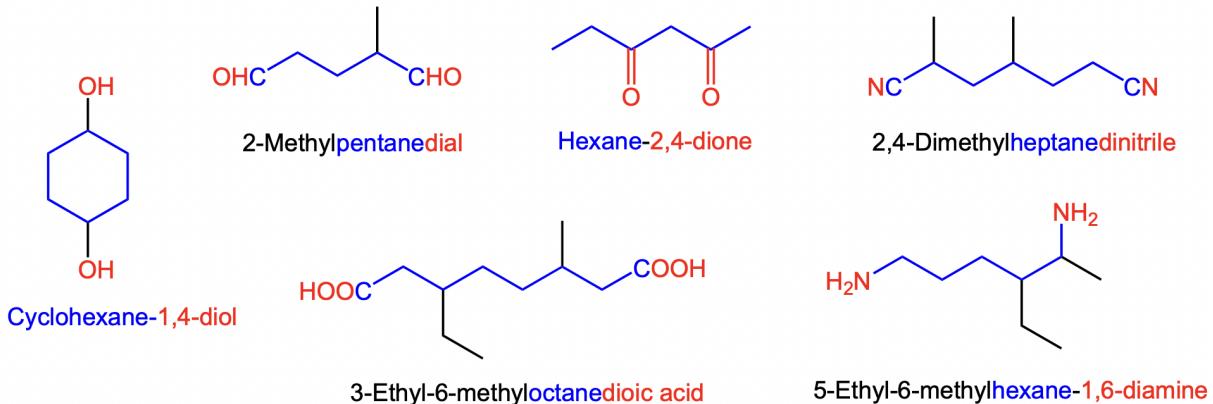


hex-1-en-4-yne

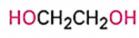


hex-4-en-1-yne

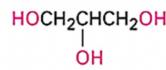
- For alcohols, aldehydes, ketones, carboxylic acids, nitriles and amines:
alkanedi(functional group)



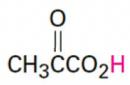
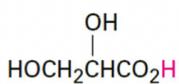
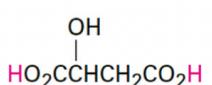
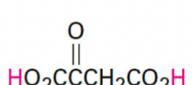
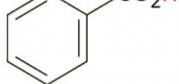
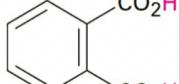
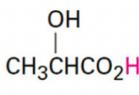
- Important diol and triol:



Ethylene glycol
(ethane-1,2-diol)



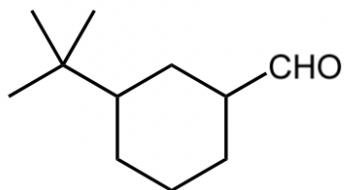
Glycerol
(propane-1,2,3-triol)

Structure	Name	Structure	Name
HCO ₂ H	Formic		Pyruvic
CH ₃ CO ₂ H	Acetic		Glyceric
CH ₃ CH ₂ CO ₂ H	Propionic		Malic
CH ₃ CH ₂ CH ₂ CO ₂ H	Butyric		Oxaloacetic
HO ₂ CCO ₂ H	Oxalic		Benzoic
HO ₂ CCH ₂ CO ₂ H	Malonic		Phthalic
HO ₂ CCH ₂ CH ₂ CO ₂ H	Succinic		
HO ₂ CCH ₂ CH ₂ CH ₂ CO ₂ H	Glutaric		
HO ₂ CCH ₂ CH ₂ CH ₂ CH ₂ CO ₂ H	Adipic		
H ₂ C=CHCO ₂ H	Acrylic		
HO ₂ CCH=CHCO ₂ H	Maleic (cis) Fumaric (trans)		
HOCH ₂ CO ₂ H	Glycolic		
	Lactic		

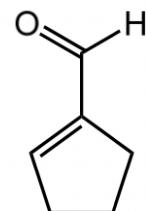
Functional Groups attached to Cycloalkanes

If the functional group is attached to a ring, use the following suffixes:

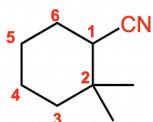
- CHO group: **carbaldehyde**
- COOH group: **carboxylic acid**
- CN group: **carbonitrile**
- The carbon of CHO, COOH or CN is not numbered in this system.
- The complete name of the parent is used, e.g. cyclohexane and cyclopentene.



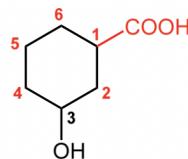
3-(1,1-Dimethylethyl)cyclohexane**carbaldehyde**



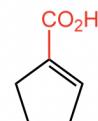
Cyclopentene-**1**-carbaldehyde



2,2-Dimethylcyclohexane**carbonitrile**



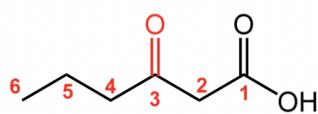
3-hydroxycyclohexane**carboxylic acid**



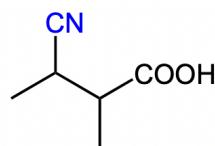
1-cyclopentene**carboxylic acid**

Functional Groups attached to COOH

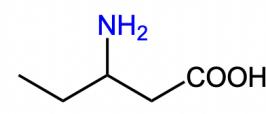
- Carboxylic acids in many cases are treated as the parent. The second functional group is considered as a substituent:
 - OH: **hydroxy** (NOT hydroxyl)
 - CHO: **formyl**
 - C=O: **oxo**
 - CN: **cyano**
 - NH₂: **amino**
 - R-C=O (acyl): suffix **-yl**.



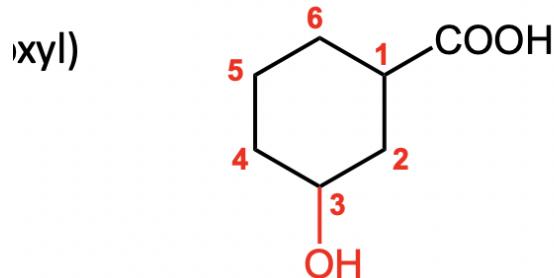
3-Oxo**hexanoic** acid



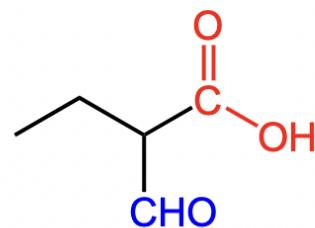
3-Cyano-2-methylbutanoic acid



3-Aminopentanoic acid

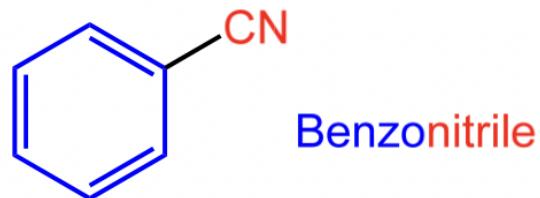


3-hydroxy**cyclohexanecarboxylic** acid



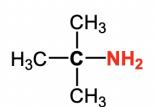
2-Formylbutanoic acid

- For nitrile, the *common name* replaces -yl with -o:

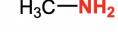


Substituted Amines

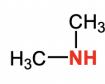
1. Mono-substituted amines: RNH_2



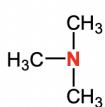
t-Butylamine
(a **primary** amine)



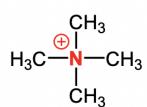
Methylamine
(a **primary** amine)



Dimethylamine
(a **secondary** amine)



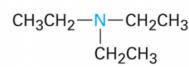
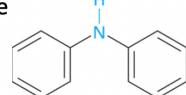
Trimethylamine
(a **tertiary** amine)



Tetramethylammonium ion
(a **quaternary** nitrogen)

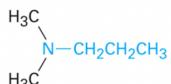
2. Classification of amines

- Take note of the difference between t-Butylamine and Trimethylamine
- Quaternary ammonium salt is NOT considered "an amine"

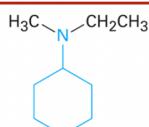


Diphenylamine

Triethylamine



N,N-Dimethylpropylamine



N-Ethyl-*N*-methylcyclohexylamine

3. Symmetrical substituted:

- secondary and tertiary amines are named by adding the prefix di- or tri- to the alkyl group

4. Unsymmetrically substituted:

- Parent is largest N-substituted primary amine
- Other alkyl groups are considered N-substituents, one prefix N for each substituent