Organic Chemistry Nomenclature Guide

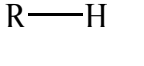
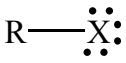
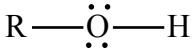
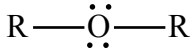
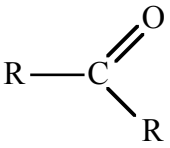
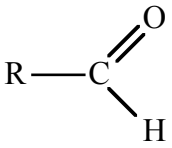
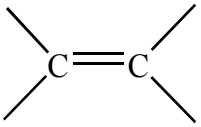
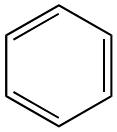
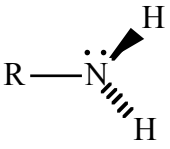
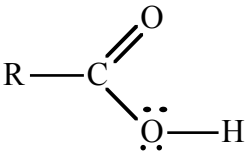
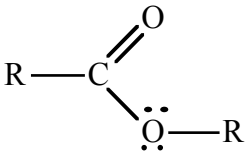
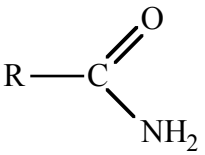
Many molecules in organic chemistry can be named using alkyl groups. *MEMORIZE THEM!*

Common Alkyl (R) Groups

Number of Carbons	Formula	Name
1	$-CH_3$	methyl
2	$-CH_2CH_3$	ethyl
3	$-CH_2CH_2CH_3$	propyl
4	$-CH_2CH_2CH_2CH_3$	butyl
5	$-CH_2CH_2CH_2CH_2CH_3$	pentyl
6	$-CH_2(CH_2)_4CH_3$	hexyl
7	$-CH_2(CH_2)_5CH_3$	heptyl
8	$-CH_2(CH_2)_6CH_3$	octyl
9	$-CH_2(CH_2)_7CH_3$	nonyl

Alkyl groups are generically referred to as R-groups, where **R** could be a methyl group, ethyl group, octyl group, etc.

Organic compounds are often lumped into families or classes of compounds. The classes we will study this term include the following:

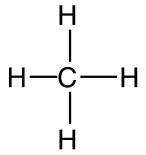
 **Alkanes**	 **Cycloalkanes**	 **Alkyl Halides** *or* **haloalkanes**	 **Alcohols**	 **Ethers**
 **Ketones**	 **Aldehydes**	 **Alkynes**	 **Alkenes**	 **Aromatics**
 **Amines**	 **Carboxylic Acids**	 **Esters**	 **Amides**	***All of these families are detailed in the pages that follow.***

Alkanes

Elemental Formula: **C_nH_{2n+2}**

Nomenclature Guidelines: **-yl** on alkyl group, +**ane** to ending

Notes: An alkane is an alkyl group plus a hydrogen, often referenced as **R-H**. Alkanes contain only carbon and hydrogen atoms in long chains with no rings. Each carbon atom is *sp³* hybridized. Alkanes make great fuels but are generally unreactive.



methane, CH_4

Example: **CH_4 - methane** - is a *methyl* group plus a hydrogen (CH_3-H)

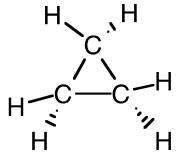
Example: **C_2H_6 - ethane** - is a *ethyl* group plus a hydrogen (CH_3CH_2-H)

Cycloalkanes

Elemental Formula: **C_nH_{2n}**

Nomenclature Guidelines: **cyclo+ -yl** on alkyl group, +**ane** to ending

Notes: Cycloalkanes are alkanes which form an internal ring within the molecule. Cycloalkanes have two less hydrogens than their straight chain alkane counterparts. Cycloalkanes are generally somewhat more reactive than alkanes.



cyclopropane, C_3H_6

Example: **C_3H_6 - cyclopropane** - is a *propyl* group in a triangular ring

Example: **C_6H_{12} - cyclohexane** - is a *hexyl* group in a six sided ring

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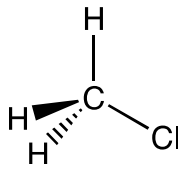
Alkyl Halides *or* Haloalkanes

Elemental Formula: **$C_nH_{2n+2-y}X_y$** *or simply* **R-X** *(where **X** = F, Cl, Br or I)*



chloromethane,

Nomenclature Guidelines: **alkyl name** + **halide** (anionic halogen) *or* **haloalkane**

Notes: Alkyl halides are often reported using two nomenclature systems. The older *alkyl halide* system (such as *methyl chloride*) is in use, but IUPAC guidelines propose a gradual transition to *haloalkane* nomenclature (such as *chloromethane* instead of methyl chloride). The latter system is preferred due to its flexibility when dealing with multiple halogens (i.e. *1,2-dichloroethane*, etc.)

Example: **CH_3Cl – chloromethane** *or* **methyl chloride** – This is a *methyl* group plus a chloride

Example: **$CH_3CHI(CH_2)_4CH_3$ – 2-iodoheptane** *or* **2-heptyl iodide** - is a *heptyl* group plus an iodide on the *second* carbon of the heptyl group

Example: **CH_2Cl_2 - dichloromethane**

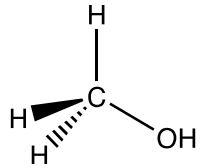
Example: **CH_2I-CHI-$(CH_2)_4CIH_2$ - 1,2,7-triiodoheptane**

Alcohols

Elemental Formula: **$C_nH_{2n+2}O$** *or* **R-OH**

Nomenclature Guidelines: **-yl** on alkyl group, +**anol** to ending

Notes: Alcohols are wonderful starting reagents for a variety of syntheses. If two –OH units are present, the compound is a *diol*, and if three –OH units are present, it is called a *triol*, etc.



methanol, CH_3OH

Example: **CH_3OH - methanol** - is a *methyl* group plus an OH (CH_3-OH)

Example: **$CH_3(CH_2)_4CH_2OH$ - hexan-1-ol** - OH on first carbon

Example: **$CH_3CH(OH)(CH_2)_3CH_3$ - hexan-2-ol** - OH on second carbon

Example: **$CH_2(OH)CH_2CH_2(OH)$ - propane-1,3-diol**

Ethers

dimethylether or

Elemental Formula: **R-O-R**

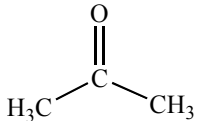
Common Nomenclature: **(alkyl name #1)** + **(alkyl name #2)** + **ether** Note that the alkyl names must be *alphabetical*; "ethyl methyl ether" and not "methyl ethyl ether"

IUPAC Nomenclature: **(shorter alkyl group - yl + oxy)** + **(longer alkyl group -yl +ane)** As an example, $CH_3OCH_2CH_3$ would be "methoxyethane" instead of "ethoxymethane" or "ethyl methyl ether"

Notes: Ethers have two common nomenclature systems, both of which appear often. The IUPAC system is more versatile, allowing for ether linkages which are difficult to name using the older "common" system.

Example: **CH_3OCH_3 - dimethyl ether** *or* **methyoxymethane**
Example: **$CH_3OCH_2CH_2CH_3$ – 1-methyl propyl ether** *or* **1-methoxypropane**
Example: **$CH_3CH(OCH_3)CH_2CH_3$ - 2-methoxybutane**

Ketones



propanone or acetone

Elemental Formula: **R-CO-R** *where CO = carbonyl (C=O) group*

Nomenclature Guidelines: Count number of carbons; determine **alkane** name, then (# of CO position) **alkane -e +one**

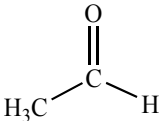
Notes: Aldehydes and ketones are similar in structure, but ketones have two alkyl groups connected to the central carbonyl carbon.

Example: **CH_3COCH_3 - propanone** – this compound is close to *propane*; the CO is on the *second* carbon. Propanone is also known as **acetone**.

Example: **$CH_3COCH_2CH_2CH_3$ - 2-pentanone** - five carbons, *pentane*

Example: **$CH_3CH_2COCH_2CH_3$ - 3-pentanone**

Aldehydes



ethanal

Elemental Formula: **R-CO-H** *where CO = carbonyl (C=O) group*

Nomenclature Guidelines: Count number of carbons; determine **alkane** name, then **alkane -e +al**

Notes: Aldehydes and ketones are similar in structure, but aldehydes have at least one hydrogen connected to the central carbonyl carbon.

Example: **CH_3COH - ethanal** - two carbon atoms like *ethane*

Example: **$CH_3CH_2CH_2COH$ - butanal** - four carbon atoms like *butane*

Alkynes

2-butyne

Elemental Formula: **C_nH_{2n-2}** *or* **R-C≡C-R**

Nomenclature Guidelines: Count number of carbons; then **alkyl -yl +yne**

Example: **$CH_3C{\equiv}CH$ - propyne** - three carbons like *propane*

Example: **$CH_3C{\equiv}CCH_2CH_2CH_3$ - 2-hexyne** - six carbons, *hexane*

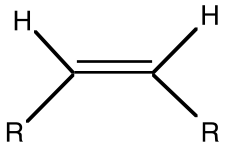
Example: **$CH_3CH_2CH_2C{\equiv}CH$ - 1-pentyne** – note that the number indicates *starting* position of triple bond, i.e. **2-pentyne** is **$CH_3CH_2C{\equiv}CCH_3$**

Alkenes

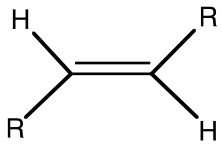
Elemental Formula: **C_nH_{2n}** *or* **R-(H)C=C(H)-R** *R can be H in these examples*

Nomenclature Guidelines: Count number of carbons; determine **alkane** name, then (# of C=C position) **alkane -ane +ene** *or (newer version):* **alkane -ane** (# of C=C position) **+ene**

Notes: Be sure to watch *cis* and *trans* configurations around a double bond where two of the groups off the double bonded carbons are the same.



cis



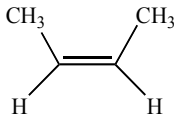
trans

Example: **$H_2C=CH_2$ - ethene** - two carbons like *ethane*

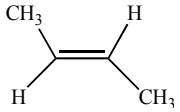
Example: **$H_2C=C(H)CH_3$ - propene** - three carbons, *propane*

Example: **$(CH_3)(CH_3)C=CH_2$ - 2-methylpropene** – *longest chain has three carbons like propane*

Example: **$(CH_3)(H)C=C(CH_3)(H)$** - this is **2-butene (*or* but-2-ene),** but is it *cis* or *trans*? We cannot tell as written; it could be ***cis*-2-butene** (*cis-but-2-ene*) **or *trans*-2-butene** (*trans-but-2-ene*) (see below).



cis-2-butene



trans-2-butene

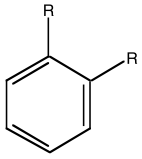
Aromatics

Elemental Formula: **R-C_6H_5** *where C_6H_5 = phenyl group and R = alkyl, halo, etc.*

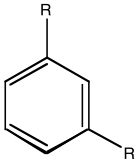
Nomenclature Guidelines: **alkylbenzene** (if **R** is alkyl) or **halobenzene** (if **R** is halo)

Notes: C_6H_5-H is **benzene**, an *aromatic* ringed compound with special stability. Substituents on the benzene ring must be *alphabetically* named.

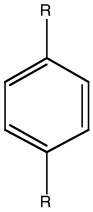
Special Note: Multiple alkyl or halo groups on a benzene ring can be named using appropriate numbers. Special cases involve *ortho* (1,2), *meta* (1,3) and *para* (1,4).



ortho (1,2)



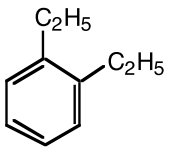
meta (1,3)



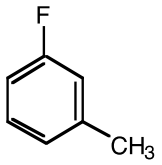
para (1,4)

Example: **C_6H_5-CH_3 - methylbenzene** - *methyl* group on a benzene ring

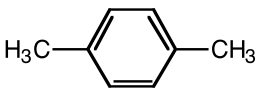
Example: **C_6H_5-Cl - chlorobenzene** - *chloro* group on a benzene ring



1,2-diethylbenzene or ortho-diethylbenzene

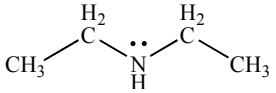


1,3-fluoromethylbenzene or meta-fluoromethylbenzene



1,4-dimethylbenzene or para-dimethylbenzene

Amines

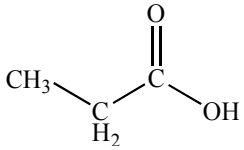

diethylamine

Elemental Formula: **R_x-NH_y** *where x + y = 3*

Nomenclature Guidelines: Count number of carbons; determine **alkane** name, then **alkane -ane +yl +amine**

Example: **CH_3NH_2 - methylamine** - a *primary* amine (2 hydrogens on N)
Example: **$(CH_3)_2NH$ - dimethylamine** - a *secondary* amine (only one hydrogen on N)
Example: **$(CH_3)_3N$ - trimethylamine** - a *tertiary* amine (no hydrogens on N)
Example: **$(CH_3CH_2)(CH_3)NH$ - ethylmethylamine**
Example: **$CH_3CH_2CH_2NH_2$ – 1-propylamine** *(choice of where N atom is connected to alkyl group)*

Carboxylic Acids

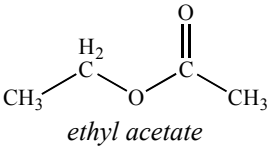

propanoic acid

Elemental Formula: **R-C(=O)OH** (R can be H)

Nomenclature Guidelines: Count number of carbons; determine **alkane** name, then **alkane -e +"oic acid"**

Example: **CH_3COOH - ethanoic acid** - also known as *acetic acid*
Example: **HCOOH - methanoic acid** - also known as *formic acid*
Example: **$CH_3(CH_2)_3COOH$ - pentanoic acid** - also known as *valeric acid*

Esters

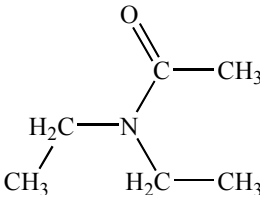

ethyl acetate

Elemental Formula: **R_1-C(=O)O-R_2**

Nomenclature Guidelines: Count number of carbons in *each R group*; determine **alkane** name *for each R*, then **{alkane(R_2) -ane +yl} {alkane(R_1) -e +oate}** *Note:* if $R_1 = CH_3$, name it "acetate" over "ethanoate"

Example: **$CH_3(CH_2)_2COO(CH_2)_3CH_3$ - butyl butanoate**
Example: **$CH_3COO(CH_2)_3CH_3$ - butyl acetate**

Amides


N-diethylacetamide

Elemental Formula: **R_1-C(=O)-$NR_xH_{(2-x)}$** *(an **amine** on an **R-(C=O)** group)*

Nomenclature Guidelines: Count number of carbons; determine **alkane** name, then ***N*- alkane(R_x) -ane +yl +alkane(R_1) -ane +amide** *Note:* if $R_1 = CH_3$, name it "acet" over "meth"

Example: **$CH_3CONHCH_3$ - *N*-methylacetamide**

Example: **$C_6H_5CON(CH_3)_2$ - *N*-dimethylbenzamide**

Common Organic Compound Names

Many organic compounds have common names that do not follow the guidelines found in this handout. Here are some of the more common examples you might encounter at MHCC.

Structural Formula	**"Official" Name**	**"Common" Name**
$CH_3CH_2OCH_2CH_3$	diethyl ether	ether
CH_3COCH_3	propanone	acetone
HCOH	methanal	formaldehyde
CH_3COH	ethanal	acetaldehyde
$H_2C{=}CH_2$	ethene	ethylene
$H_2C{=}C(H)CH_3$	propene	propylene
$HC{\equiv}CH$	ethyne	acetylene
CH_3COOH	ethanoic acid	acetic acid
$C_6H_5\text{-}CH_3$	methylbenzene	toluene

-=-

Many more classes of organic compounds exist,
but you'll have to wait until CH 241 to see the rest of them! ☺