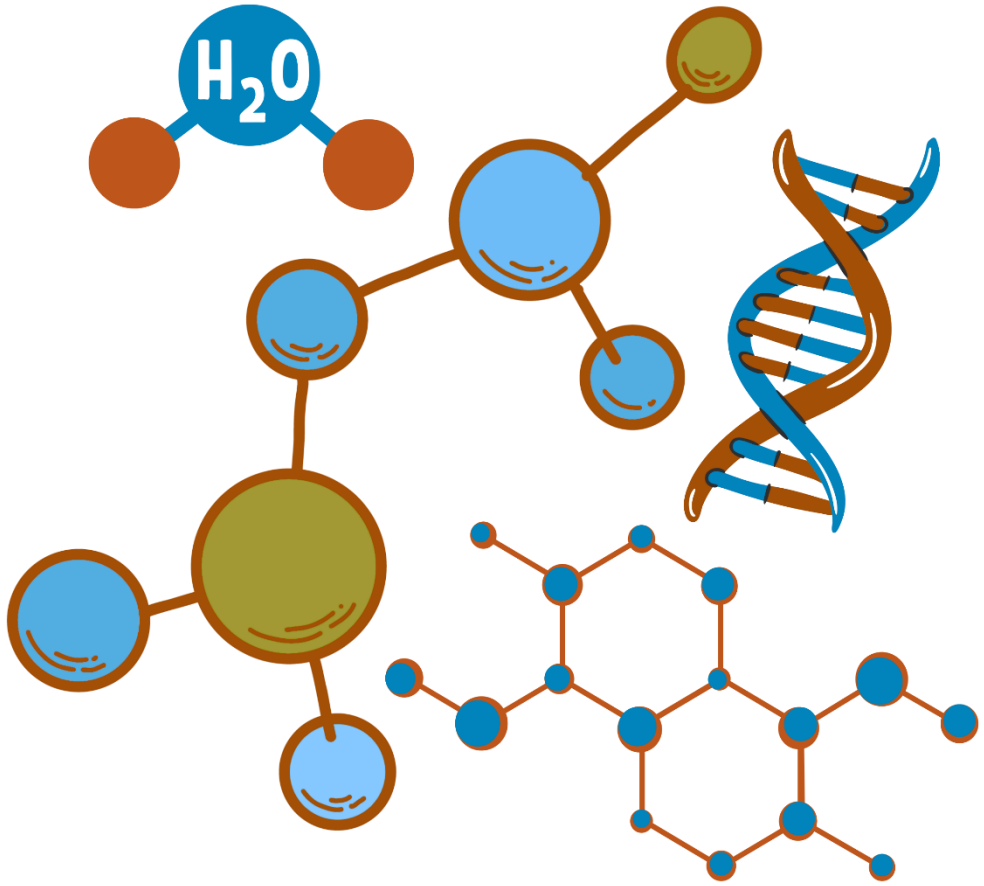
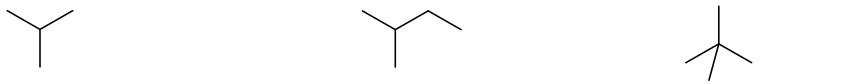
Organic Chemistry I
CHEM 240

Chapter 3: Nomenclature of Organic Compounds



Chapter 3: Nomenclature of Organic Compounds

- The older unsystematic names, (*Common names*).
- Systematic nomenclature developed and updated by the *International Union of Pure and Applied Chemistry (IUPAC)*.



Common name	Isobutane	Isopentane	Isopentane
IUPAC name	2-Methylpropane	2-Methylbutane	2-Methylbutane

1. Nomenclature of Alkanes and Cycloalkanes

- The names for some unbranched alkanes are listed in Table 3.1.
- The ending for all of the names of alkanes is *-ane*.
- The stems of the names of most of the alkanes (above C4) are of Greek and Latin origin. Thus, one, two, three, four, and five become meth-, eth-, prop-, but-, and pent-.

Table 3-1 The Unbranched alkanes

Name	Number of Carbon Atoms	Structure	Name	Number of Carbon Atoms	Structure
Methane	1	CH_4	Hexane	6	$CH_3(CH_2)_4CH_3$
Ethane	2	CH_3CH_3	Heptane	7	$CH_3(CH_2)_5CH_3$
Propane	3	$CH_3CH_2CH_3$	Octane	8	$CH_3(CH_2)_6CH_3$
Butane	4	$CH_3(CH_2)_2CH_3$	Nonane	9	$CH_3(CH_2)_7CH_3$
Pentane	5	$CH_3(CH_2)_3CH_3$	Decane	10	$CH_3(CH_2)_8CH_3$

Chapter 3: Nomenclature of Organic Compounds

1. Nomenclature of Alkanes and Cycloalkanes

1.1. How to Name Alkyl Groups

- If we remove **one terminal hydrogen** atom from an alkane, we obtain what is called an **alkyl** group.
- These alkyl groups have names that end in *-yl*.

Alkane ⟹ Alkyl

- **Example;**

$CH_3—H$

Methane

$CH_3—$

Methyl

Me-



$CH_3CH_2—H$

Ethane

$CH_3CH_2—$

Ethyl

Et-



Chapter 3: Nomenclature of Organic Compounds

1. Nomenclature of Alkanes and Cycloalkanes

1.1. How to Name Alkyl Groups

- For alkanes with more than two carbon atoms, more than one derived group is possible.
- For example;

  Two groups can be derived from propane,

  the propyl group is derived by removal of a terminal hydrogen, and

  the isopropyl (common name) is derived by removal of a hydrogen from the central carbon.

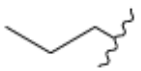
Three-Carbon Groups

$CH_3CH_2CH_3$

Propane

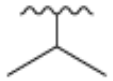
$CH_3CH_2CH_2$—

Propyl (or Pr)



CH_3CHCH_3

Isopropyl (or *i*-Pr)



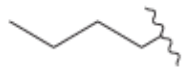
Four-Carbon Groups

$CH_3CH_2CH_2CH_3$

Butane

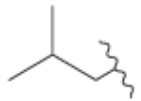
$CH_3CH_2CH_2CH_2$—

Butyl (or Bu)



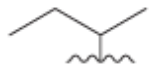
CH_3CHCH_2— (CH_3 above)

Isobutyl



$CH_3CH_2CHCH_3$ (CH_3 below)

***sec*-Butyl**



$(CH_3)_3C$ —

***tert*-Butyl (or *t*-Bu)**



- The common names isopropyl, isobutyl, *sec*-butyl, and *tert*-butyl are approved by IUPAC for the unsubstituted groups, and they are still very frequently used.

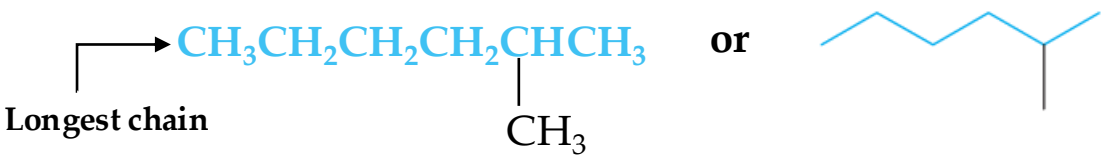
1. Nomenclature of Alkanes and Cycloalkanes

1.2. How to Name Alkanes

- **Branched-chain alkanes are named according to the following rules:**

1. Locate the longest continuous chain of carbon atoms; this chain determines the parent's name for the alkane.

The longest continuous chain may not always be obvious from the way the formula is written.



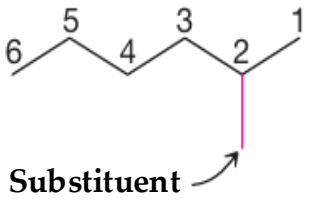
or

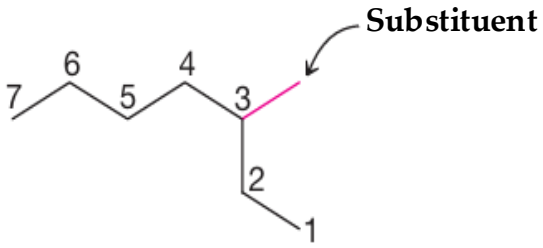
Hexane
Because the longest continuous chain contains six carbon atoms



Heptane
Because the longest chain contains seven carbon atoms

2. Number the longest chain beginning with the end of the chain nearer the substituent.



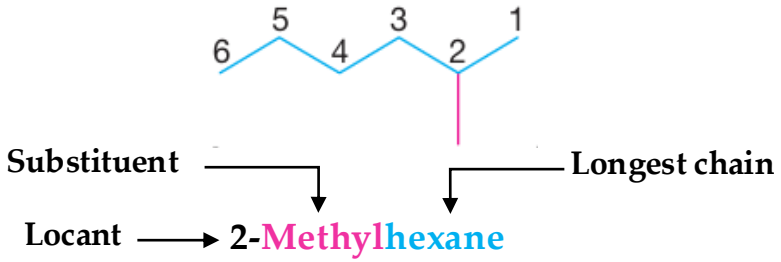


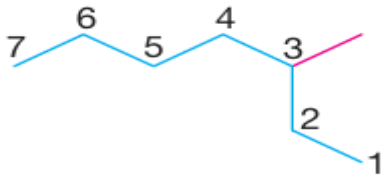
1. Nomenclature of Alkanes and Cycloalkanes

1.2. How to Name Alkanes

3. Use the numbers obtained by application of rule 2 to designate the location of the substituent group.

The parent's name is placed last, and the substituent group, preceded by the number designating its location on the chain, is placed first. Numbers are separated from words by a hyphen (-).

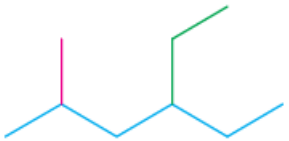




4. When two or more substituents are present, give each substituent a number corresponding to its location on the longest chain.

The substituent groups should be listed alphabetically (i.e., ethyl before methyl).

In deciding on alphabetical order, disregard multiplying prefixes such as "di" and "tri".



4-Ethyl-2-methylhexane

1. Nomenclature of Alkanes and Cycloalkanes

1.2. How to Name Alkanes

5. When two substituents are present on the same carbon atom, use that number repeated twice.



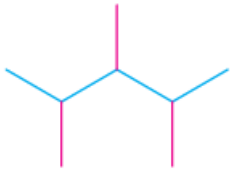
3-Ethyl-3-methylhexane

6. When two or more substituents are identical, indicate this by the use of the prefixes di-, tri-, tetra-, and so on.

Then, make sure that each substituent is assigned a number. Commas (,) are used to separate numbers from each other.



2,3-Dimthylbutane



2,3,4-Trimthylpentane

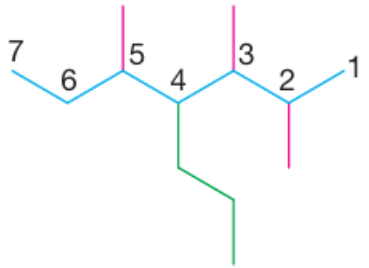


2,2,4,4-Tetramthylpentane

1. Nomenclature of Alkanes and Cycloalkanes

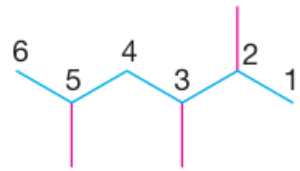
1.2. How to Name Alkanes

7. **When two chains of equal length compete for selection as the parent chain, choose the chain with the greater number of substituents.**



2,3,5-Trimthyl-4-propylheptane
(four substituent)

8. **When branching first occurs at an equal distance from either end of the longest chain, choose the name that gives the lower number at the first point of difference.**



2,3,5-Trimthylhexane
(*not* 2,4,5-Trimthylhexane)

1. Nomenclature of Alkanes and Cycloalkanes

1.2. How to Name Alkanes

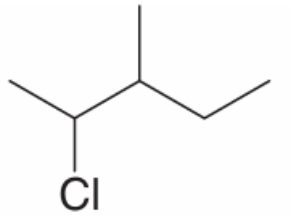
11. Halogen substituents are named by changing the -ine ending of the element to -o.

F—	Cl—	Br—	I—
fluoro-	chloro-	bromo-	iodo-

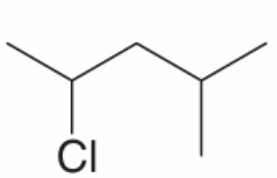
- **Common names for many simple haloalkanes are still widely used.**

  In this common nomenclature system, haloalkane are named as alkyl halide.

	CH_3CH_2Cl	$CH_3CH_2CH_2F$	$CH_3CHBrCH_3$
IUPAC name:	**Chloroethane**	**1-Fluoropropane**	**2-Bromopropane**
common name:	**Ethyl chloride**	**Propyl fluoride**	**Isopropyl bromide**



IUPAC name: **2-Chloro-3-methylpentane**



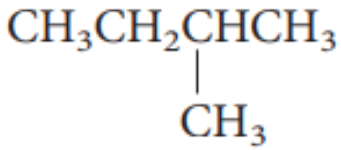
2-Chloro-4-methylpentane

Chapter 3: Nomenclature of Organic Compounds

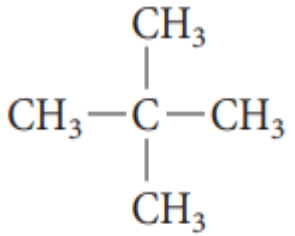
1. Nomenclature of Alkanes and Cycloalkanes

1.2. How to Name Alkanes

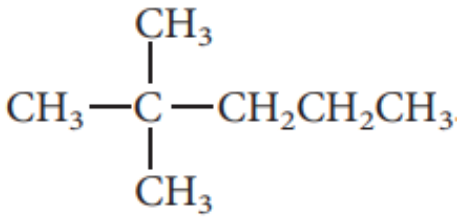
Examples:



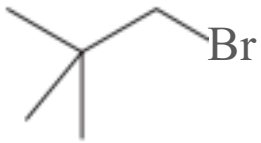
IUPAC name: 2-Methylbutane
common name: Isobutane



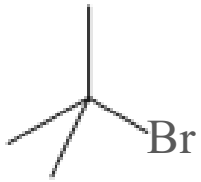
IUPAC name: 2,2-Dimethylpropane
common name: Neopentane



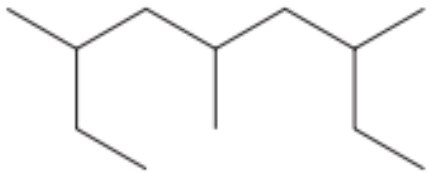
IUPAC name: 2,2-Dimethylpentane
common name: Neoheptane



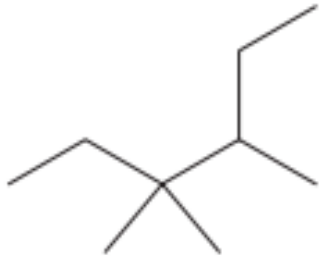
IUPAC name: 1-Bromo-2,2-Dimethylpropane
common name: Neopentyl bromide



IUPAC name: 2-Bromo-2-methylpropane
common name: *tert*-Butyl bromide



IUPAC name: 3,5,7-Trimethylnonane



IUPAC name: 3,3,4-Trimethylhexane

1. Nomenclature of Alkanes and Cycloalkanes

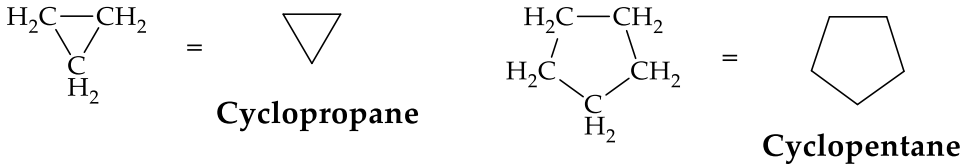
1.3. How to Name Monocyclic Cycloalkanes

- **Cycloalkanes are named by adding "*cyclo*" before the parent's name.**

1. Cycloalkanes with one ring and no substituents:

Count the number of carbon atoms in the ring, then add "*cyclo*" to the beginning of the name of the alkane with that number of carbons.

Example; cyclopropane has three carbons and cyclopentane has five carbons.



2. Cycloalkanes with one ring and one substituent:

Add the name of the substituent to the beginning of the parent's name.

For compounds with only one substituent, it is not necessary to specify a number (locant) for the carbon bearing the substituent.



1. Nomenclature of Alkanes and Cycloalkanes

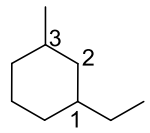
1.3. How to Name Monocyclic Cycloalkanes

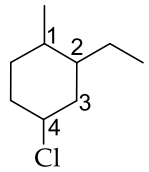
3. Cycloalkanes with one ring and two or more substituents:

For a ring with two substituents, begin by numbering the carbons in the ring, starting at the carbon with the substituent that is first in the alphabet and number in the direction that gives the next substituent the lower number possible.

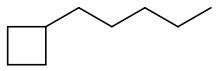
When there are three or more substituents, begin at the substituent that leads to the lowest set of numbers (locants).

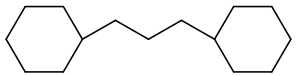
The substituents are listed in alphabetical order, not according to the number of their carbon atom.





4. When a single ring system is attached to a single chain with a greater number of carbon atoms, or when more than one ring system is attached to a single chain, then it is appropriate to name the compounds as cycloalkylalkanes.





Chapter 3: Nomenclature of Organic Compounds

1. Nomenclature of Alkanes and Cycloalkanes

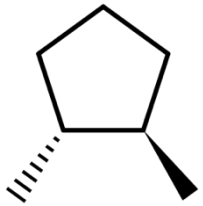
1.4. Cis–Trans Isomerism in Disubstituted Cycloalkanes

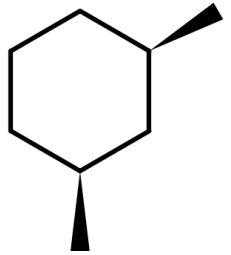
- **Rotation about the C–C bonds of a ring is restricted. Two substituents on different ring carbons can therefore lie on the same side or on opposite sides of the ring plane.**

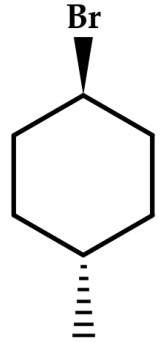
  A wedged bond points toward the viewer (above the ring plane); a hashed bond points away from the viewer (below the plane).

- ***cis-*** **(Latin: "on this side"): both groups on the same side.** ***trans-*** **(Latin: "across"): the groups on opposite sides.**
- **The prefix is written in italics before the name and joined by a hyphen. Cis and trans isomers are stereoisomers: same connectivity, different arrangement in space.**

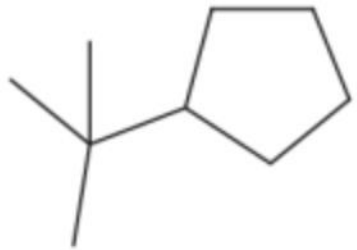


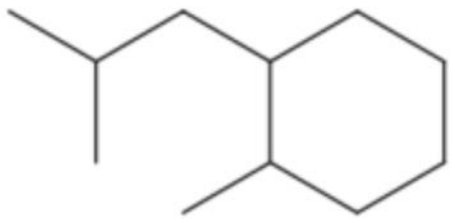


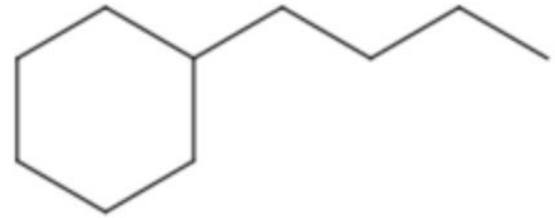


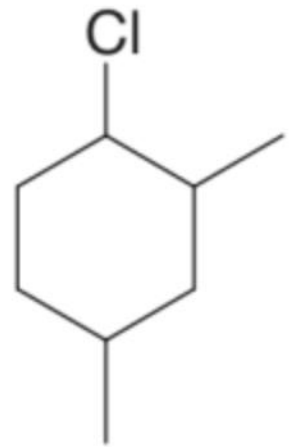


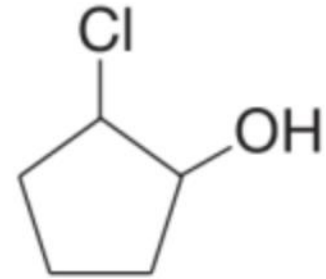
Give names for the following substituted alkanes:

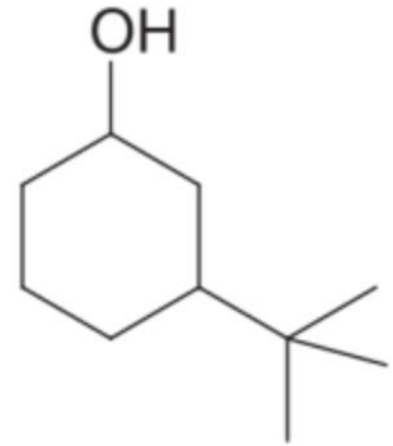
(a) 

(b) 

(c) 

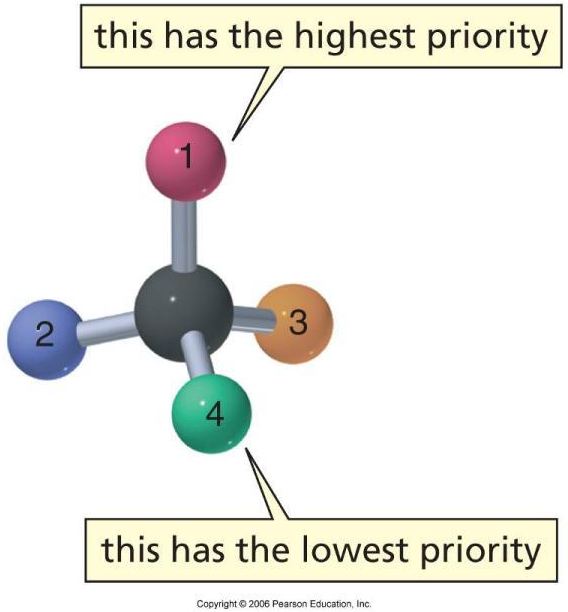
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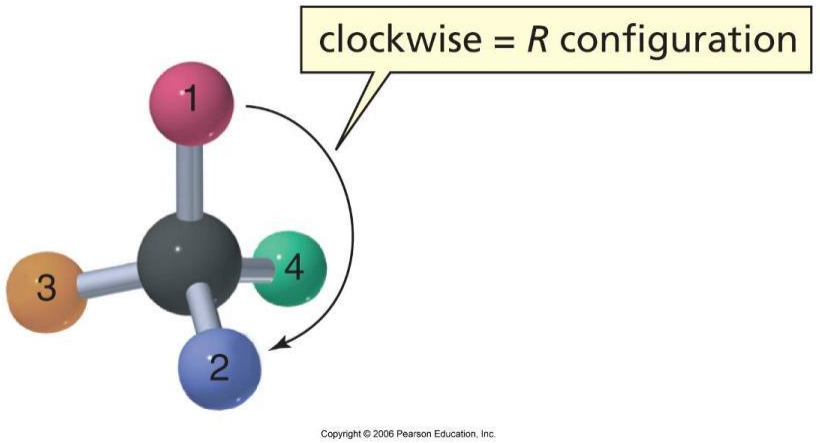
(e) 

(f) 

2. Naming Enantiomers: The *R,S* System

Cahn, Ingold, Prelog sequence rules:



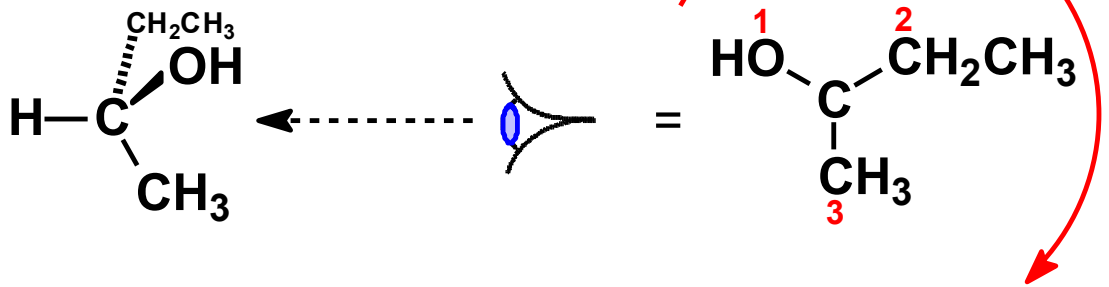


R and *S*

Assign priorities to the remaining groups based on atomic numbers.

Clockwise (highest to lowest priority) ⇒ R

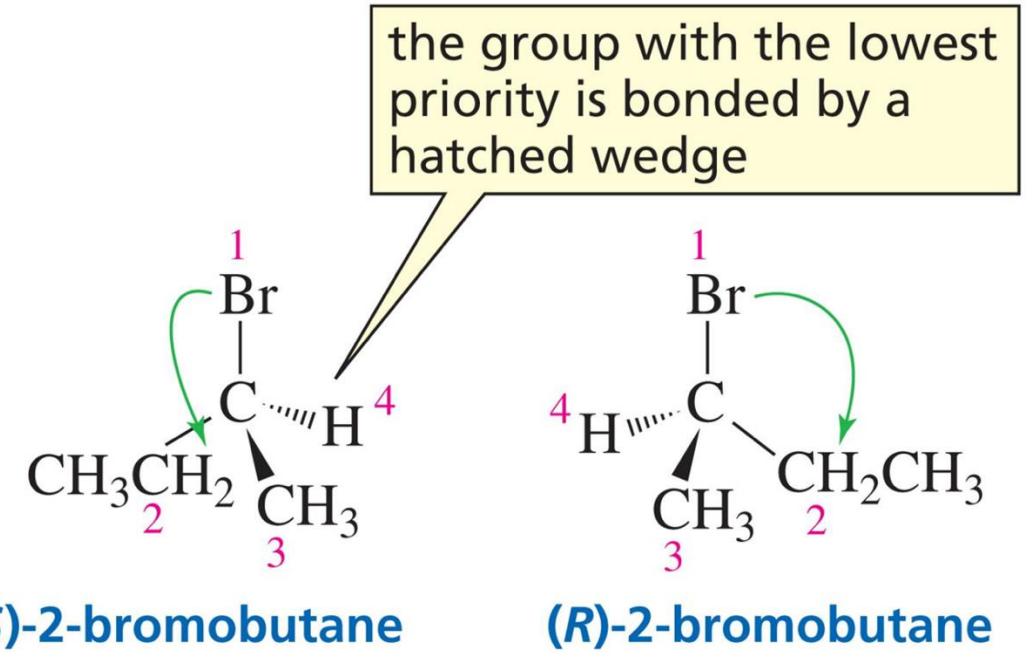
Counterclockwise ⇒ *S*



(*R*)-2-butanol

2. Naming Enantiomers: The *R,S* System

Cahn, Ingold, Prelog sequence rules:



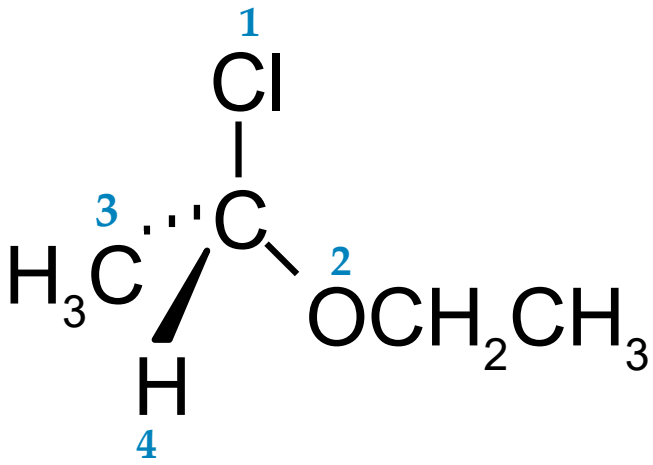
- **Assign a numerical priority to each group bonded to the asymmetric carbon:**
  - **group 1 = highest priority**
  - **group 4 = lowest priority**

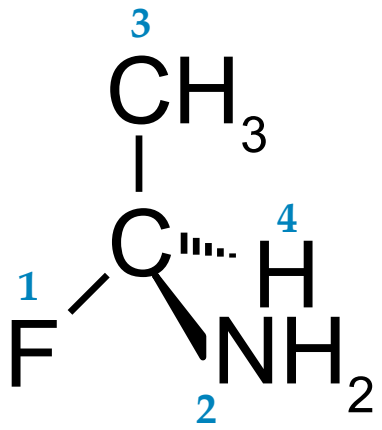
- **Rules for assigning priorities:**
  - **Compare the first atom in each group (i.e. the atom directly bonded to the asymmetric carbon)**
  - **Atoms with higher atomic numbers have higher priority**

2. Naming Enantiomers: The *R,S* System

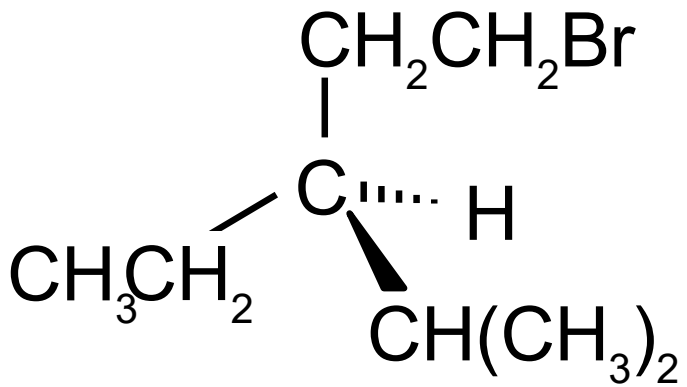
Cahn, Ingold, Prelog sequence rules:

- **Example priorities:**
  I > Br > Cl > S > F > O > N > C > H





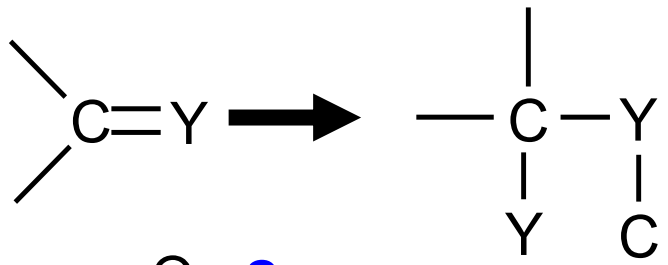
- **In case of ties, use the next atoms along the chain as tiebreakers.**
  $CH(CH_3)_2$ > CH_2CH_2Br > CH_3CH_2

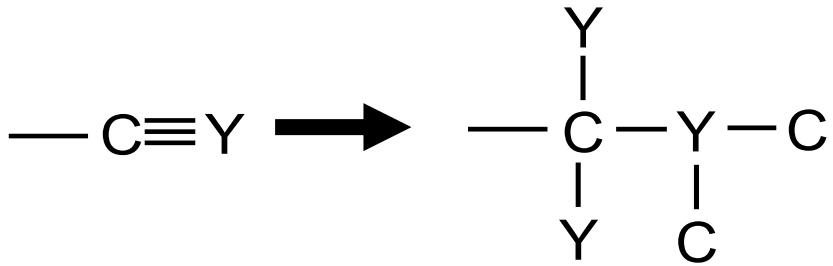


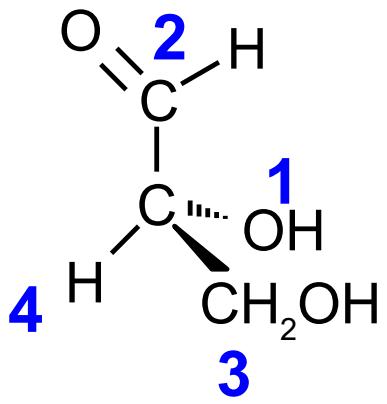
2. Naming Enantiomers: The *R,S* System

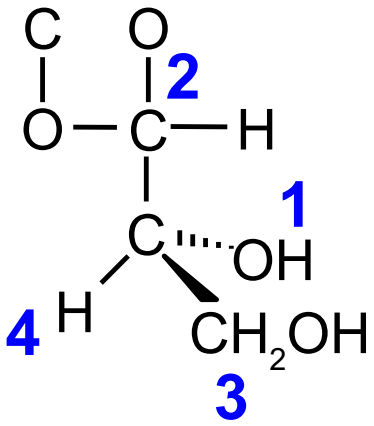
Cahn, Ingold, Prelog sequence rules:

- **Treat double and triple bonds as if both atoms in the bond were duplicated or triplicated:**





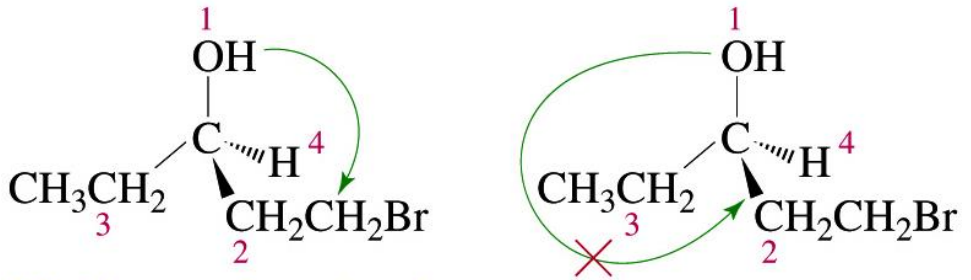




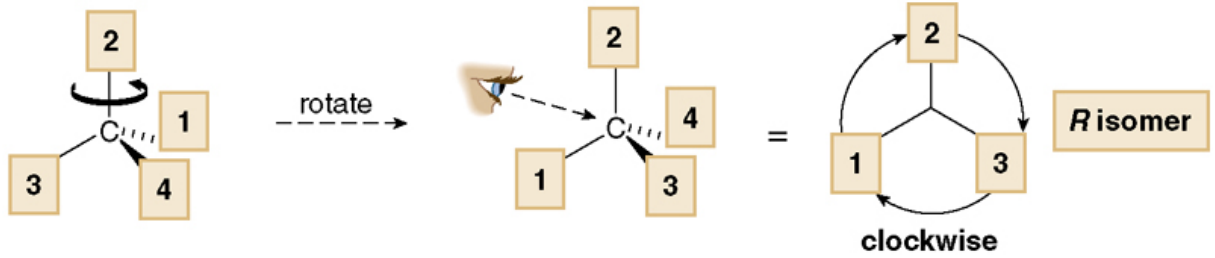
2. Naming Enantiomers: The *R,S* System

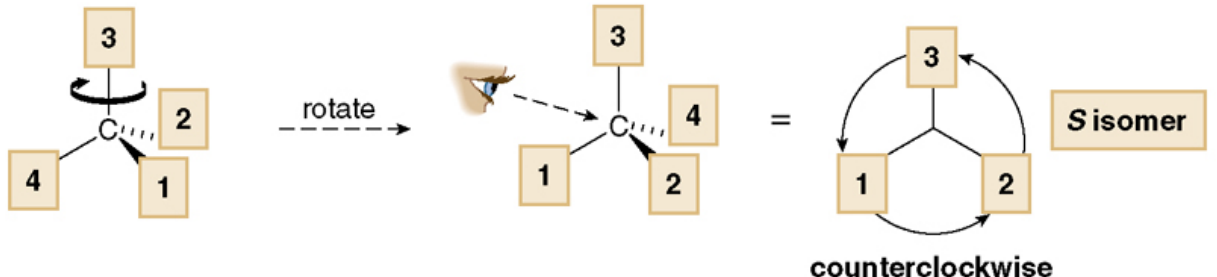
Cahn, Ingold, Prelog sequence rules:

- **In drawing the arrow from group (1) to group (2), you can draw past the group with the lowest priority (4) but never draw past the group with the next lower priority (3)**



- **Orienting the lowest priority group in back**

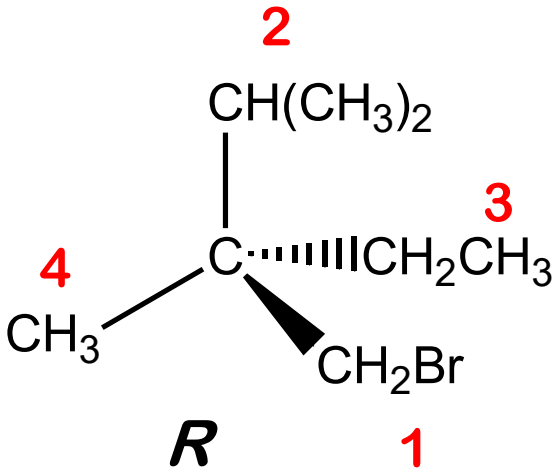




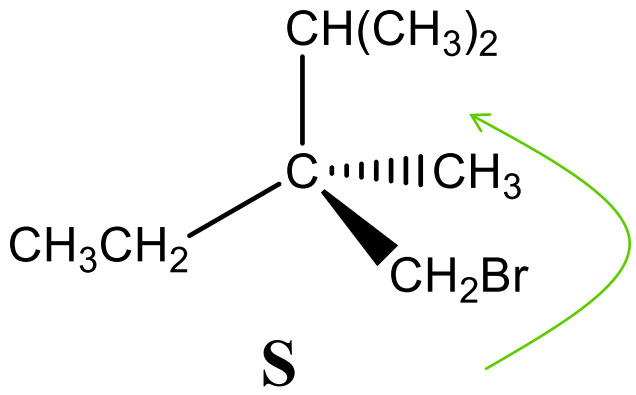
2. Naming Enantiomers: The *R,S* System

Cahn, Ingold, Prelog sequence rules:

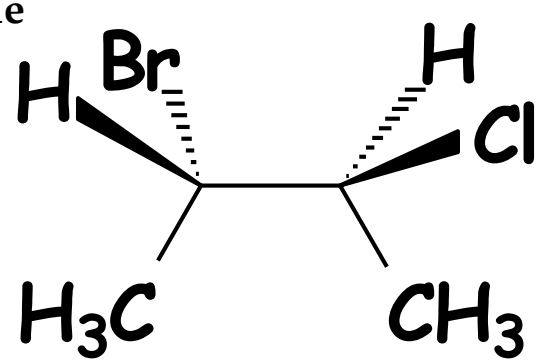
Indicate whether the structure has *R* or *S* configuration:



switch CH_3 and CH_3CH_2



- When naming compounds containing multiple chiral atoms, you must give the configuration around each chiral atom:
  - position number and configuration of each chiral atom in numerical order, separated by commas, all in ( ) at the start of the compound name



(2*S*, 3*S*)-2-bromo-3-chlorobutane

3. Nomenclature of Alkenes and Cycloalkenes

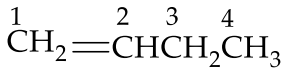
3.1. How to Name Alkenes

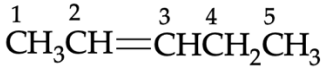
- The IUPAC rules for naming alkenes are similar in many respects to those for naming alkanes:

1. **Determine the parent's name by selecting the longest chain that contains the double bond and change the ending of the name of the alkane of identical length from *-ane* to *-ene*.**

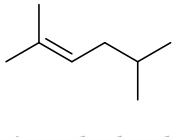
IUPAC name Common name	 Ethene Ethylene	 Propene Propylene	 2-Methylpropene Isobutylene

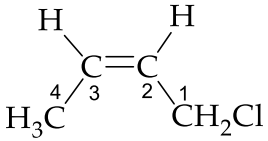
2. **Number the chain from the end nearest the double bond, ensuring that both double-bonded carbon atoms are included in the parent chain.**
   - Designate the location of the double bond by using the number of the first atom of the double bond as a prefix. The locant for the alkene suffix may precede the parent's name or be placed immediately before the suffix.
3. **Indicate the locations of the substituent groups by the numbers of the carbon atoms to which they are attached.**

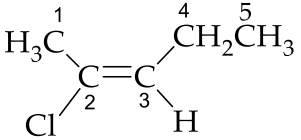












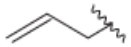
3. Nomenclature of Alkenes and Cycloalkenes

3.1. How to Name Alkenes

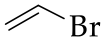
4. **Two frequently encountered alkenyl groups are the vinyl group and the allyl group.**



The vinyl group

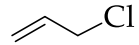


The allyl group



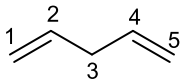
IUPAC name
Common name

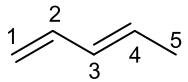


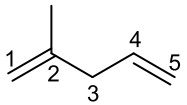


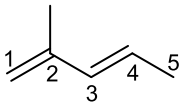
3.2. How to Name Dienes

5. **Number the chain from the end nearest the first double bond, giving the substituents the lowest possible numbers.**







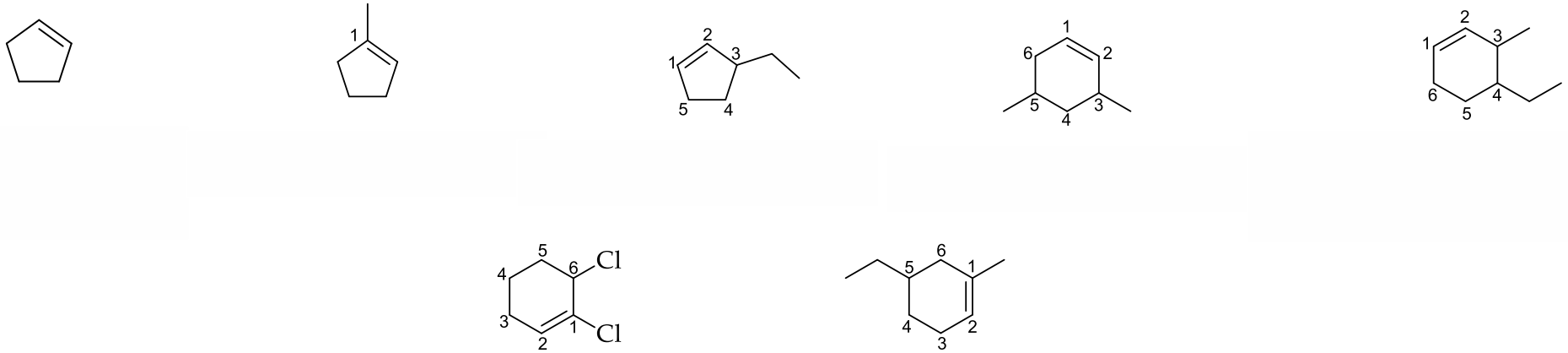


2. Nomenclature of Alkenes and Cycloalkenes

3.3. How to Name Cycloalkenes

6. **Number substituted cycloalkenes in the way that gives the carbon atoms of the double bond the 1 and 2 positions and that also gives the substituent groups the lower numbers at the first point of difference.**

- *With substituted cycloalkenes it is not necessary to specify the position of the double bond since it will always begin with C1 and C2.*

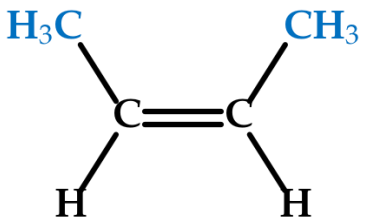


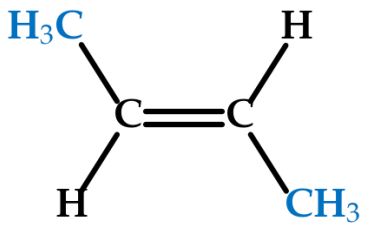
3. Nomenclature of Alkenes and Cycloalkenes

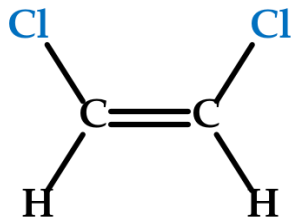
3.4. Cis–Trans Isomerism in Alkenes

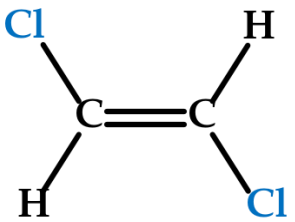
- Rotation about a C=C double bond is restricted, so an alkene such as 2-butene exists as two different compounds (stereoisomers).
- *cis*-: two identical (or similar) groups on the same side of the double bond; *trans*-: the groups on opposite sides.
- Cis–trans isomerism is possible only when each carbon of the double bond carries two different groups. If either carbon bears two identical groups (e.g., $=CH_2$ or $=C(CH_3)_2$), no cis–trans isomers exist.
- Cycloalkenes with fewer than eight ring carbons exist only in the *cis* form, so no prefix is needed (e.g., cyclohexene).

Cis–trans isomers exist

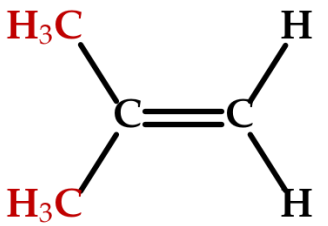


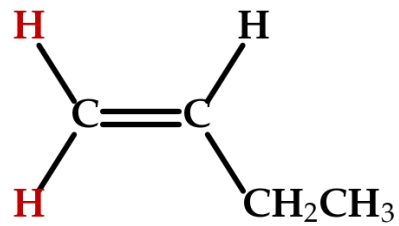






No cis–trans isomers





3. Nomenclature of Alkenes and Cycloalkenes

3.5. The (E)–(Z) System for Naming Alkenes

- When a double bond carries three or four different groups, cis and trans become **ambiguous**. IUPAC then uses the **(E)–(Z) system**, based on the **Cahn–Ingold–Prelog (CIP) priority rules**:

1. Look at each carbon of the double bond separately. The attached atom with the **higher atomic number** has the higher priority:

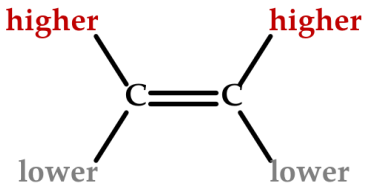
   I > Br > Cl > S > F > O > N > C > H

2. If the first atoms are the same, compare the atoms attached to them and decide at the **first point of difference**: $-CH_2CH_3$ (C,H,H) > $-CH_3$ (H,H,H).

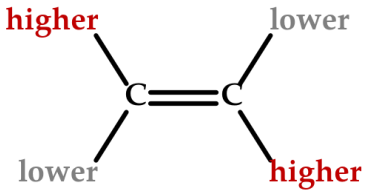
3. Multiple bonds are counted as **duplicated atoms**: $-CH=CH_2$ is treated as (C,C,H).

- ***(Z)*** **(*zusammen* = together): higher-priority groups on the same side.**
- ***(E)*** **(*entgegen* = opposite): higher-priority groups on opposite sides.**

The italic letter, in parentheses, is placed at the beginning of the name.



***(Z)*-isomer: same side**



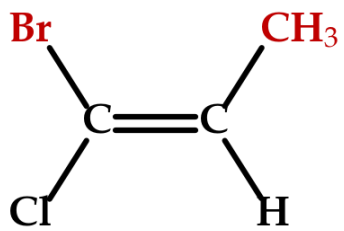
***(E)*-isomer: opposite sides**

3. Nomenclature of Alkenes and Cycloalkenes

3.5. The (E)–(Z) System: Worked Examples

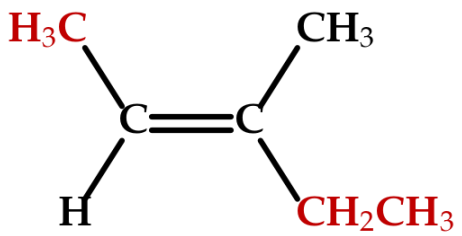
- **Step 1:** at each carbon of the double bond, rank the two attached groups (the higher-priority group is shown in **red**).
- **Step 2:** higher-priority groups on the same side → *(Z)*; on opposite sides → *(E)*.

a)



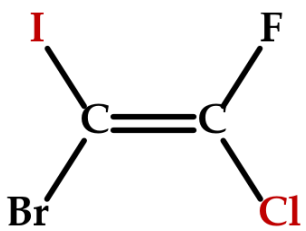
C1: Br > Cl; C2: CH_3 > H

b)



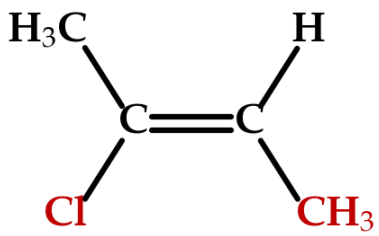
C2: CH_3 > H; C3: CH_2CH_3 > CH_3

c)



C1: I > Br; C2: Cl > F

d)



C2: Cl > CH_3; C3: CH_3 > H

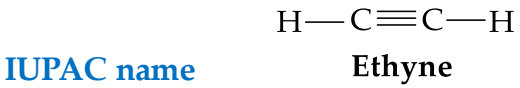
- **Note:** cis/trans and (E)/(Z) do not always correspond. In (b) the two methyl groups are cis, yet the alkene is *(E)*; in (d) they are trans, yet it is *(Z)*.

4. Nomenclature of Alkyne

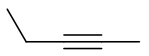
4.1. How to Name Alkyne

- **Alkynes are named in much the same way as alkenes.**
- **Alkynes, are named by replacing the *-ane* of the name of the corresponding alkane with the ending *-yne*.**

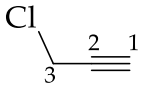
  The chain is numbered to give the carbon atoms of the triple bond the lower possible numbers. The lower number of the two carbon atoms of the triple bond is used to designate the location of the triple bond.
- **The locations of substituent groups of branched alkynes and substituted alkynes are also indicated with numbers.**



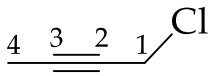
IUPAC name: **Ethyne**
Common name: **Acetylene**

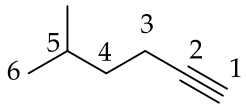


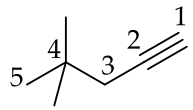
2-Pentyne



3-Chloropropyne



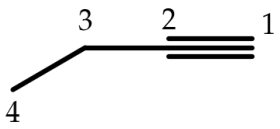




4. Nomenclature of Alkyne

4.2. Terminal and Internal Alkynes, and Alkynyl Groups

- A terminal alkyne has the triple bond at the end of the chain (–C≡C–H); an internal alkyne has it within the chain.
- When a triple bond is part of a substituent, the group is an alkynyl group: the ending *-yl* replaces the final *-e* of the alkyne name (ethyne → ethynyl).
- The ethynyl group is HC≡C–; the propargyl group (IUPAC: prop-2-yn-1-yl, or 2-propynyl) is HC≡C–CH_2–.
- A ring attached to a C≡C unit may be named as an ethynyl-substituted ring or as a ring-substituted alkyne (see aryl groups, section 4.4).



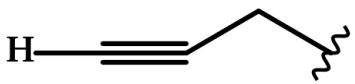
1-Butyne
(terminal alkyne)



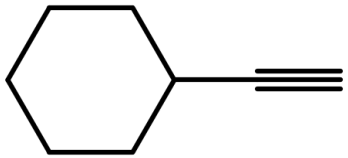
2-Butyne
(internal alkyne)

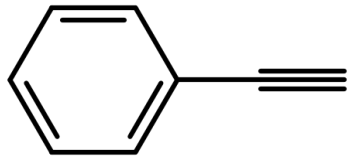


Ethynyl group



Propargyl group
(2-propynyl)



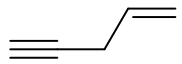


4. Nomenclature of Alkyne

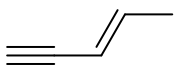
4.3 Priority of Multiple Bonds in IUPAC Nomenclature

- When both double and triple bonds are present, number the parent chain to give the multiple bonds the lowest possible set of locants. In case of a tie, the double bond is given the lower locant.

- Example 1 – Tie: The double bond is given the lower locant.



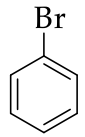
- Example 2 – No Tie: The lowest set of locants determines the direction of numbering.

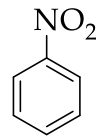


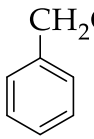
5. Nomenclature of Aromatic Compounds

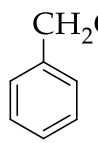
5.1. How to Name Monosubstituted Benzene

- **Benzene is the simplest aromatic compound, and the simple monosubstituted ring is named as derivative of benzene.**

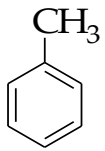

Bromobenzene

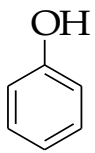

Nitrobenzene

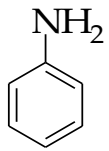

Ethylbenzene

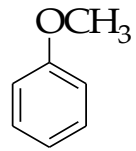

Propylbenzene

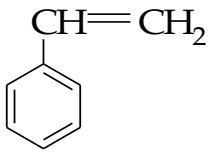
- **Common names are accepted by IUPAC as parent compounds.**

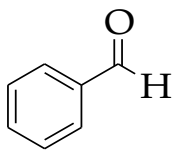

Toluene

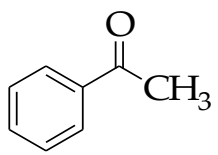

Phenol

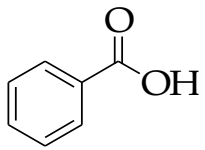

Aniline


Anisole


Styrene


Benzaldehyde


Acetophenone


Benzoic acid

5. Nomenclature of Aromatic Compounds

5.2. How to Name Disubstituted Benzene

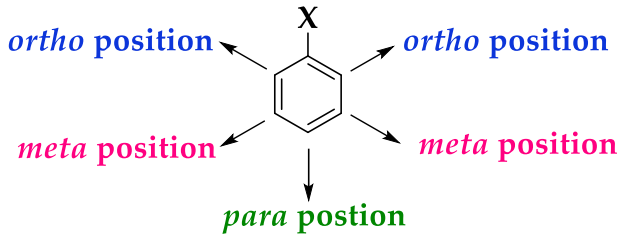
- When two substituents are present, their relative positions are indicated by the prefixes *ortho-*, *meta-*, and *para-* (abbreviated *o-*, *m-*, and *p-*) or using numbers.

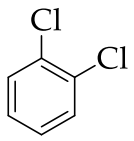
- If substituent X is attached to carbon 1;

  o- groups are on carbons 2 and 6;

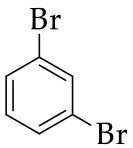
  m- groups are on carbons 3 and 5, and

  p- groups are on carbon 4.

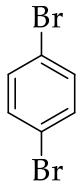




1,2-Dichlorobenzene
(*o*-Dichlorobenzene)



1,3-Dibromobenzene
(*m*-Dibromobenzene)

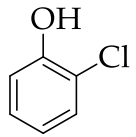


1,4-Dibromobenzene
(*p*-Dibromobenzene)

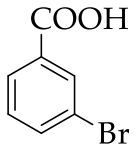
5. Nomenclature of Aromatic Compounds

5.2. How to Name Disubstituted Benzene

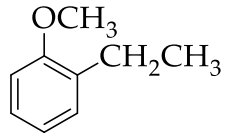
- If a substituent have a special name, it could be used as the parent's name with the possible lowest number .
- Some disubstituted benzene derivatives have a common names.



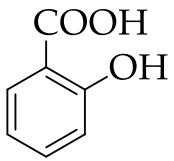
2-Chlorophenol
(*o*-Chlorophenol)

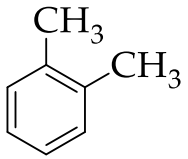


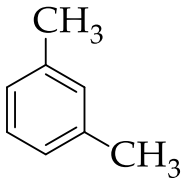
3-Bromobenzoic acid
(*m*-Bromobenzoic acid)

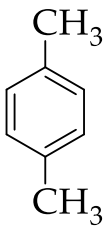


2-Ethylanisole
(*o*-Ethylanisole)







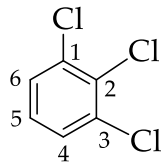


IUPAC name	2-Hydroxybenzoic acid	1,2-Dimethylbenzene	1,3-Dimethylbenzene	1,4-Dimethylbenzene
Common name	Salicylic acid	*ortho*-xylene	*meta*-xylene	*para*-xylene

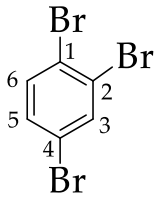
5. Nomenclature of Aromatic Compounds

5.3. How to Name Polysubstituted Benzene

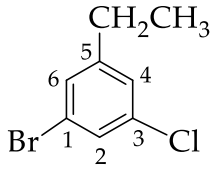
- If more than two groups are present on the benzene ring, their positions must be indicated using numbers only.
- The benzene ring is numbered so as to give the lowest possible numbers to the substituents.



1,2,3-*Tri*chlorobenzene

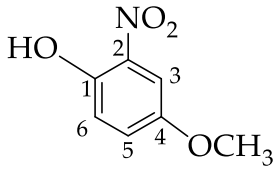


1,2,4-*Tri*bromobenzene

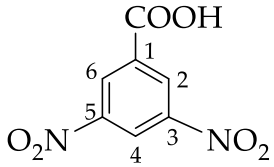


1-Bromo-3-chloro-5 ethylbenzene

- When a substituent is one that together with the benzene ring gives a new base name, that substituent is assumed to be in position 1 and the new parent's name is used.



4-Methoxy-2-nitro-phenol

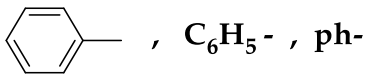


3,5-Dinitrobenzoic acid

5. Nomenclature of Aromatic Compounds

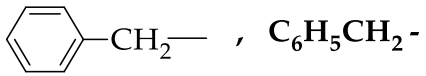
5.4. How to Name Aryl Groups

- When the C_6H_5– group is named as a substituent, it is called a phenyl group (Ph–).
- Benzyl group ($C_6H_5CH_2$-) is an alternative name for the phenylmethyl group.



, C_6H_5- , ph-

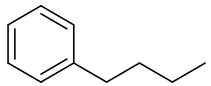
Phenyl group



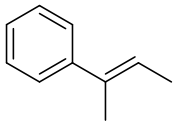
, $C_6H_5CH_2$-

Benzyl group

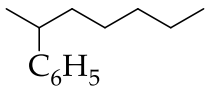
- A hydrocarbon composed of one saturated chain and one benzene ring is usually named as a derivative of the larger structural unit.



Butylbenzene

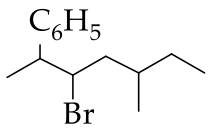


(*E*)-2-Phenyl-2-butene

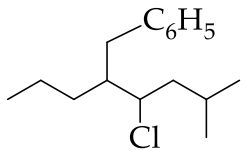


2-Phenylheptane

- If the chain is unsaturated, the compound may be named as a derivative of that chain, regardless of ring size.



3-Bromo-5-methyl-2-phenylheptane

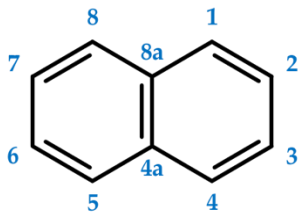


5-Benzyl-4-chloro-2-methyloctane

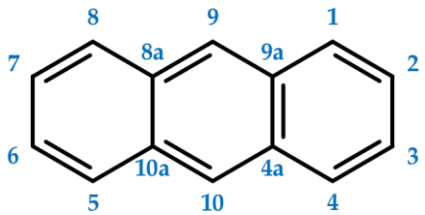
5. Nomenclature of Aromatic Compounds

5.5. How to Name Polycyclic Aromatic Hydrocarbons

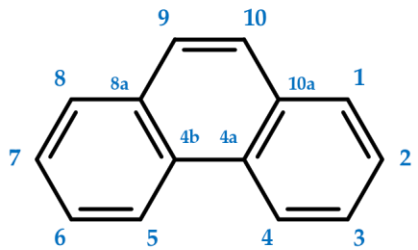
- Benzene rings that share two adjacent carbon atoms are **fused rings**; such compounds are **polycyclic aromatic hydrocarbons (PAHs)**.
- The common PAHs keep their retained names: **naphthalene** (two rings), **anthracene** (three rings in a line) and **phenanthrene** (three rings, angular).
- Each parent has a **fixed numbering**; carbons shared by two rings are given the letter *a* (4a, 8a, …). Substituents receive the lowest possible locants.
- In naphthalene, positions 1, 4, 5, 8 are **α (alpha)** and positions 2, 3, 6, 7 are **β (beta)** positions.



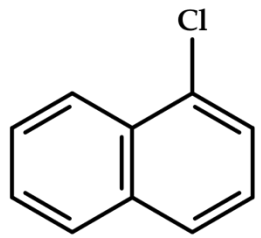
Naphthalene



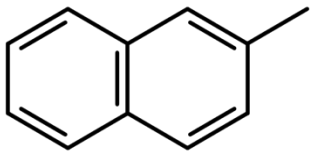
Anthracene



Phenanthrene



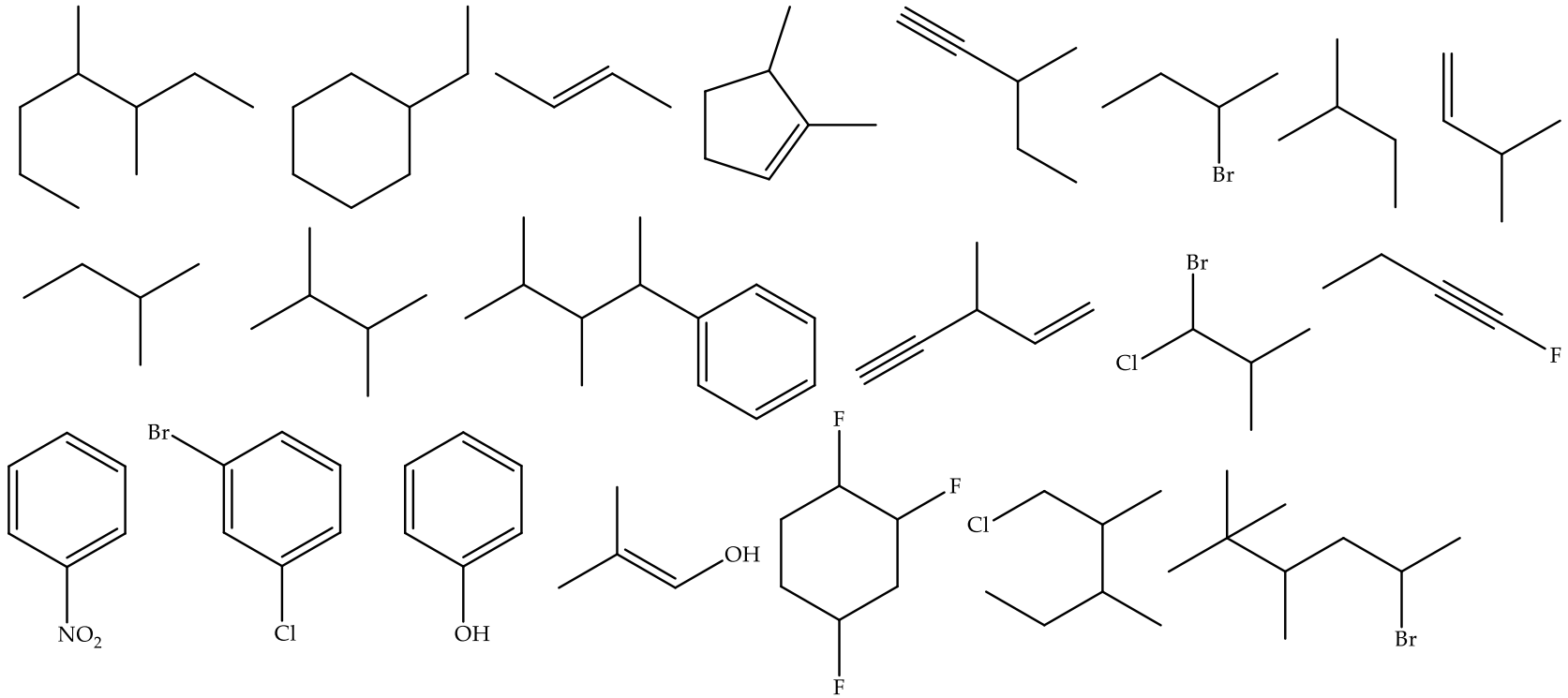
1-Chloronaphthalene
(α-chloronaphthalene)



2-Methylnaphthalene
(β-methylnaphthalene)

6. Practice Problems

1) Give the IUPAC name of each of the following compounds



2) Write the structural formula for:

a) 2,2,4-trimethylpentane

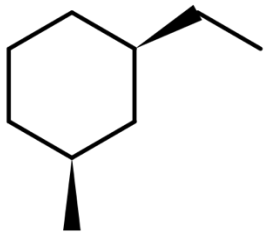
b) 4-Isopropyl-3,5-dimethyl-2-octene

c) 5-Bromo-4-ethyl-6-methyl-2-nonyne

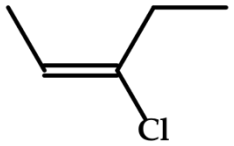
d) 1,3-Difluoro-4-methylbenzene

6. Practice Problems (continued)

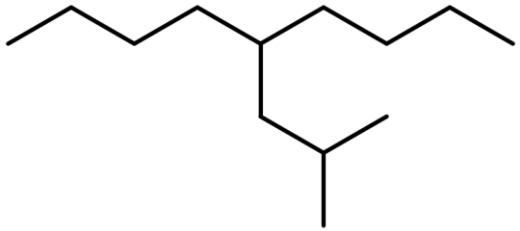
3) Give the IUPAC name of each compound (include cis/trans or (E)/(Z) where needed):



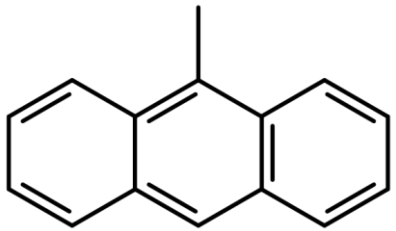
a)



b)



c)



d)

4) Write the structural formula for:

a) *(Z)*-3-Methylhex-3-ene
b) *trans*-1,2-Dibromocyclohexane
c) 2-Bromonaphthalene
d) 4-Isopropyl-2-methylheptane
e) 3-Cyclopentylprop-1-yne

5) Rank in order of decreasing priority:

a) -COOH -H $-NH_2$ -OH

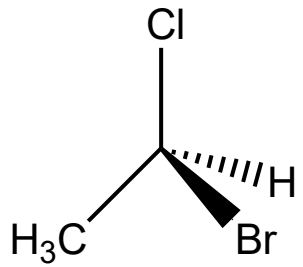
b) 

6) Which group in each pair has the highest priority?

a) -I or -Br

b) $-CH_3Br$ or $-CH_2CH_2Br$

7) Label each compound as R or S

a) 

b) 