

Chapter 5. Functional Groups

□ What to master

- ◆ Naming Alkanes Using Systematic Nomenclature
- ◆ Drawing the Structure of an Alkane from the Name
- ◆ Naming Complex Alkyl Groups
- ◆ Naming Cycloalkanes, Alkenes, Alkynes, Alkyl Halides, Alcohols, Ethers, and Amines
- ◆ Drawing Structures from their Names
- ◆ Predicting Approximate Physical Properties of Compounds with These Functional Groups

Chapter 5. Functional Groups

“a group of atoms *where a reaction takes place*”

- Alkanes: saturated hydrocarbons (C_nH_{2n+2} / C_nH_{2n})
 - ◆ all single bonds: alkanes & cycloalkanes; [📖 143 top](#)
 - ◆ nonpolar: very weak intermolecular forces (London forces)
 - low mp & bp: size & symmetry; [📖 144 Table 5.1](#)
 - ◆ hydrophobic, lighter than H_2O , unreactive (paraffins)
 - ◆ occurrence: natural gas, **petroleum** & coal
 - **distillation cuts**: reforming & cracking; [📖 144 Table 5.2](#)
 - ◆ fossil fuels: emission of CO_2 (greenhouse effect), [📖 145 top](#)
 - energy content of fuels: [📖 146 Focus On](#)









Common (Trivial) Nomenclature

- Common names: named after the source
 - ◆ four-carbon acid: **butyric acid**; [📖 145 bottom](#)
 - isolated from rancid butter (*butyrum* in Latin: butter)
 - four-carbon straight-chain alkane: butane (normal, *n*-butane: not used) vs **isobutane** (branched butane)
 - ◆ five-carbon alkane: pentane; [📖 145 bottom](#)
 - new name for another branched pentane: **neopentane**
 - ◆ 75 isomers of decane!! a systematic naming needed
- Types of carbon: 1°, 2°, 3°, 4°; [📖 154 top](#)
- Systematic nomenclature for isopentane: [📖 147 top](#)



Systematic (IUPAC) Nomenclature

□ How to name **alkane**: **prefix**+**root**+**suffix**

1. the longest continuous carbon chain: **root**,  **148** [Table 5.3](#)
 - chains of **equal length**: greater number of branches,  [148 middle](#)
 2. **suffix** for the saturated carbons: **-ane**, **root+ane**; **alkane**
 3. smaller location number for **branches**: **prefix**,  [149 middle](#)
 4. name the **branches**: **number-root+yl**; **3-alkyl**,  [149 bottom](#)
 5. **prefix** for **multiple** branches & in an alphabetical order (one word): **5-ethyl-2,3-dimethyldodecane**;  [150 top](#)
- ◆ **practice**:  **150-1 Problems** [5.1](#), [5.2](#) & [5.3](#)



IUPAC Nomenclature for Complex Branches

□ Naming branched branches:  152 [Fig. 5.1](#)

1. the longest chain **beginning at the branch**: **propyl**
2. name the branch **from the branching point** : **2-methylpropyl**
3. put the complex group in parenthesis: **(2-methylpropyl)**

◆ *practice*:  153 Problems [5.4](#), [5.5](#) & 5.6

□ Common group names:  155 [Table 5.4](#)

◆ *practice*:  154 Problems 5.8 & 5.9



Cycloalkanes

□ Cycloalkane / cycloalkyl-

- ◆ no numbering for one substituent: [📖 156 top](#)
- ◆ smaller numbering to multiple groups: [📖 156 top](#)
- ◆ cyclic vs acyclic for the root: longer skeleton; [📖 156 middle](#)
- ◆ *practice*: [📖 156 Problems 5.10 & 5.11](#)



Alkenes

□ **alkene** / **alkenyl**-: C=C; **unsaturated**

- ◆ the longest chain containing the double bond: [📖 157 bottom](#)
 - smaller numbering to the double bond & substituents
- ◆ -(a)diene or -(a)triene for 2 or 3 double bonds: [📖 158 top](#)
- ◆ common names for some groups: [📖 159 Table 5.5](#)
- ◆ some natural alkenes: [📖 159 bottom](#)
 - ethylene/propylene: polyethylene, polypropylene, ethylene glycol
- ◆ *practice*: [📖 158 Practice 5.5 & Problems 5.12 & 5.13](#)








Alkynes

- **alkyne** / **alkynyl**-: $C\equiv C$; **unsaturated**
 - ◆ the same rules for naming alkenes: [📖 160 bottom](#)
 - ◆ both alkenes & alkynes present: -enyne; [📖 160 bottom](#)
 - ◆ similar physical properties to alkanes & alkenes
 - bp ($^{\circ}C$): hexane 69, 1-hexene 63, 1-hexyne 71
 - ◆ acetylene with O_2 : fuel for an welding torch
 - ◆ *practice*: [📖 160-1 Problems 5.14 & 5.15](#)



(Alkyl) Halides

- halo- / halide (halogen): fluorine, chlorine, bromine, iodine
 - ◆ as a substituent: haloalkane or alkyl halide: **R-X**;  [161 bot.](#)
 - ◆ types of halides: 1°, 2°, 3°;  [151 top](#)
 - depending on the types of the carbon attached
 - ◆ slightly polar, insoluble in water and more dense than water
 - ◆ inert and stable: refrigerant & propellant, flame retardant, solvent for dry cleaning, anesthetic;  [162 middle](#)
 - ◆ *practice*:  [162 Problem 5.16](#) &  [163 5.17](#)



Alcohols

- alkanol or alkyl alcohol / hydroxy-: R-OH
 - ◆ the longest chain containing a hydroxy(l) group
 - -(a)diol or -(a)triol for 2 or 3 hydroxyl groups & smaller numbering to the -OH group: [📖 162-3](#)
 - order of priority: [📖 492 Table 12.3](#)
 - ◆ types of alcohols: 1°, 2°, 3°; [📖 151 top](#) & [📖 166 top](#)
 - ◆ polar C-O & H-bonding of O-H: higher mp & bp ([📖 166 middle](#)), hydrophilic
 - ◆ natural alcohols: MeOH, EtOH & [📖 166 bottom](#)
 - ◆ *practice*: [📖 163 Problems 5.18 & 5.19](#)



Ethers

- alkoxyalkane / alkyl alkyl ether: R-O-R', [📖 167 top](#)
- ◆ lower mp & bp than alcohols but similar solubility in water
 - bp (°C): diethyl ether 35, pentane 36, 1-butanol 117
 - solubility (g/100 mL of water): diethyl ether 8.4, 1-butanol 7.4
- ◆ anesthetic (ethyl ether): methoxyflurane, [📖 168 top](#)
- ◆ solvents for strong bases: [📖 168 middle](#)
 - medium polarity, Lewis base for metal cations, non-acidic proton
- ◆ *practice*: [📖 167 Problem 5.20](#)



Amines

- *N*-alkylalkan**amine** or alkyl**amine** / **amino**-: R-NH-R'
 - ◆ the longest chain attached to the nitrogen: [📖 169 bot.-170 top](#)
 - other alkyl groups on the nitrogen: *N*-alkyl-*N*-alkyl- or *N,N*-dialkyl-
 - ◆ common names: [📖 169 top](#) & aromatic amines: [📖 169 mid.](#)
 - ◆ types of amines: 1°, 2°, 3°, 4°; [📖 168 bottom](#)
 - natural amines: alkaloids; isolation with acid, [📖 171 middle](#)
 - ◆ weaker H-bonding (1°/2°), no H-bonding (3°)
 - bp (°C): butylamine 78, 1-butanol 117
 - ◆ unpleasant odor (putrescine, cadaverine): [📖 171 top](#)
 - ◆ *practice*: [📖 169 Problem 5.21](#) & [📖 170 Problems 5.22 & 5.23](#)



공부하는 방법

“그저 익숙하도록 읽는 것뿐이다. 글을 읽는 사람이, 비록 글의 뜻은 알았으나, 만약 익숙하지 못하면 읽자마자 곧 잊어버리게 되어, 마음에 간직할 수 없을 것은 틀림없다.

이미 읽고 난 뒤에, 또 거기에 자세하고 익숙해질 공부를 더한 뒤라야 비로소 마음에 간직할 수 있으며, 또 흐뭇한 맛도 있을 것이다.” - 퇴계 이황 (금장태 著)

