Properties of Organic Compounds
(Summary)

I. Hydrocarbons:

A. Alkanes:

- Alkanes are nonpolar molecules, therefore, generally have weak intermolecular forces, consequently, they have lower melting and boiling points compared to other organic compounds of similar molar masses.
- Alkanes (nonpolar) are insoluble in water (polar).
- They are less dense than water; consequently, they float on water surface.
- Alkanes are hydrophobic (water fearing) since they do not dissolve in water.
- Chemically, alkanes are the least reactive of all organic compounds. They do not usually react with strong acids or bases, or with most oxidizing or reducing agents.

B. Alkenes & Alkynes:

Many of the physical properties of alkenes are similar to those of alkanes.

- Alkenes are nonpolar compounds.
- Insoluble in water.
- Soluble in nonpolar solvents.
- They are less dense than water.
- Generally, they have range of physical states:

  Less than four carbons: gases

  Between 5-17 carbons: Liquids

  More than 18 carbons: Solids.

- Chemically, they are completely different from alkanes, different reactions may happen on the multiple bonds. *(see the "reactions" part)*

C. Aromatic Compounds:

- Aromatic compounds are nonpolar. *(unless other substituents, such as OH groups, are present).*
- Insoluble in water. *(unless other substituents, such as OH groups, are present).*
- Usually less dense than water.
- Many aromatic compounds are obtained from petroleum and coal origins.
- Chemically, aromatic compounds are stable (unlike alkenes). They do NOT undergo any of the reaction of alkenes. The major reaction of interest is a substitution reaction as seen before.

II. Alcohols:

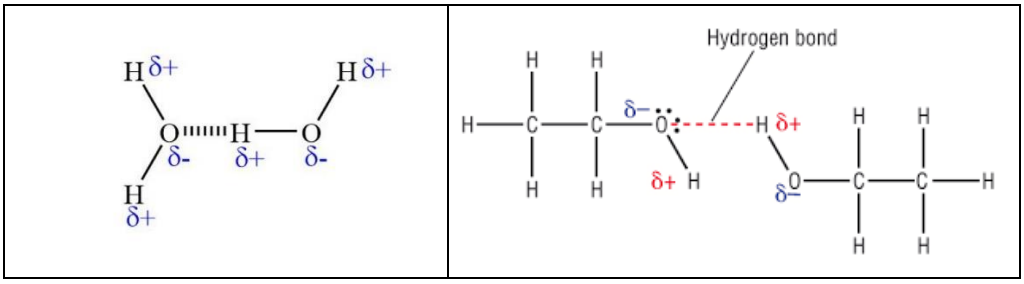
- Alcohols are polar compounds since they contain the polar hydroxyl group (⍰OH).
- Soluble in water and other polar solvents. HOWEVER, the longer the carbon chain, the less soluble the alcohol is. The water solubility behavior is:-

  Short chain alcohols: Methanol, ethanol and isopropanol are soluble. Butanol is less soluble.

  Long chain alcohols: Pentanol is of low solubility, Hexanol, heptanol are insoluble.

III. Ethers:

- Ethers do not have hydroxyl group, so, they do not have hydrogen bonding between their molecules. Therefore, ethers have low boiling points compared to alcohols, but their boiling-points are higher compared to hydrocarbons. Boiling point: alcohols > ethers > hydrocarbons.



- Ethers are slightly polar, and can weakly hydrogen-bond to water through the oxygen atom. Therefore, ethers have higher solubility in water than hydrocarbons.
- Ethers are inert to most reagents, therefore, they are good solvents for chemical reactions.

IV. Aldehydes and Ketones:

Boiling Points:

- Carbonyl compounds are polar, containing a dipole along the carbon-oxygen double bond. This creates weak attractive forces between their molecules. These attractions are weaker than those due to hydrogen bonding, therefore, aldehydes and ketones have boiling points that are in between those of alcohols and hydrocarbons of similar molecular masses.

Water Solubility:

- Carbonyl compounds cannot hydrogen bond to each other, but they can hydrogen bond to water through the carbonyl oxygen. Therefore, low-molecular weight aldehydes and ketones are water-soluble. Water solubility decreases as the size of the molecule increases.

Compared to other organic compounds of similar MM:

- Boiling Points: Alcohols > Aldehydes/Ketones > Ethers > Alkanes
- Water Solubility: Alcohols > Aldehydes/Ketones > Ethers > Alkanes

V. Carboxylic acids:

Boiling Points:

- The boiling points of carboxylic acids are usually higher than those of other types of organic molecules of similar MM since they can form more than one set of hydrogen bonds per molecule.
- The boiling points of carboxylic acid series increase with the increase in the number of carbon atoms.

Water Solubility:

- Short-chain carboxylic acids, generally, are more soluble in water than compounds of similar MM since they can hydrogen bond to more than one water molecule.
- As the number of carbons in a carboxylic acid series becomes greater, the solubility in water decreases.

Physical State:

- Low MM carboxylic acids are generally liquids (usually oily) at room temperature. Higher MM carboxylic acids are generally waxy solids. / compare this to hydrocarbons.

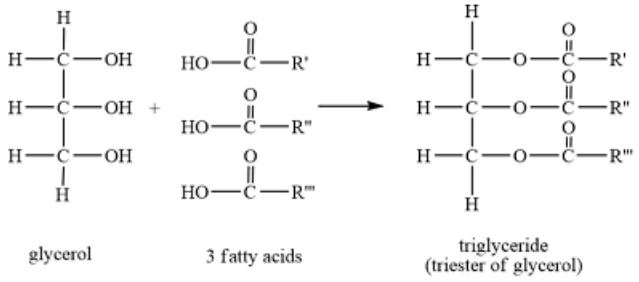
Compared to other organic compounds of similar MM:

- Boiling Point: Carboxylic acid > Alcohols > Aldehydes/Ketones > Ethers > Alkanes
- Water Solubility: Carboxylic acid > Alcohols > Aldehydes/Ketones > Ethers > Alkanes

Other properties:

- Many carboxylic acids that are liquids at room temperature have characteristically sharp or unpleasant odors. (Search the net for odors of carboxylic acids).
- Like most acids, carboxylic acids tend to have a sour taste (e.g., vinegar, citric acid, ...)

Carboxylic acids with 12 to 20 carbon atoms are, often referred to as fatty acids, since they are found in the triglycerides in fats and oils.



VI. Amines:

- 1° and 2° amines can hydrogen bond to each other, while 3° amines cannot.
- Nitrogen is less electronegative than oxygen, so the N—H bond is less polar than the O—H bond. Consequently, hydrogen bonds from 1° and 2° N—H's are not as strong as those resulting from O—H's found in alcohols or carboxylic acids. This affects the boiling points and water solubility.

Boiling Points:

- 1° and 2° amines have lower boiling points than alcohols of similar molecular masses.
- 3° amines have boiling points similar to hydrocarbons of the same molecular masses since they do not hydrogen bond to each other.
- Boiling Point: Carboxylic acid > Alcohols 1° and 2° > 1° and 2° Amines > 3° Amines > Alkane

Water Solubility:

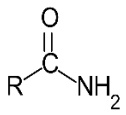
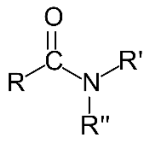
- 1°, 2°, and 3° amines can all form hydrogen bonds with water.
- Low-molecular weight amines are generally water-soluble.

Other Properties:

- Low molecular-weight amines tend to have sharp, penetrating odors similar to ammonia
- Higher molecular-weight amines often smell like rotten fish, and are often found in decaying animal tissues.

VII. Amides:

- Amides contain a nitrogen, which is directly attached to carbonyl group carbon.
- N,N-unsubstituted amides (primary amides) can form a complex network of hydrogen bonds. They tend to have high melting points and also high boiling points.

	 
N,N-unsubstituted amides (1º)	N-substituted amides (2 º and 3º)

- N-substituted amides (2 º and 3º) often have lower melting points and boiling points than N,N-unsubstituted amides because fewer hydrogen bonds can form.
- N,N-disubstituted amides cannot form hydrogen bonds, and have even lower melting points and boiling points.
- All amides can hydrogen bond with water, so low molar mass amides are water-soluble.
- Boiling Point: N,N-unsubstituted amides > N-mono substituted amides > N,N-disubstituted amide.

$1^{o} > 2^{o} > 3^{o}$

THE END

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