

SCIENCE 1109

CARBON CHEMISTRY:

FUNCTIONAL GROUPS

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II. OXYGEN FUNCTIONAL GROUPS

The organic compounds that contain oxygen are important compounds to study. They have many of the properties of H₂O but are modified by the type of alkyl or hydrocarbon residue (R—) group(s) involved. Much of the chemistry of life involves the reaction of oxyorganic compounds. You will learn a) to classify oxyorganic compounds by their functional groups, b) to write balanced equations

involving the oxygen functional groups, and c) to list common examples of each oxyorganic group. Review the Introduction to this LightUnit to get a picture of how oxyorganic compounds fit into the scheme of things. As you progress through the rest of this LightUnit you will become VERY FAMILIAR with the forms of each functional group.

SECTION OBJECTIVES

Read these objectives. When you have completed this section, you should be able:

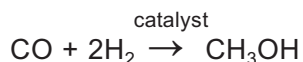
7. To classify and identify oxyorganic families by functional group.
8. To describe the properties of the different oxyorganic functional groups.
9. To balance equations involving the functional groups.
10. To list some common examples of each of the oxygen functional groups.

ALCOHOLS

Organic compounds are grouped according to characteristic properties that result from structural characteristics. These set them apart from other compounds. One such important group is the alcohols. Just as the alkanes are saturated hydrocarbons, and the alkenes are hydrocarbons with a double bond, alcohols are characterized by having a *hydroxy* (—OH) structure.

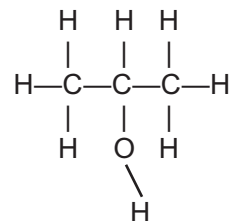
Structure and Properties. The group of compounds with the functional hydroxy group (—OH) bonded to an alkyl group (R—) are called *alcohols* (R—OH). The word *alkyl* is short for any hydrocarbon chain. The hydroxy group is characteristic of alcohols, some of which have familiar common names. A few typical alcohols are described here.

Methyl alcohol, methanol, or wood alcohol: CH₃OH. Around 2.5 million tons of methyl alcohol is manufactured in the United States each year. This reaction shows its formation.



Methanol is then used in the manufacture of numerous other chemical products such as formaldehyde, jet fuel, and antifreeze. (DANGER: Methyl alcohol or wood alcohol is very poisonous.)

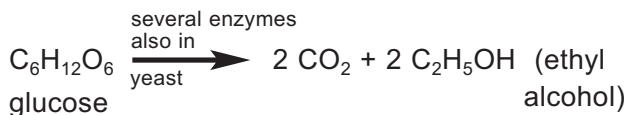
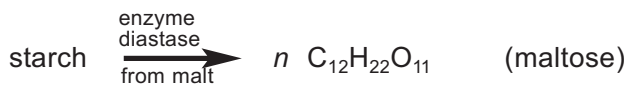
Rubbing alcohol or *isopropyl* is another alcohol familiar to most people.



This alcohol is a derivative of propane with the —OH replacing an —H on the central or number 2 carbon. Another name for the compound is 2-propanol. Rubbing alcohol is quite toxic, but ingestion is not especially dangerous because it induces severe vomiting and does not stay down long enough to kill you.

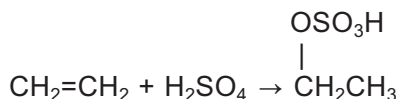
Ethanol is produced by a natural chemical process known as fermentation in which sugars are broken down into simpler compounds. Fermentation is made possible by certain enzymes, which are complex chemical catalysts produced by living cells. The sugars used for fermentation are often formed by enzymatic decomposition of starches from corn, potatoes, rice, or grain.

The fermentation reaction which produces ethyl alcohol is shown in the third equation.

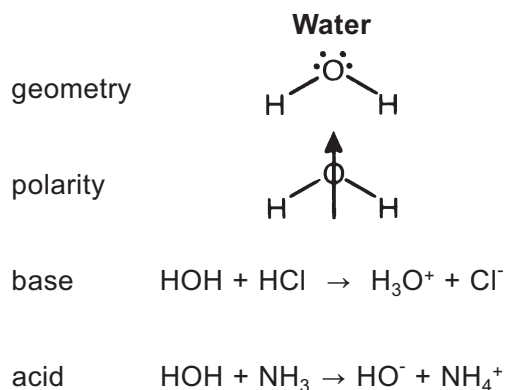
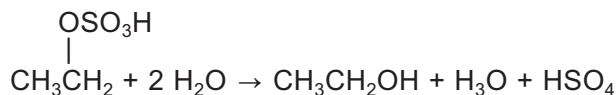


In addition to fermentation, over 1 million tons of ethyl alcohol are manufactured each year by the following industrial method.

Step 1:



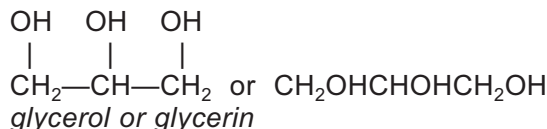
Step 2:



Alcohols that have more than one hydroxy group attached to a carbon sequence are called polyhydroxy alcohols. Two important polyhydroxy alcohols are described here.

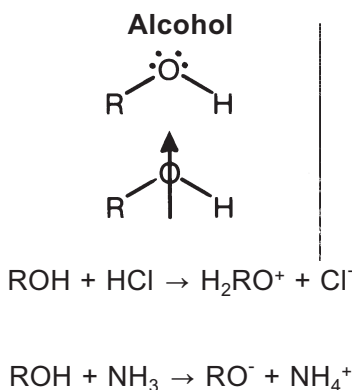


Ethylene glycol is used as an antifreeze and engine coolant.

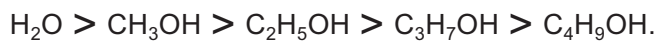


Glycerol is used in the manufacture of plastics, drugs, cosmetics, inks, food products, and nitroglycerin.

Alcohols as a family have much the same characteristics as water. The structure is bent at the oxygen atom, is polar, and is acid or base depending upon the chemical environment.



The strength and similarity of the properties of the ROH compared to H₂O depends upon the R- group. The smaller the R- group, the more similar is ROH to HOH. For example, the order of polarity strength is



As the R- chain increases in length, the

properties of the ROH become more like the R- (nonpolar) and less like the -OH (polar). The same trend is true for the other three properties listed comparing ROH to HOH.

Examples. We have already studied some examples of alcohols. These examples have been simple compounds. The following examples are more complex -OH compounds.

