SCH4U1 Name:
OC04 Date:

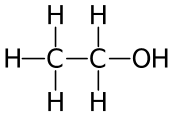
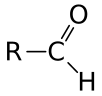
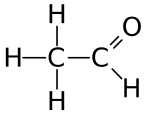
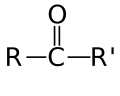
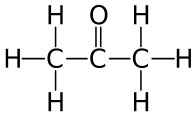
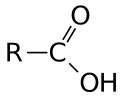
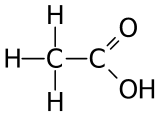
FUNCTIONAL GROUPS I

The characteristics of organic compounds (boiling point, odour, reactivity etc.) depend on the composition and arrangement of atoms. For example the properties of **alkanes** depend greatly on the number of carbon atoms in the hydrocarbon chain due to the increased strength of the van der Waal attractions. **Alkenes** have lower boiling points but greater chemical reactivity than their saturated counterparts. In an alkene, it is the presence (and position) of the double bond that is responsible of these properties. Any atom, group of atoms or organization of bonds that determines the specific properties of a molecule is known as a **functional group**.

The double bond in an alkene and the triple bond of an alkyne are functional groups. A functional group can also be an atom or group of atoms attached to some carbon in a hydrocarbon chain. The most common atoms encountered are oxygen, nitrogen or both.
Even chlorine attached to an alkane can be considered a functional group and this class of hydrocarbons is called **alkyl halides**. When discussing functional groups, it is common to use **R** to represent the **rest of the molecule** to which the functional group is attached.

Two common oxygen-containing functional groups attached to hydrocarbons are the hydroxyl group (**R-OH**) and the carbonyl group (**R-C=O**). Depending on how these are arranged, these can form four types of organic compounds shown below.

Table 1: Structures and Examples of Aldehydes, Ketones and Carboxylic Acid

General Structure	Type	Example	
	alcohol		ethan<u>ol</u>
	aldehyde		ethan<u>al</u>
	ketone		propan<u>one</u>
	carboxylic acid		ethan<u>oic acid</u>

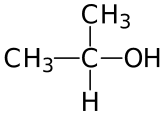
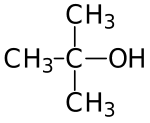
As you may see from Table 1, the hydroxyl group appears in two types of organic compounds (alcohols and carboxylic acids) while the carbonyl group is found in three (aldehydes, ketones, acids).

Since the functional group is considered the most important part of the molecule, the nomenclature is based on the group. Fortunately, most of the rules for organic nomenclature still apply (see Table 1). We simply change the end of the root name from –ane to either –ol, -al, -one or –oic acid, depending on the length of the

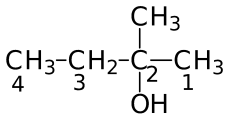
longest continuous chain that contains the functional group. In fact, you have already been using this system to name alkenes and alkynes!

Alcohols

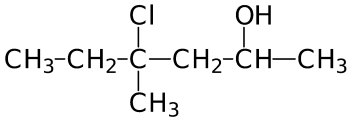
Alcohols are classified as primary, secondary or tertiary depending on the number of carbons bonded to carbon 1.

Primary (1°)	Secondary (2°)	Tertiary (3°)
		
ethanol	2-propanol	2-methyl-2-propanol

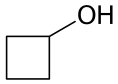
For alcohols with longer chains, it is necessary to identify the location of the hydroxyl group.



2-methyl-2-butanol



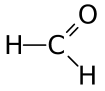
4-chloro-4-methyl-2-hexanol



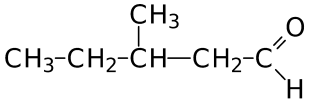
cyclobutanol

Aldehydes

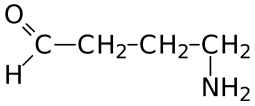
Since the carbonyl group of aldehydes is ALWAYS at carbon 1, it is not necessary to identify the location. Since aldehydes are at the end of a chain, they can not be cyclic.



methanal



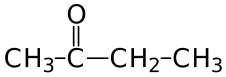
3-methylpentanal



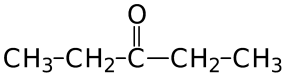
4-aminobutanal

Ketones

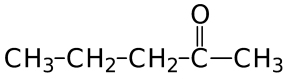
Ketones may or may not require a number to identify the location of the carbonyl group.



butanone



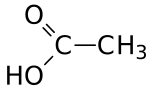
3-pentanone



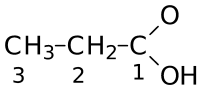
2-pentanone

Carboxylic Acids

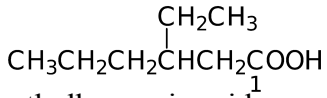
In these compounds, carbon 1 is bonded to both a carbonyl and hydroxyl group. Also, note that the carboxylic acid group is sometimes represented as –COOH.



ethanoic acid (acetic acid)

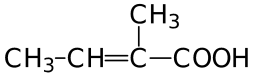


propanoic acid



3-ethylhexanoic acid

..and sometimes 2 groups can appear.



2-methyl-2-butenoic acid