Name_____ Class_____

Organic Lab 2
Unsaturated Compounds: Alkenes and Alkynes

Introduction

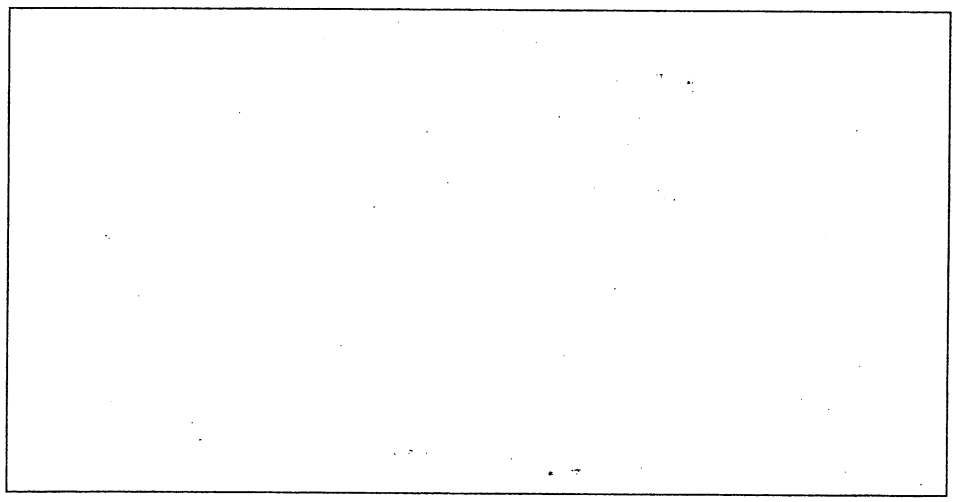
Another unusual capability of carbon is its ability to share more than one pair of electrons with another carbon atom. Carbon often forms **double bonds** with other carbon atoms. These double bonds have profound effects on the geometry and physical properties of molecules. Hydrocarbons with double bonds are called **alkenes**. There is a **homologous series of alkenes** (ethene, propene, etc.) with increasing numbers of a new kind of isomer, a geometric isomer, which we will look at briefly. **Triple bonds** are also possible, but less common.

Carbon also forms numerous ring structures, typically of five or six carbons. Multiple ring structures are also common. Many of these have multiple double bonds, and commonly have strong odors, hence they are often given the name "aromatics."

Methods

1. Building Alkenes

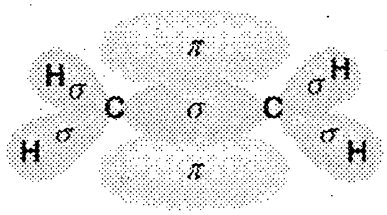
   Build a molecule of ethane, C_2H_6. Rotate the methyl groups about the carbon-carbon bond. Now remove the carbon-carbon bond and two hydrogens, along with their sticks. Replace them with two of the longer, flexible double bonds and draw your structural formula below. **Name** the compound, and write its **chemical formula** in the box as well.



   Measure the carbon-carbon-hydrogen bond angle. _____

Notice that you cannot rotate this molecule at all. The positions of each atom are frozen in place by the double bond. What kind of shape does the molecule have?

The models give a good representation for the geometry of the molecule, and the inability of the bonds to rotate. However, these models do not explain what actually happens to the electrons. Other models do that better:



The second bond of the double bond is best represented by the two ovals labeled "π". These two areas, above and below the plane of the carbon-carbon bond, are where the extra two electrons can be found most of the time. Those π electrons repel the bonding pairs in C-H bonds, keeping them "stuck" in one place, unable to rotate in the way that alkanes can.

Make a model of propene, and **draw its structural formula** below. Write its **chemical formula** in the box as well.

Now try making butene. You will find that there are four possible structures (isomers) of butene, although the fourth one may be difficult to see at first. See if you can find them all! (Hint: two of them appear to have the same name, but are not quite the same.) Alkenes use the same naming system that alkanes do. You must specify the number of the carbon that begins with a double bond in the name. Write the **name**, the **structural formula** and **chemical formula** for each isomer on the following page.

2. Alkynes

Carbon also forms triple bonds. Removing two more hydrogens from ethene and replacing them with the longer sticks gives you ethyne (acetylene), the compound used as a fuel in blow torches. Write the chemical formula and draw the structural formula below.

What is the shape of this molecule? _____

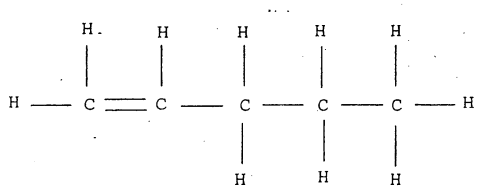
You can now make a molecule of hydrogen cyanide, HCN, which has a similar triple bond (the nitrogen is the blue sphere). This compound binds haemoglobin at the oxygen binding site in your red blood cells. Note that for the nitrogen atom, only three holes of the model are filled – nitrogen contains a pair of non-bonding electrons.

Problems

1. Draw structural formulas of the following compounds, write the chemical formula for each, and indicate whether the molecule is saturated or unsaturated.

Name	Structural Formula	Chemical Formula	Saturated or Unsaturated?
3-octene			
2,3-dimethyl pentane			
2-butyne			

2. Name the following unsaturated hydrocarbons.



a)

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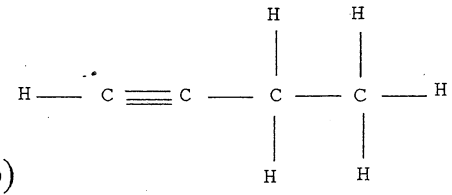

b)

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2. A student took a prepared sample of ethene and added hydrogen gas (H_2). In the chemical reaction that followed, all of the ethene and hydrogen disappeared, and a new product, an alkane, was formed. She repeated the same experiment using ethyne instead of ethene. The same alkane was produced, but it took twice as much hydrogen to make it. Explain what happened, using structural formulas. Begin by drawing the structural formulas of the reactants below.

Exp. 1 + →

Reactant 1 Reactant 2 Product

Exp 2: + →

Reactant 1 Reactant 2 Product