Name____Class____________

Organic Lab 4: Halocarbons

Introduction

So far we have considered organic compounds containing only two elements. Now we will expand our horizons further. First we will consider a group of elements collectively known as **the halogens**. On the periodic table, elements in columns are known as groups or families. They have similar chemical and physical properties, and make similar kinds of compounds. The halogens are in the second column from the right.

Which elements are halogens? ____

If you recall, different elements have different numbers of electrons (valence electrons) available to make chemical bonds. How many valence electrons does carbon and hydrogen have?

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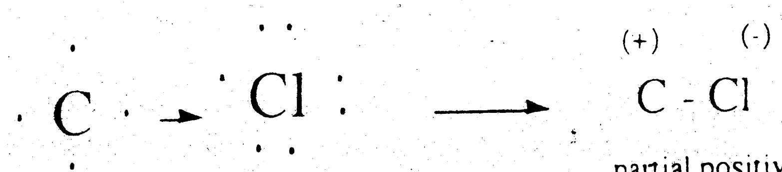
Halogens each have **seven** valence electrons. They are very hungry to gain an 8th electron. When they do, the eight electrons collectively drop in energy and are more stable. The halogens tend to share electrons, but not equally. They tend to make a bond, known as a **polar covalent bond**. For example, in a bond between carbon and chlorine, the chlorine has the electron a greater percentage of the time than the carbon does. This leads to a slight negative charge on the chlorine, and a slight positive charge on the carbon:



electron is shared, but not equally

partial positive and negative charges

These atoms that are highly electronegative (attract electrons) are often called **functional groups**, because their effects on the physical and chemical properties of atoms are profound. We shall look at three classes of organic compounds with polar functional groups: halocarbons, oxygenated compounds such as alcohols, ethers, carbonyl compounds, and esters, and nitrogenous compounds like amines and amides.

Halocarbons

Halocarbons do not generally exist in nature. They are made in the laboratory using the halogen elements in their pure form, which is a diatomic molecule:

F_2, Cl_2, Br_2, I_2

Draw the structural formulas of these elements below. Remember, they each share one electron with each other!

When a halogen is added to an alkane, it has the ability to displace a hydrogen atom, producing a halocarbon and an acid. These reactions are called **substitution reactions.**

We can represent this symbolically below

$$R\text{-}H + X_2 \rightarrow R\text{-}X + HX$$

The symbol "R" is often used to refer to a hydrocarbon, plus a vulnerable hydrogen. "X" is one of the four halogens mentioned above. Which one is the acid, and which one is the halocarbon?

If the initial hydrocarbon is propane, and the halogen is chlorine, write a possible substitution reaction, and name the products.

Note that halogens are prefixes such as chloro-, fluoro-, bromo-, etc., and their location on the hydrocarbon must be stated. The halogen acids are named by placing a "Hydro" prefix in front of the halogen name, plus an "ic" suffix. For example, "Hydrobromic Acid," or HBr.

See if you can name compounds with the following condensed structural formulas:

1. CH_3F ____________________

2. $CHBr_2CH_3$ ______________________________

3. $CH_3CHClCH_2CH_2Cl$ ______________________________

Make models of all three molecules and draw their complete structural formulas below. Use the green spheres to represent halogens.

Now build a molecule of ethene and a molecule of any halogen. What do you think would be the effect of putting these two together in a closed container? (hint: these reactions are called addition reactions) Draw the structural formulas of your reactants and possible product(s) below, and name them all.

Substitute ethyne for ethene. What would the product be? Draw and name it below.

How many molecules of your halogen do you need to produce your molecule? ________

Draw structural formulas for the following compounds:

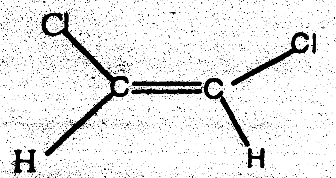
1. 2,2,4 trichloro pentane
2. tetrachloroethene (TCE)
3. trans-1,2-dibromo ethene

Conclusion

Halocarbons are very useful compounds. They replace hydrogens easily in hydrocarbons, yet are easy to remove themselves. They are often used as building blocks by organic chemists to construct more complicated molecules. They also have many industrial uses. That utility often comes at a price, however. Consider this evening's homework......

Name the following structures based on their structural or condensed structural formulas.

1. $CH_2ClCH_2CH_2C(Cl)_2CH_3$ ______________________________

2. 

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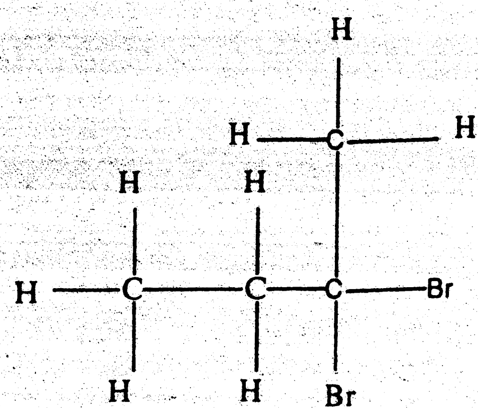
3. 

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Write structural formulas for the following named compounds. Write their chemical formula next to the structure.

4. 1,2 difluoro butane

5. 1,2 dichloro-1,2 difluoro ethane