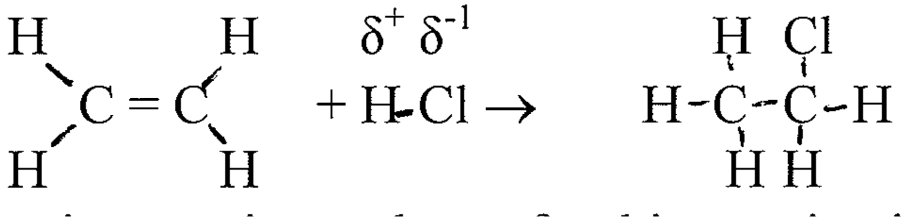
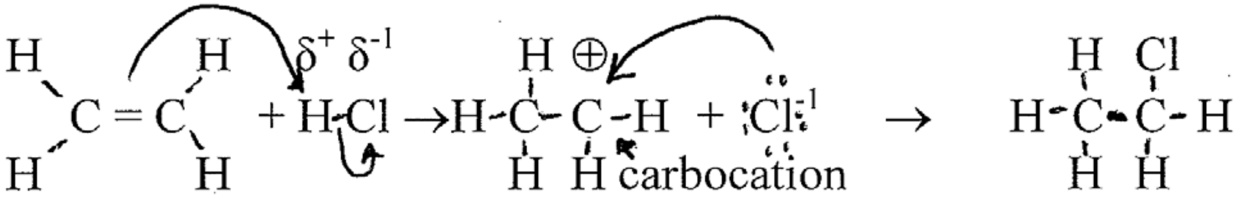
3.7 Addition Of HCl To An Alkene

An example is shown below.



The precise reaction pathway for this reaction is as follows:



Note that the pair of pi electrons in the alkene are relatively reactive. Next note that HC1 is a polar bond: the H has a δ^+ and the Cl has a δ^{-1}. The reactive pi electrons of the alkene are attracted to the partially positively charged H. The H atom lets go of the pair of electrons it was sharing with the Cl (it was getting the "short end" of the deal anyway) and hops over and shares the pi electrons with one of the C atoms of the alkene. In the process, the other carbon atom of the alkene loses its share of the pi electrons. Since the second C atom has lost an electron, it now has a positive charge and we call a C atom with a positive charge a **carbocation**. Note that a carbocation does not have a full octet (8) of electrons. It only has 6. It is unstable because it does not have a full outer shell. In order to remedy the situation it needs to obtain an additional pair of electrons. Let's see how this happens.

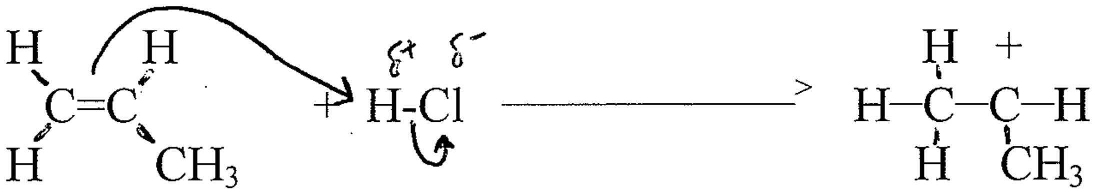
*The "double headed" arrow indicates that **both** electrons go with the arrow.*

When the H of HCl reacts with the pi electrons of the alkene, the Cl atom of HCl takes full possession of the pair of electrons it was formerly sharing with the H, essentially gaining an electron and becoming a negatively charged chloride ion (Cl^{-1}). Chloride ion can share one of its non-bonding pair of electrons with the carbocation and all the atoms once again regain their full outer shells.

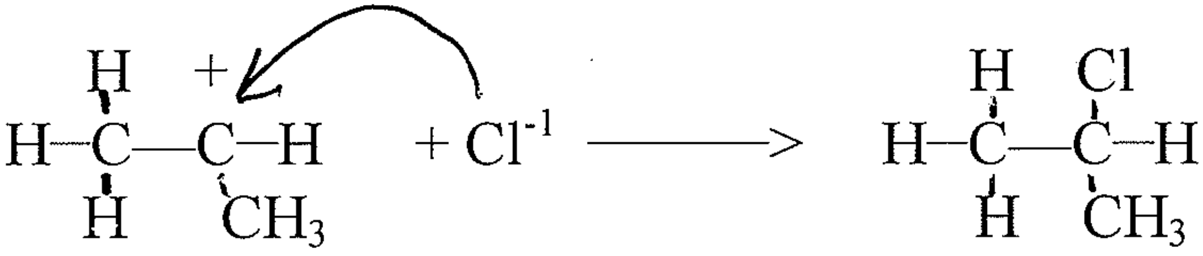
In the first step of the above reaction, the partially positively charged H is seeking out the negatively charged pi electrons of the C=C double bond the H is referred to as an **electrophile**. Since the pair of pi electrons is attracted to the partially positively charged H, the pair of pi electrons is referred to as a **nucleophile**. (Remember that atomic nuclei have a positive charge!) In the second step of the reaction the **carbocation acts as an electrophile** and the **chloride ion acts as a nucleophile.** These terms are commonly used by chemists.

“Ethyl chloride has been used as a refrigerant, an aerosol spray propellant, an anesthetic, and a blowing agent for foam packaging.” Wikipedia. These are being phased out.

Here is a second example1-propene.

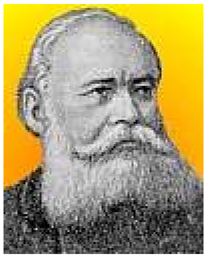


In the above first step the H is acting as the electrophile and the C=C is acting as the nucleophile.

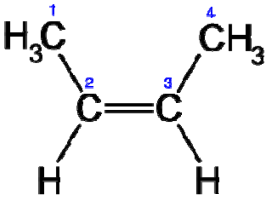


In the second step of the reaction pathway the carbocation acts as the electrophile and the chloride ion acts as the nucelophile. The final product is 2-chloropropane.

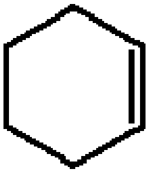
If you look at this first step of the above reaction carefully you might note that one could have added the H from the HCl onto the middle C atom rather than the end C, which would produce a different product. In fact, the H ion preferentially adds to whichever C has the most H atoms, which in this case is the end C. This is referred to as **Markovnikov’s Rule** in honor of the Russian organic chemist, Vladimir Vasiliivich Markovnikov who formulated it in 1870.



Show the reaction pathway, labeling all the intermediate steps as nucleophiles or electrophiles.

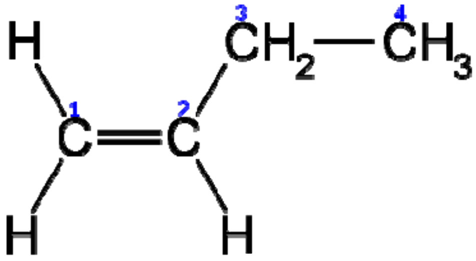
a) 

+ H-Cl ——>

b) 
+ H-Cl ———>

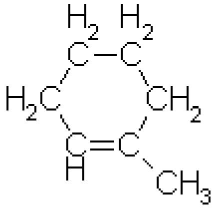
Think about Markovnikov's rule when you do the next two problems

c)



———HCl—>

d)



+ HCl ———>