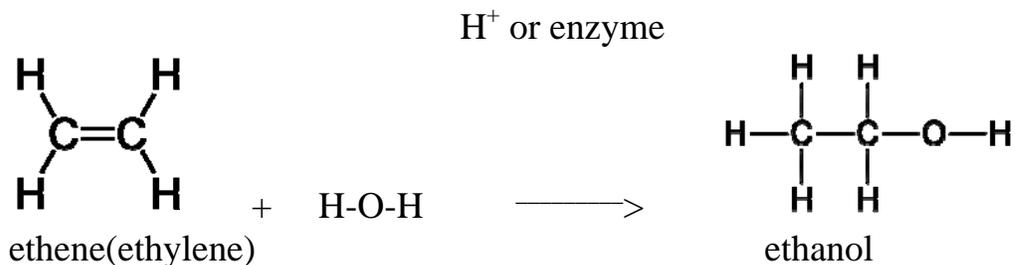


3.8 ADDITION OF WATER TO AN ALKENE

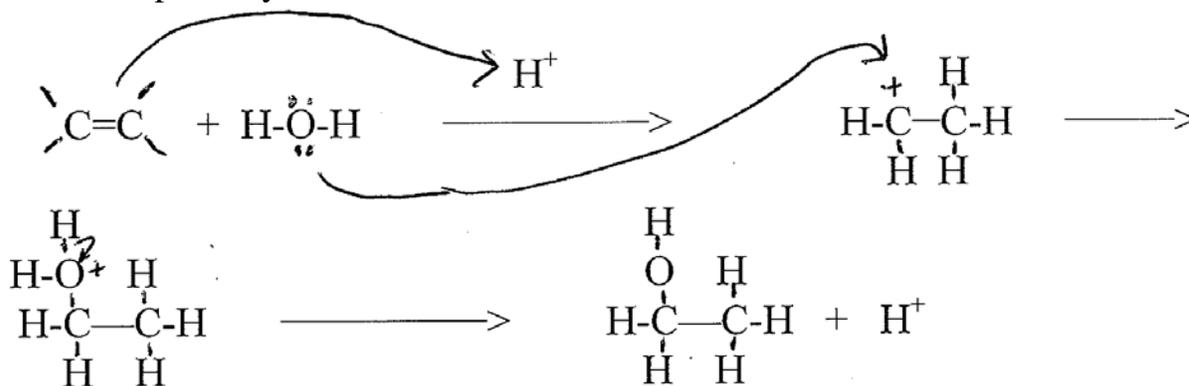


Much of the industrial (as opposed to beverage) ethanol in this country is actually made by this process. The ethene is a byproduct of the petroleum refineries.

Ethanol is frequently added to gasoline in this country as a way to increase the octane value and decrease pollution emissions of gasoline. Most of this ethanol is made from the fermentation of corn and helps support the corn industry, but it should be kept in mind that a lot of fossil fuel is used to grow corn and that this is driving up the price of food that directly or indirectly requires corn. Making ethanol by fermenting cellulose from wood is also being actively researched.

The reaction is catalyzed by the presence of a small amount of acid. Recall that a catalyst lowers the activation energy of a reaction and hence makes a reaction occur faster. The catalyst in this case is a hydrogen ion (H^+) from an acid such as sulfuric acid or hydrochloric acid and it initiates the reaction pathway, but is regenerated at the end of the pathway so that there is no net consumption of H^+ in the reaction. We indicate the need for a hydrogen ion catalyst by writing H^+ above the arrow between reactants and products.

The reaction pathway is similar to addition of HCl:



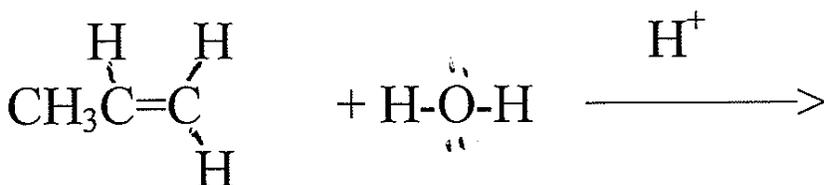
Note that the H^+ is a catalyst. In the absence of a small amount of acid, this reaction goes exceedingly slowly, but the addition of even a drop of acid causes the reaction to go much more rapidly. Since H^+ is regenerated at the end of the reaction pathway of one molecule, it can go on and catalyze the reaction pathway of another molecule.

Questions: Is the hydrogen ion a nucleophile or electrophile?

Is the pair of pi electrons a nucleophile or electrophile?

Is the carbocation in the second step a nucleophile or an electrophile?

Show the reaction pathway:



(The middle carbon preferentially forms the carbocation.)

The above reaction has considerable economic importance. The reactant, 1-propene, is obtained as a byproduct of oil. When it is hydrated it produces 2-propanol, more commonly known as isopropyl or rubbing alcohol, which is commonly used to clean skin before giving an injection. The copious quantities of rubbing alcohol used in this country come from petroleum, just like our gasoline, motor oil, and most plastics!

Show the complete reaction pathway, labeling the intermediates:



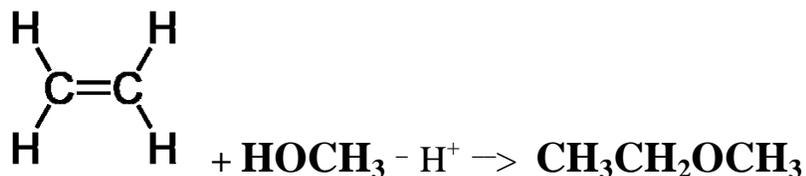
(You should draw out the full structure of cyclohexene when you do the reaction pathway.)

Several steps in the metabolism of glucose (Krebs cycle to be specific) in the body involve hydration reactions;

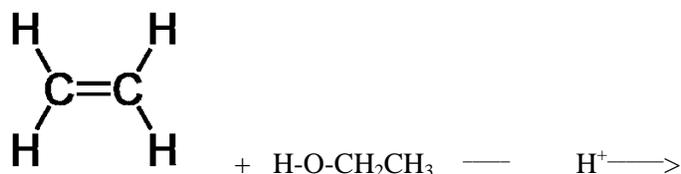
Fumarate \longrightarrow malate

Aconitate \longrightarrow isocitrate

3.9 ADDITION OF AN ALCOHOL TO AN ALKENE

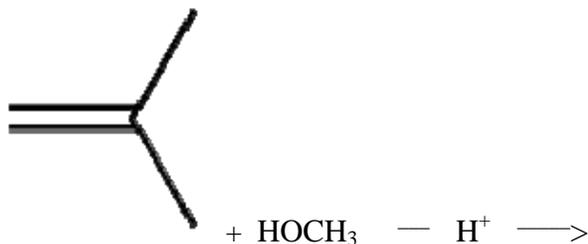
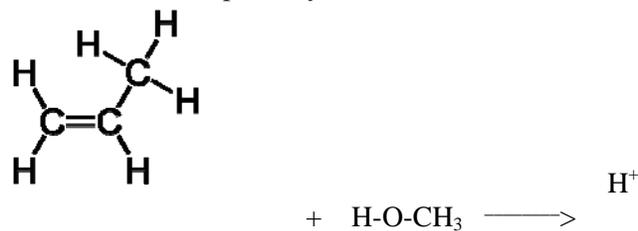


The reaction pathway is exactly like that of the addition of water, with the alcohol substituting for the water molecule. Show the complete reaction pathway:



The product is diethyl ether, a molecule that was commonly used as an inhalation anesthetic for many years and that is used as a solvent to dissolve trimyristin from ground nutmeg. (It is typically prepared by a different reaction.)

Show the reaction pathway for:



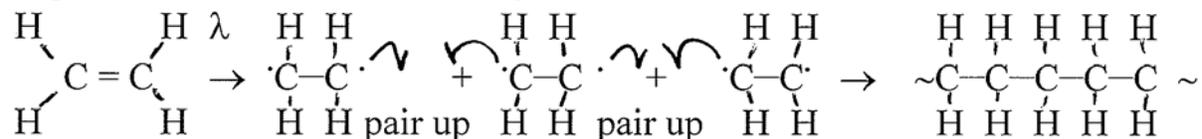
The last product has the common name methyl tertiary butyl ether (MTBE) and was used in gasoline for quite a few years. Use Google and find out what its function was and the problems with it.

3.10 POLYMERIZATION

Polymerization is the formation of extremely long molecules from small molecules called **monomers**. The plastics and rubber are examples of the most common polymers which are commonly used in both everyday life and in medical applications. The exact properties of polymers depends on a variety of chemical details and this unit will give you a brief introduction into some of the common polymers and how their properties depend on their specific chemical details.

Polymers can be formed by a variety of reaction pathways. In this unit we will look at those formed by the process of free radical polymerization. Suppose we have a container full of ethene (ethylene) monomers and we unpair the pi electrons by a suitable method, either by appropriate radiation, or a **free radical initiator** such as a peroxide molecule (the most common way of producing them industrially).

By one means or another, we produce free radical ethylene molecules which can pair up with each other to form a long chain:



Our example just shows one molecule of monomer as a reactant, although in fact there are large numbers of them that will react with each other to form the polymer:

The one sided arrows indicate that one electron goes to each C atom. This is in contrast to the previous reaction pathways where both electrons went to the same atom and we showed a double sided arrow. The ~ indicates that the chain can extend for many thousands (or even millions) of C atoms.

What sort of functional group have we produced in the product? It's an alkane. However, it is named on the basis of the fact that it is formed from polymerization of ethylene: polyethylene.