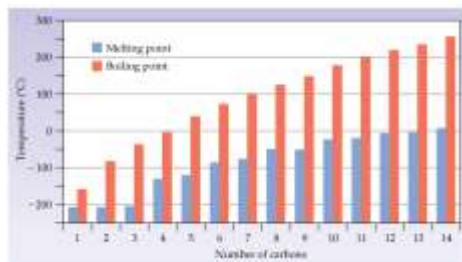


## Reactions of Hydrocarbons

### Chapter 1.3

## Properties of Alkanes

- Melting points and boiling points of straight chain alkanes increases with molecular size.



- The first four alkanes, methane, ethane, propane, and butane are gases.
- Alkanes with 5-15 carbon atoms are liquids.
- Alkanes with 16 or more carbon atoms are low melting waxy solids.
- Alkanes are insoluble in water but soluble in nonpolar organic solvents, including other alkanes.
- Alkanes are generally less dense than water as result they float on water.
- Low molecular-weight alkanes are volatile and their vapors are highly flammable.

## Reactions of Alkanes

- Alkanes don't react with acids, bases, or most other common laboratory reagents. Their only major reactions are with oxygen and with halogens.

• **Combustion:** Reaction of alkanes with oxygen. Carbon dioxide and water are produced in this combustion reaction.

• **Halogenation reaction:** Replacement of a hydrogen of alkanes by a chlorine or bromine. Initiation of halogenation reaction requires heat or light. Complete chlorination of methane produces carbon tetrachloride.

## Properties of Alkenes and Alkynes

- Nonpolar, insoluble in water, soluble in nonpolar organic solvents.
- Less dense than water as a result floats on water.
- Flammable
- Nontoxic
- Alkenes display cis-trans isomerism whereas alkynes do not.
- Both alkenes and alkynes are chemically reactive.

## Kinds of Organic Reactions

- **Addition reactions:** A substance add to the multiple bond of an unsaturated reactant to yield a saturated product that has only single bonds.
- **Elimination reaction:** In which a saturated reactant yields an unsaturated product by losing groups from two adjacent carbons.

- **Substitution reaction:** In which an atom or group of atoms in a molecule is replaced by another atom or group of atoms.
- **Rearrangement reaction:** In which a molecule undergoes bond reorganization to yield an isomer.

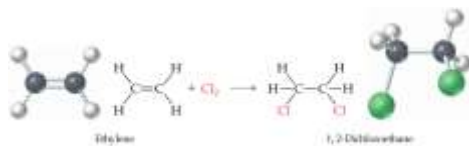
## Reactions of Alkenes and Alkynes

- **Addition of  $H_2$  to alkenes and alkynes:** Alkenes and alkynes react with hydrogen in the presence of a metal catalyst such as palladium to yield the corresponding saturated alkane products – called hydrogenation.



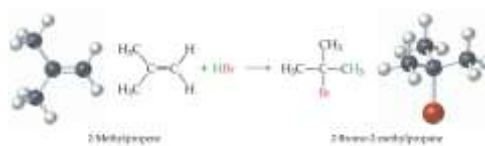
- **Addition of  $Cl_2$  and  $Br_2$  to alkenes: Halogenation**

- Alkenes react with the halogens  $Br_2$  and  $Cl_2$  to give 1,2-dihaloalkane.

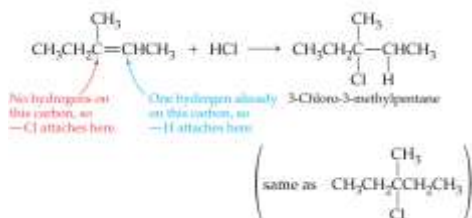


- **Addition of  $HCl$  and  $HBr$  to alkenes:**

- Alkenes react with the hydrogen bromide and hydrogen chloride to give alkyl bromide or alkyl chloride product.

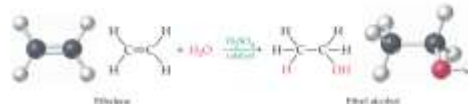


- **Markovnikov rule:** In the addition of  $HX$  to an alkene, the  $H$  becomes attached to the carbon that already has the most  $H$ 's, and  $X$  becomes attached to the carbon that has fewer  $H$ 's.



- **Addition of water to alkenes: Hydration**

- Alcohol is produced on treatment of the alkene with water in the presence of a strong acid catalyst, such as  $H_2SO_4$ . Markovnikov's rule can be used to predict the product when water adds to an unsymmetrically substituted alkene.

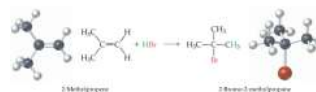


## How an Alkene Addition Reaction Occurs

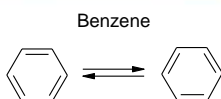
- **Reaction mechanism:** A description of the individual steps by which old bonds are broken and new bonds are formed.
- Consider the following two step mechanism for addition of HBr to an alkene.

## Reaction Mechanism

- In the 1<sup>st</sup> step, the alkene reacts with H<sup>+</sup> from the acid HBr and produces a carbocation. In the 2<sup>nd</sup> step, this reactive carbocation immediately reacts with Br<sup>-</sup> ion to form the product.



## Properties of Benzene



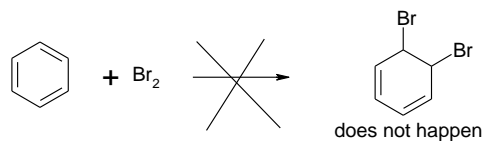
Kekule's Structures explain equal bond lengths  
Each Lewis structure is a Contributing Structure

Shown Below is a Resonance Hybrid Structure



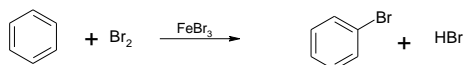
## Reactions of Aromatics

- Due to the stability of the alternating double bonds, benzene reacts different than alkenes

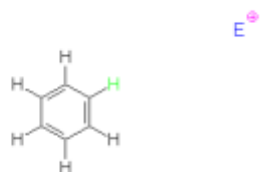


## Reactions of Aromatics

### Halogenation



## Halogenation of Benzene

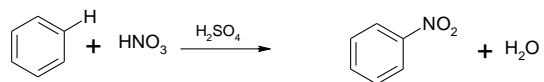


## Chlorination of Benzene (with Mechanism)



## Reactions of Aromatics

### Nitration



## Reactions of Aromatics

### Sulfonation

