5.2 Reactions of Hydrocarbons

Combustion

All hydrocarbons will burn in air to produce large amounts of light and heat. This reaction makes hydrocarbons useful as fuels. It is an example of a combustion reaction. The only products formed from a combustion reaction of a hydrocarbon are water and carbon dioxide.

hydrocarbon + oxygen → carbon dioxide + water

For example propane gas is often used in barbeques, and the combustion reaction is:

propane + oxygen → carbon dioxide + water

$$C_3H_{8\,(g)} + 5\,O_{2\,(g)} \rightarrow 3\,CO_{2\,(g)} + 4\,H_2O_{\,(g)}$$

Write a balanced chemical equation to represent the combustion of 1 hexene using a condensed structural formula to represent the hydrocarbon.

Step 1: Write the word equation

1-hexene + oxygen → carbon dioxide + water

Step 2: Write the chemical formulas

$$CH_2{=}CHCH_2CH_2CH_2CH_3 + O_2 \rightarrow CO_{2\,(g)} + H_2O_{\,(g)}$$

Step 3: Balance the equation

$$CH_2{=}CHCH_2CH_2CH_2CH_3 + 9\,O_2 \rightarrow 6\,CO_{2\,(g)} + 6\,H_2O_{\,(g)}$$

Addition Reactions

Alkenes and alkynes are much more reactive than alkanes because the double and triple bonds are easily converted to single bonds. When one of the bonds in a double or triple bond breaks apart, the carbon atoms on each end of the broken bond must bond with new atoms. The other atoms are usually hydrogen called hydrogenation. Reactions with halogens are called halogenation or substitution reactions. These alkanes are also referred to as **alkyl halide**. Small groups of atoms such as –OH or small molecules like water (hydration) can be added in this fashion as well.

The reaction below shows part of the double bond breaking to allow the addition of two hydrogen atoms to the two carbon atoms. The addition of a hydrogen molecule to ethene, C_2H_4, produces ethane, C_2H_6.

This type of reaction is called an addition reaction because it adds a small molecule to the structure of the hydrocarbon. Alkenes and alkynes can undergo addition reaction with hydrogen, and other small molecules like hydrogen bromide (hydrohalogenation), and bromine.

When a molecule contains double or triple bonds it contains less than the maximum number of atoms the carbon can bond to. Alkenes and alkynes are said to be unsaturated. When a molecule contains only single bonds, no more addition reactions can take place and the molecule is said to be saturated.

Markovnikov's Rule

When a hydrogen halide or water is added to an alkene or alkyne, the hydrogen atom bonds to the carbon atom within the double bond that *already has more hydrogen atoms*. This rule may be remembered simply as "the rich get richer."

Naming Organic Halides

When naming organic halides, consider the halogen atom as an attachment on the parent hydrocarbon. The halogen name is shortened to fluoro-, chloro-, bromo-, or iodo-.

Properties of Organic Halides

The presence of the halogen atom on a hydrocarbon chain or ring renders the molecule more polar. This increases the intermolecular forces. Thus boiling points of alkyl halides is greater than those of the corresponding hydrocarbons

SCH 4C: Organic Chemistry

Worksheet 5.2: Reactions of Hydrocarbons

1. Write a balanced chemical equation to represent the combustion of each hydrocarbon below. Represent the hydrocarbon as a condensed structural formula.
    a) methane
    b) ethane
    c) propyne
    d) 3-hexene
    e) octane

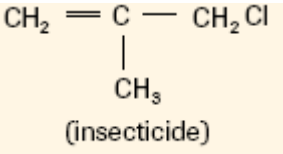
2. Draw structural formulas to show the addition reaction for:
    a) ethene and hydrogen bromide, HBr
    b) 3-hexene and water
    c) 2-butyne and chlorine.

3. Draw structural formulas to show an addition reaction between propyne and hydrogen to form an alkene. Continue the addition reaction to form an alkane. Name the alkene and the alkane that formed.

4. Draw structural formulas to show an addition reaction that will produce octane form an alkene. Name all of the reactants in your reaction.

5. Draw structural diagrams for each of the following alkyl halides:
    (a) 1,2-dichloroethane (solvent for rubber)
    (b) tetrafluoroethene (used in the manufacture of Teflon)
    (c) 1,2-dichloro-1,1,2,2-tetrafluoroethane (refrigerant)
    (d) 1,4-dichlorobenzene (moth repellent)

6. Write IUPAC names for each of the formulas given.
    (a) CHI_3 (antiseptic)
    (b)



(insecticide)

    (c) CH_2Cl_2 (paint remover)
    (d) $CH_2Br\text{-}CHBr\text{-}CH_2Br$ (soil fumigant)