ORGANIC MOLECULES & THEIR PROPERTIES 5 FEBRUARY 2013

Lesson Description

In this lesson we will

- Identify organic reactions as substitution, addition, elimination or combustion.
- Predict the products, reactants and conditions during organic reactions.
- Answer exam style questions about organic reactions.

Key Concepts

Reactions of Organic Molecules

Examples of Organic Reactions

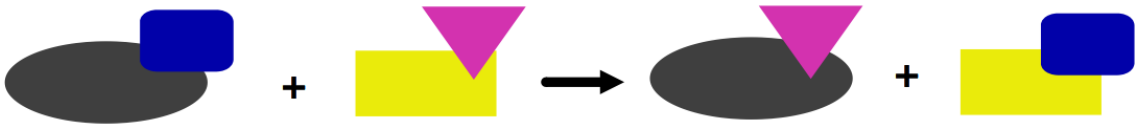
- Substitution (replacement of parts of a molecule)
- Addition (combination of two molecules into one saturated molecule)
- Elimination (splitting apart of a organic molecule to make an unsaturated product)
- Combustion (burning of a hydrocarbon in oxygen)

The first step in getting to know how organic reactions work, we much first take a look at how to identify the type of reaction is occuring.

Substitution

Substitution involves the replacement of one group or atom with another.

Pattern:



How can we tell that there is substitution going on?

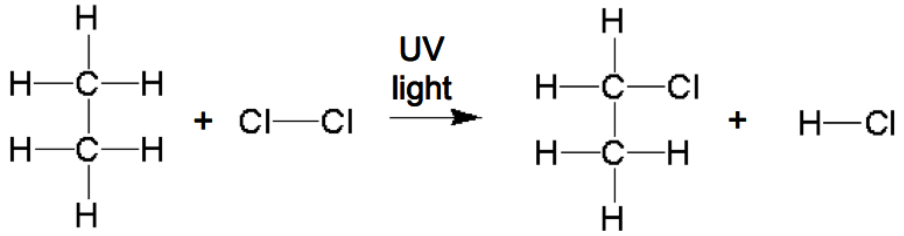
Clue 1: The number of reactants and products

2 Reactants -> 2 Products

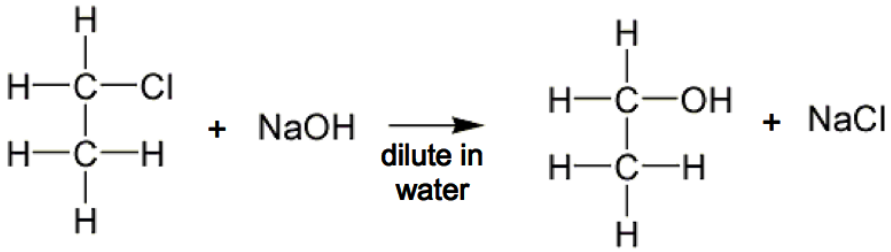
Clue 2: The reactants are saturated -> The products are saturated.

Examples:

Replacement of hydrogen on an alkane with a halogen (F, Cl, Br, I)



Replacement of halogen on a haloalkane with a hydroxyl



Real-world applications?

Substitution reactions are used to turn alkanes into useful starting materials for other organic molecules.

Esterification is a substitution reaction that makes esters – these compounds often smell sweet or fruity and are used in foods and perfumes as a result!

Addition

Addition involves the combination of two groups or atoms with an unsaturated compound..

Pattern:

How can we tell that there is addition going on?

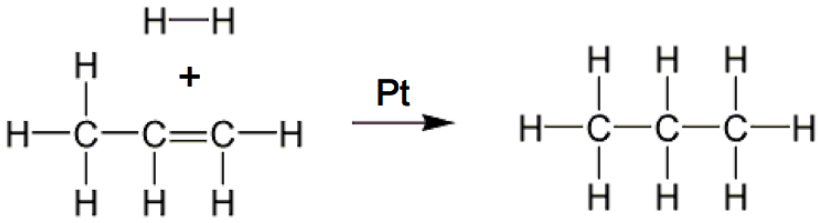
Clue 1: The number of reactants and products

2 Reactants -> 1 Product

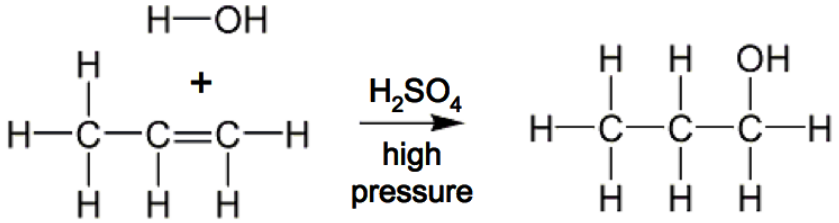
Clue 2: The reactants are unsaturated -> The product is saturated.

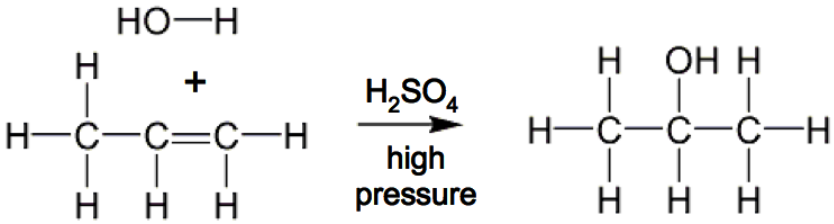
Examples:

Addition of hydrogen to an alkene



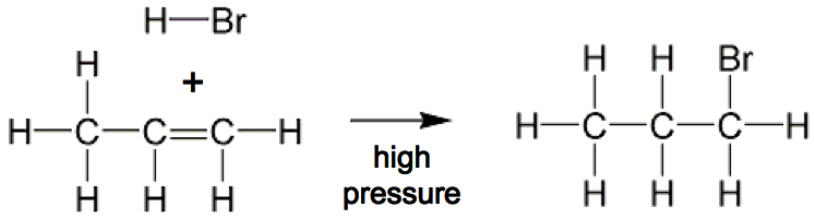
Addition of water to an alkene

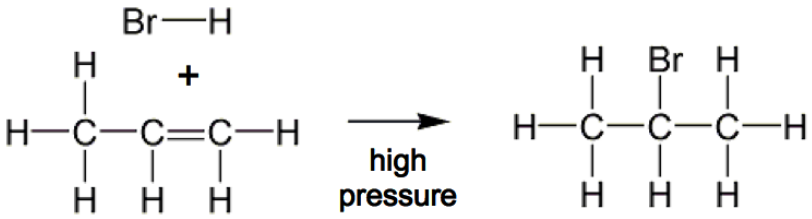




Note: the bottom reaction is preferred. The bigger “part” of water would prefer to be on the carbon in the middle of the chain. (This is called Markovnikov’s Rule)

Addition of a hydrohalogen to an alkene





Real-world applications?

The addition of hydrogen to sunflower or canola oil produces margerine! The unsaturate oils are not viscous, but when hydrogen is added – they become saturated and are harder and solid at room temperature.

Elimination

Elimination involves the removal of two groups or atoms from a saturated compound.

Pattern:

How can we tell that there is elimination going on?

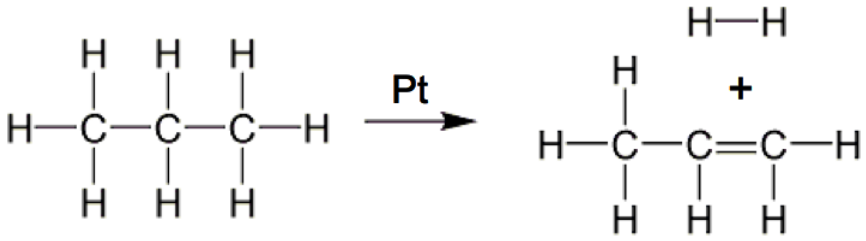
Clue 1: The number of reactants and products

1 Reactant -> 2 Products

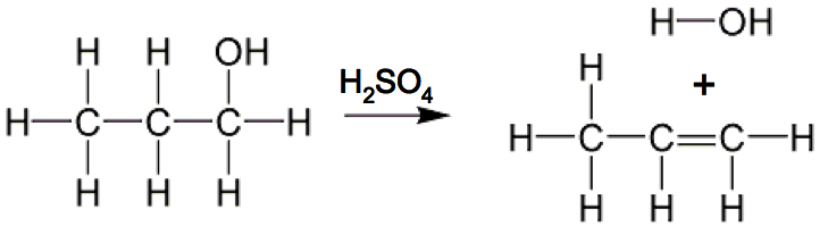
Clue 2: The reactants are saturated -> The products are unsaturated.

Examples:

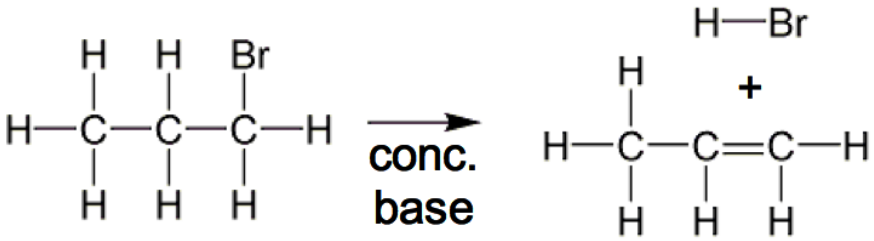
Elimination of hydrogen from an alkane



Elimination of water from an alcohol



Elimination of a hydrohalogen from a haloalkane



Real-world applications?

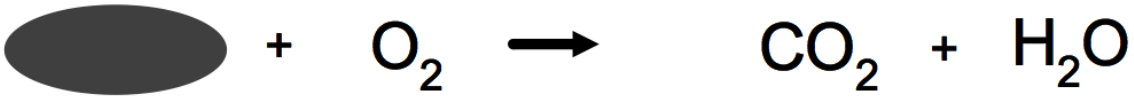
The elimination of water from ethanol is a useful way of making ethene – the starting material for polyethylene.

Cracking is a process by which hydrocarbons are eliminated – making shorter, more useful chains out of longer ones. By doing this – we can use the longer hydrocarbons present in oil as fuels and starting materials for plastics.

Combustion

Combustion involves the burning of a hydrocarbon to form carbon dioxide and water.

Pattern:



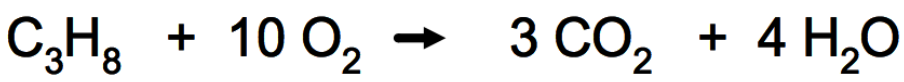
How can we tell that there is elimination going on?

Clue 1: The number of reactants and products

2 Reactants (one is oxygen) -> 2 Products (carbon dioxide and water).

Examples:

Complete combustion of propane in oxygen



Combustion of ethanol in oxygen

Real-world applications?

Combustion is VERY useful because this is how we produce most of the energy needed by transport and industry. Hydrocarbons are most commonly used as fuels in cars, busses and airplanes.

Terminology

Saturated: a hydrocarbon with only single bonds between carbon atoms.

Unsaturated: a hydrocarbon containing double or triple bonds between carbon atoms.

Catalyst: A chemical used to speed up the reaction without being chemically changed by it.

Reagant: a chemical used to react with another.

Reflux: process of boiling a mixture and allowing the solvent to condense and fall back into the mixture.

Polymer: a long chain of repeated pieces made by addition or esterification. Often called a plastic.

Demonstration

When an unsaturated compound is treated with bromine, the bromine quickly reacts with the unsaturated molecule. The brown colour of the bromine quickly dissapears, indicating that the reaction has taken place.

If an unsaturated compound is treated with bromine, the brown colour of the bromine remains. After some time, with the help of UV light, the colour slowly fades.

This is a simple and effective test for the presence of unsaturated compounds.

Questions

Question 5

(Adapted from Nov 2010, DOE, P2, Question 5)

5.1 Why is prop-1-ene considered to be a dangerous compound? (1)

Through addition reactions, prop-1-ene can be converted to other compounds, such as alkanes and alcohols.

5.2 Which part of the structure of an alkene allows it to undergo addition reactions? (1)

5.3 In one type of addition reaction, prop-1-ene can be converted to an alcohol.

5.3.1 Use structural formulae to write a balanced equation for the formation of the alcohol during this addition reaction. (4)

5.3.2 Name the type of addition reaction that takes place. (1)

5.3.3 Write down the name or formula of the catalyst used in this reaction. (1)

5.4 Use molecular formulae to write down a balanced chemical equation for the complete combustion of propane. (3)

Prop-1-ene can be produced from an alcohol by an elimination reaction.

5.5 Use structural formulae to write a balanced chemical equation for the formation of prop-1-ene from a PRIMARY alcohol. (4)

5.6 Name the type of elimination reaction that takes place. (1)

Links

- http://en.wikipedia.org/wiki/Organic_chemistry
- http://www.mindset.co.za/learn/xtra
- http://www.education.gov.za/Examinations/PastExamPapers/tabid/351/Default.aspx