

Part 2 - Addition and Substitution Reactions

Additions Reactions

- Occurs when an **unsaturated** hydrocarbon reacts with a small **diatomic** molecule (like H₂, Br₂, Cl₂, F₂, I₂, H₂O) $\text{H}-\text{OH}$

- Addition reactions occur in the presence of a **catalyst**

- called **hydrogenation** when hydrogen is being added

- called **halogenation** when it is a halogen being added

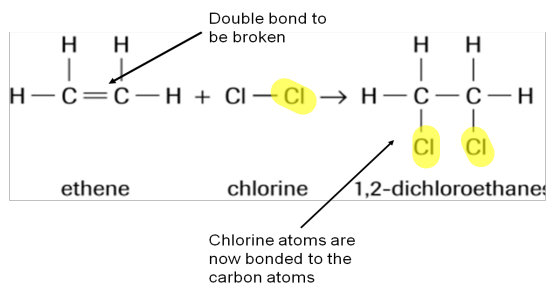
- called **hydration** when water is being added

To determine the new product in an addition reaction:

- Break the double or triple bond

- Add one of the new atoms to each of the carbon atoms that was previously double or triple bonded

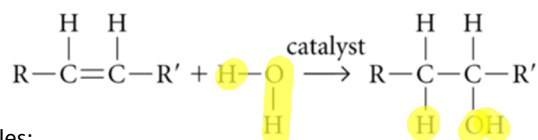
- **Remember:** Carbon atoms can only make 4 bonds



- Alcohols can be made through an addition reaction using water

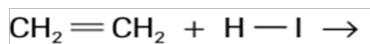
Addition reactions with water

• alkenes + water → alcohols

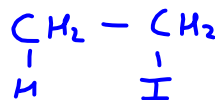


(R and R' can be the same or different alkyl groups. Isomers often result.)

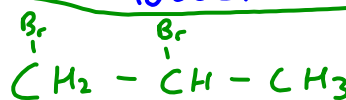
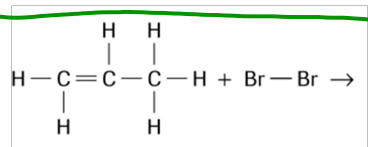
Examples:



ethene +

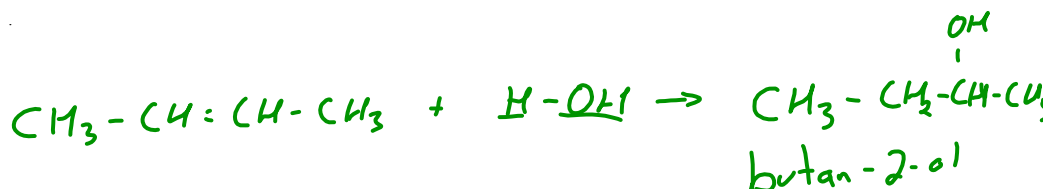


iodoethane



1,2-dibromopropane

but-2-ene + water →



Substitution Reactions

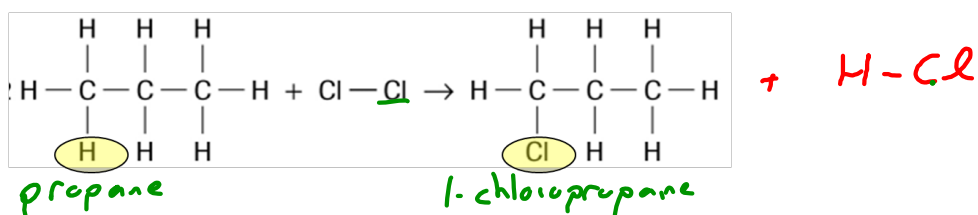
- A substitution reaction occurs when a saturated hydrocarbon (alkane) or aromatic reacts with a diatomic halide molecule (like Br₂, Cl₂, F₂, I₂)

- The products of a substitution reaction are an organic halide and a hydrogen halide molecule

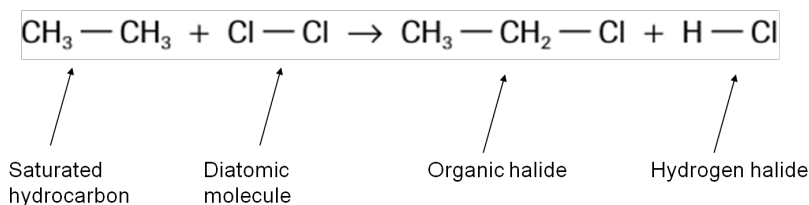
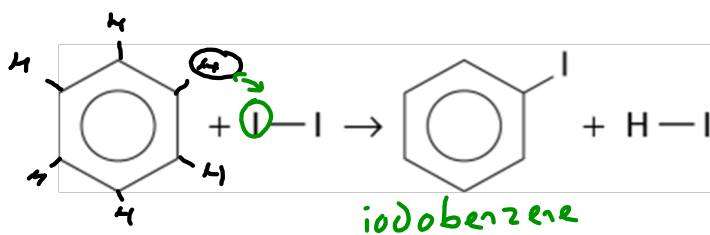
- Carbon-hydrogen bonds in the hydrocarbon are broken and the hydrogen is replaced with a halogen atom

To determine the new product in a substitution reaction:

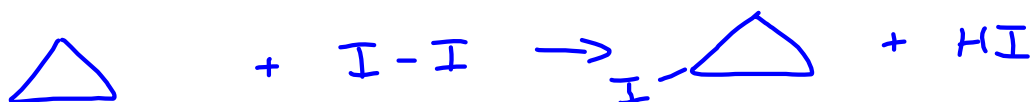
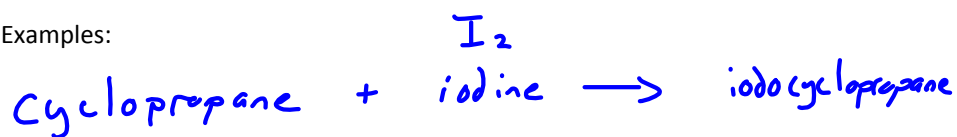
- Substitute one of the atoms bonded to a carbon with one of the atoms to be added



- Benzene rings (aromatics) can also undergo substitution reactions



Examples:

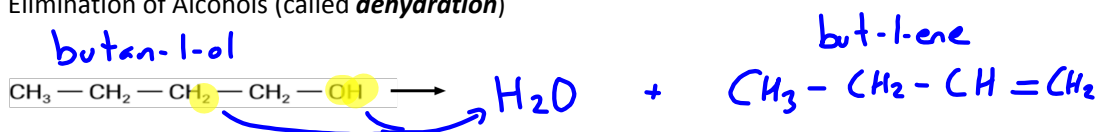


Part 3 - Elimination and Combustion Reactions

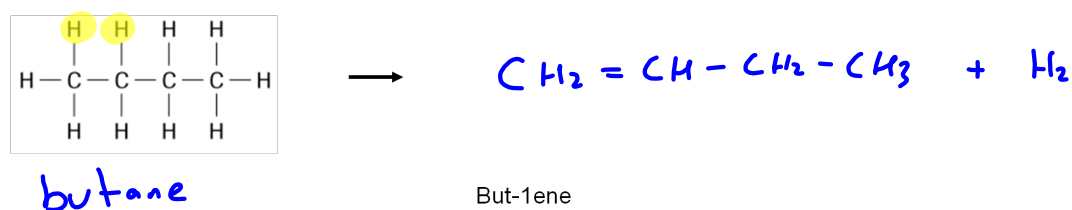
Elimination Reactions

- An elimination reaction involves *eliminating* atoms and/or groups of atoms from adjacent (neighboring) carbon atoms in an organic molecule
- Elimination reactions are easy to recognize because they only have one reactant
- Elimination reactions can involve
 - **Alkanes** – hydrogens on adjacent carbon atoms are removed
 - **Alcohols** – the hydroxyl group on one carbon and a hydrogen on an adjacent carbon are removed (*also called dehydration*)

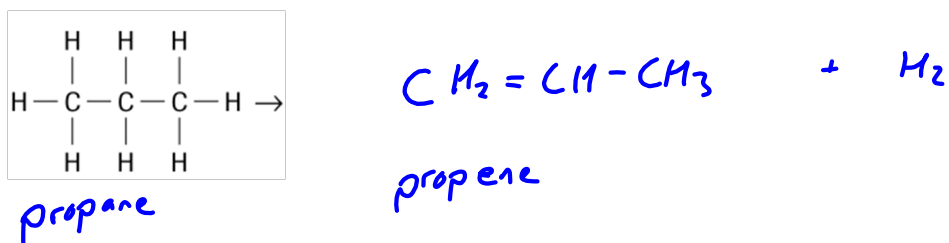
Elimination of Alcohols (called *dehydration*)



Elimination of Alkanes



Example:



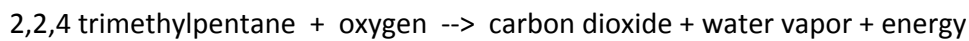
Combustion Reactions

- A combustion reaction occurs when a hydrocarbon reacts with oxygen
- This produces **energy** (exothermic) and a number of possible chemical products including
 - water vapor, carbon dioxide, carbon monoxide, and solid carbon (soot).
- There are two possible types of combustion reactions
 - Complete combustion
 - Incomplete combustion

Complete Combustion

- Complete combustion occurs when there is more than enough (excess) oxygen to react with the hydrocarbon

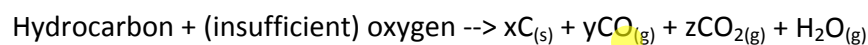
- The products of this reaction are only carbon dioxide and water vapor



Incomplete Combustion

- Incomplete combustion occurs when there is not enough oxygen available to react with the hydrocarbon

- As a result the following products are produced
 - Carbon monoxide
 - Solid carbon (soot)
 - Water vapor
 - Carbon dioxide



- The ratio of x:y:z depends on the amount of oxygen available (more oxygen means less C_(s) and CO_(g) produced)