Chapter 4

Organic Reactions

Types and Mechanism

Classification of Organic reaction

There are so many types of organic reactions:

- **Addition Reactions**
- **Elimination Reactions**
- **Substitution Reactions**

In this lecture, we're going to focus on these only

- **Oxidation – Reduction Reaction**
- **Rearrangement Reaction**

We will also study:

Reaction Mechanisms

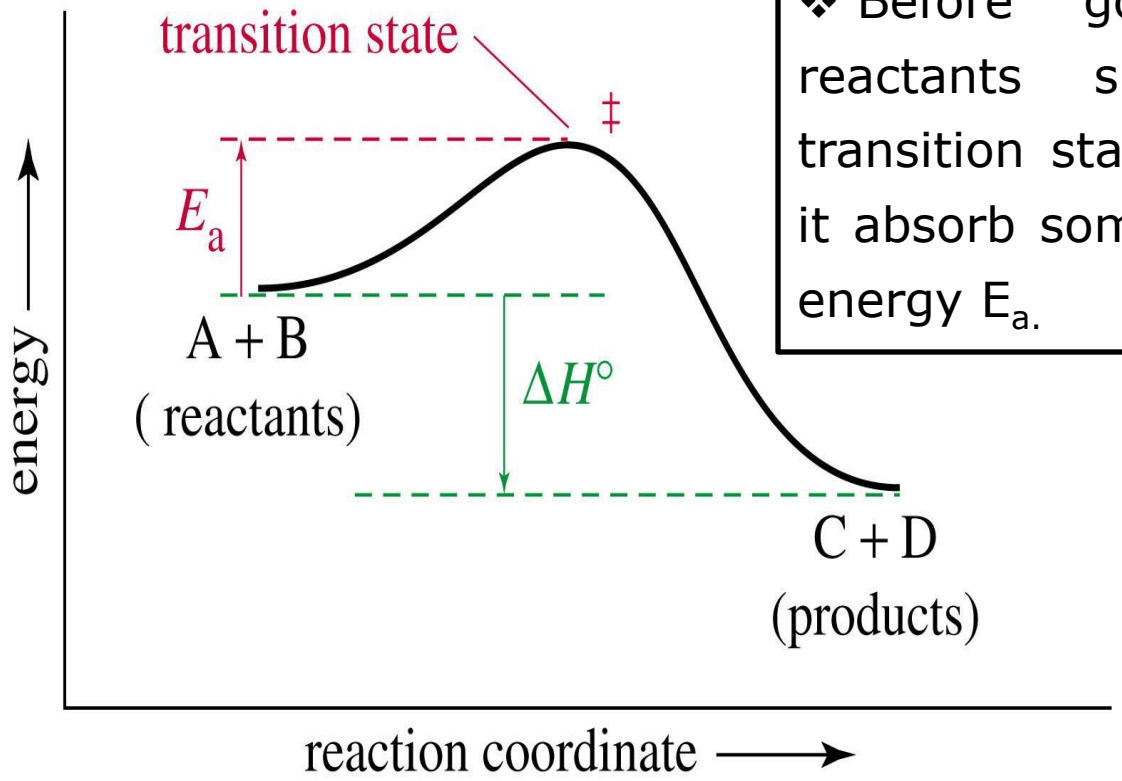
✓ Bond Dissociation

✓ Bond Formation

Let's start with Reaction Profile (Exothermic)

If we have the following reaction:

A + B ⟶ C + D



- In this reaction, the reactants have higher energy than products. So, they lose energy equal to ΔH to form products.
- Before going to the products, reactants should transform to a transition state (an intermediate), thus it absorb some energy called activation energy E_a.

Some Definitions

- **Reaction Mechanism**: sequence of reaction steps that must occur to go from reactants to products.

Each step include dissociation of certain bond, or formation of new one.

- **Thermodynamics**: The study of the energy changes that occur in chemical transformations. It shows us the stability of reactants compared to products.
- **Kinetics**: The study of reaction rates:

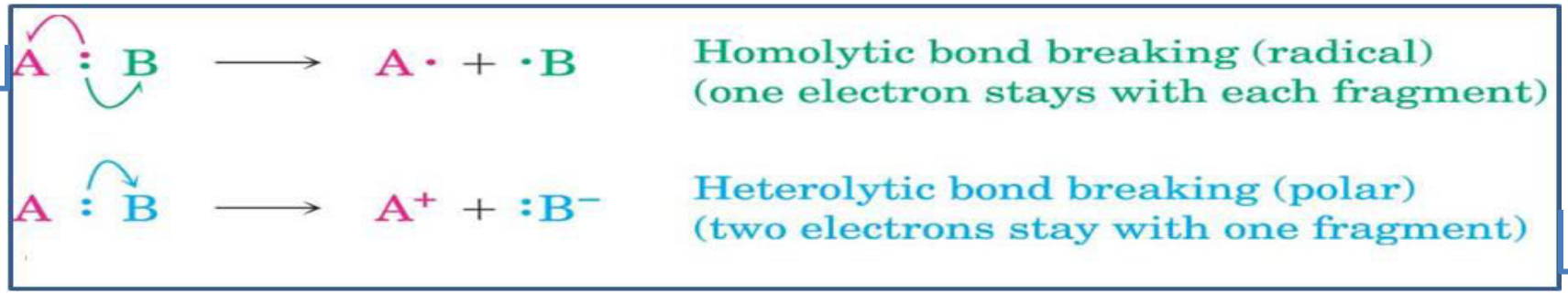
  - determining which product is formed rapidly.

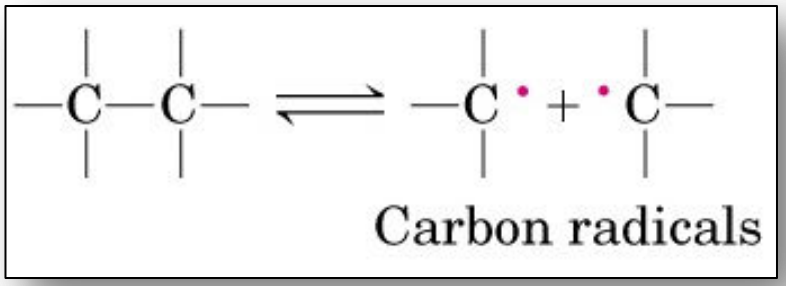
  - predicting the factors affecting the reaction rate.

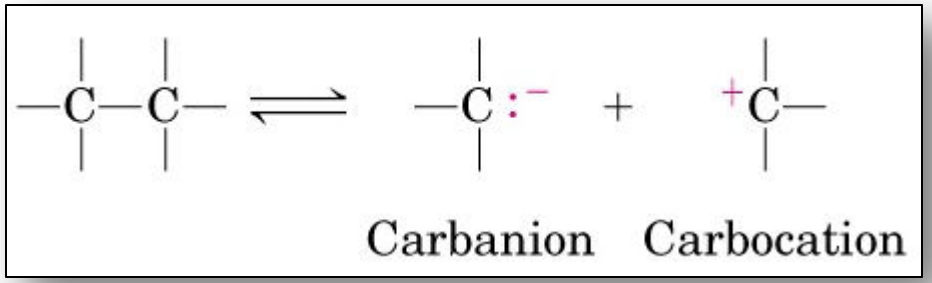
- **Transition state**: unstable species that has short life time, and convert rapidly to the final product.

Bond Breaking and Formation
Polar and Non Polar

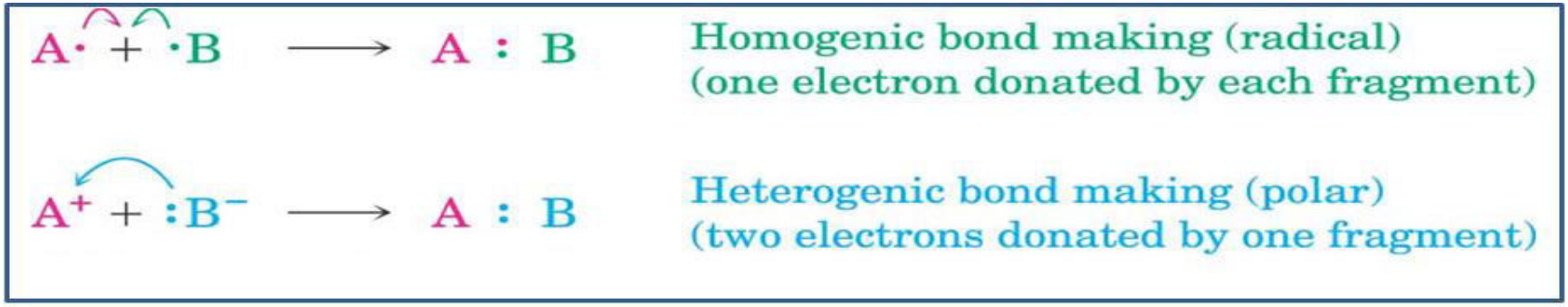
Bond Breaking:





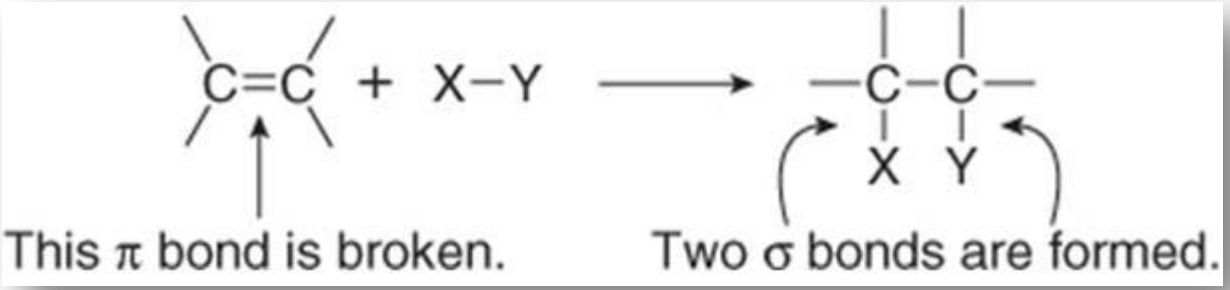


Bond Formation:



I- Addition Reactions

Addition reaction: two molecules combine to give one molecule.

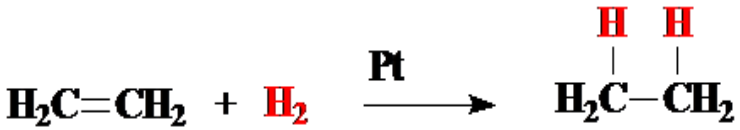


- It Occurs in alkene & alkyne.
- The double or triple bond is easily broken (highly reactive).
- Reactants are added to the carbon atoms in these bonds.

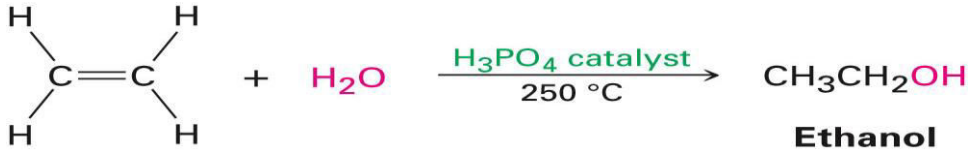
Reactant Added	Name of Addition Reaction
H_2	Hydrogenation
Cl_2, Br_2	Halogenation
HCl, HBr, HI	Hydrohalogenation
HOH	Hydration

Examples of Addition Reactions

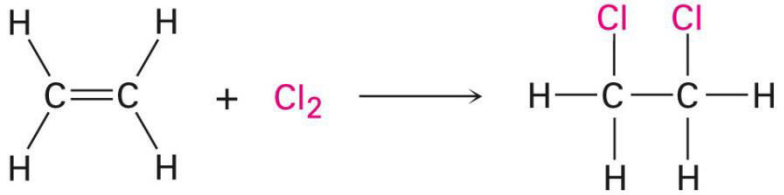
1- *Hydrogenation:* addition of Hydrogen



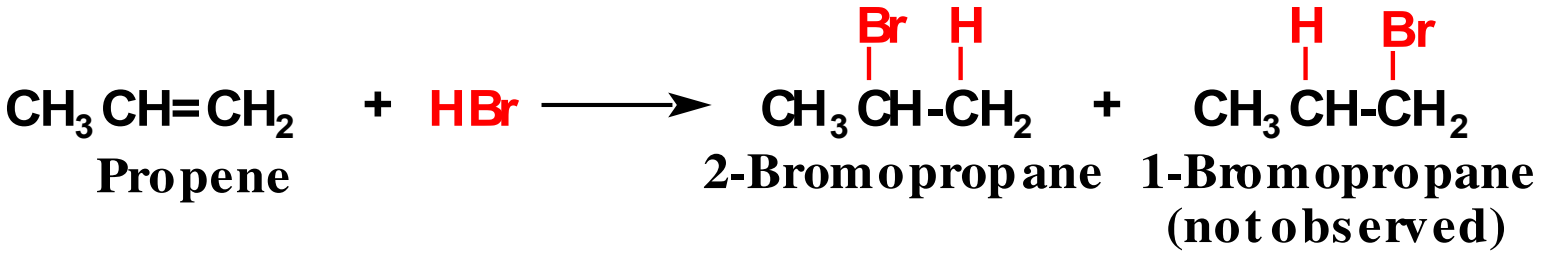
2- *Hydration:* addition of water



3- *Halogenation: addition of halogen*



4- *Hydrohalogenation*

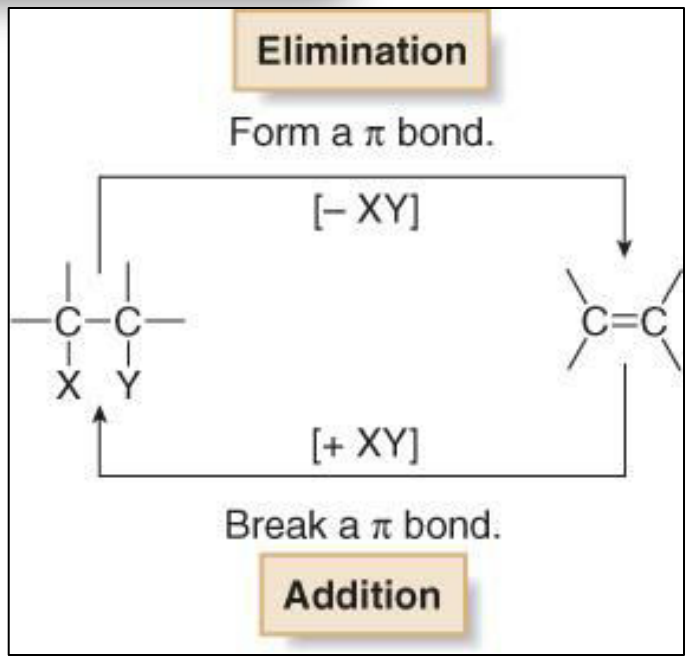


II- Elimination Reactions

Elimination Reaction: removal of a molecule from two adjacent carbon atoms. Ex. Preparation of alkene or alkyne

- Two groups X and Y are removed from a starting material.
- Two σ bonds are broken, and a π bond is formed between adjacent atoms.

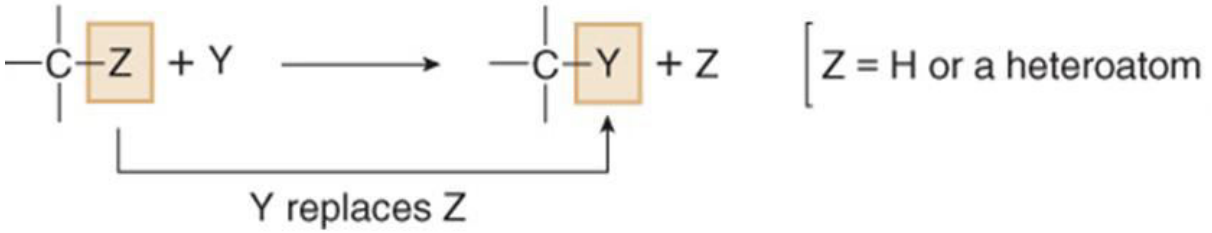
Addition and elimination reactions are exactly opposite.



III- Substitution Reactions

Substitution Reaction: a reaction in which an atom or a group of atoms is replaced by another atom or group of atoms.

- It occurs on σ bonds and at the same carbon atom: one σ bond breaks and another forms

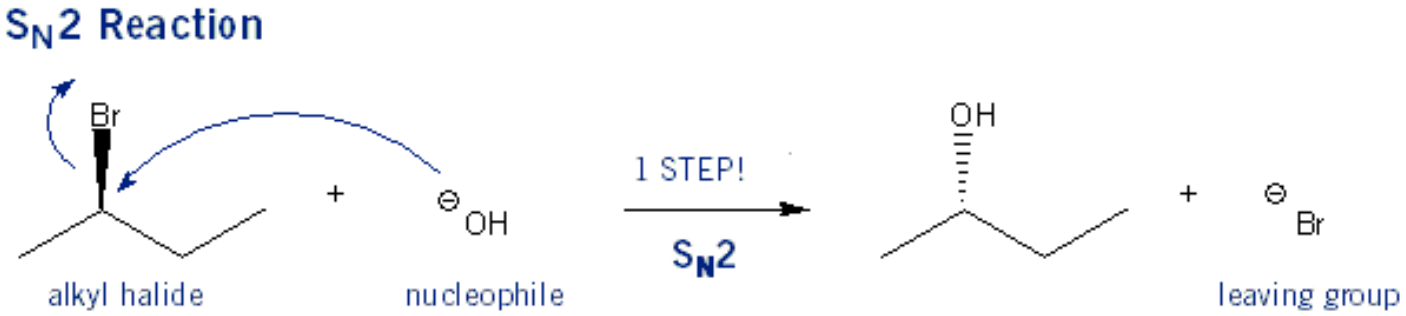


In a general substitution, Y (nucleophile) replaces Z on a carbon atom. Its mechanism can be classified into: (SN^1) or (SN^2) depending on timing of bond breaking and bond forming steps and the strength of Nu.

Nucleophile: a molecule or ion that donates a pair of electrons to another molecule or ion to form a new covalent bond.

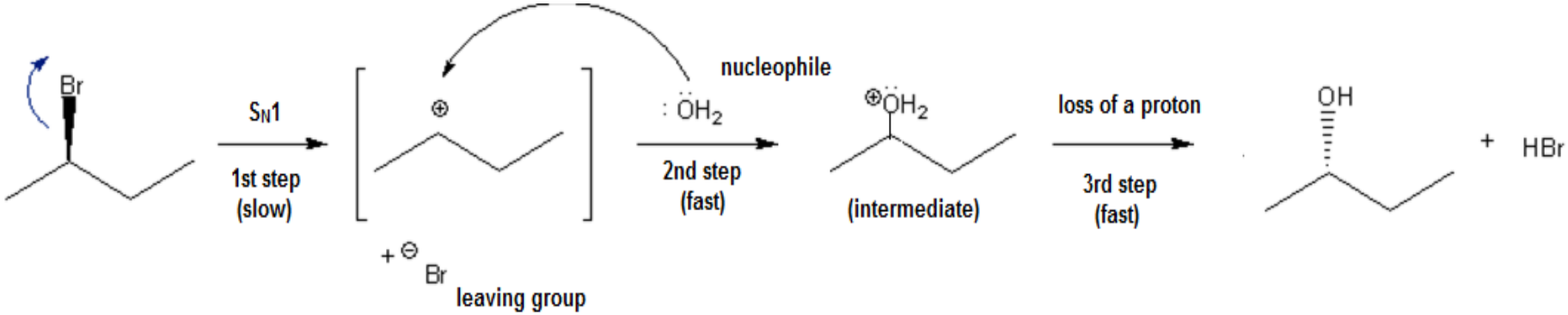
S_N2 Reaction: Bimolecular Nucleophilic Substitution Reaction

It takes place in a single step without intermediate



S_N1 Reaction: Unimolecular Nucleophilic Substitution Reaction

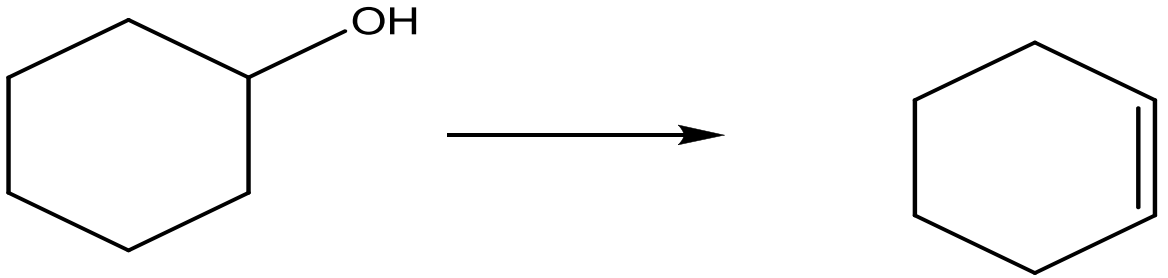
It takes place in a three steps and involve formation of intermediate



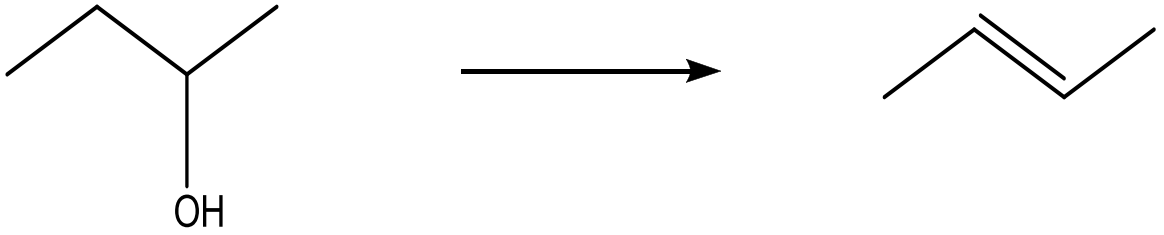
Practice Exercises:

Classify the following reactions as substitution, elimination, or addition.

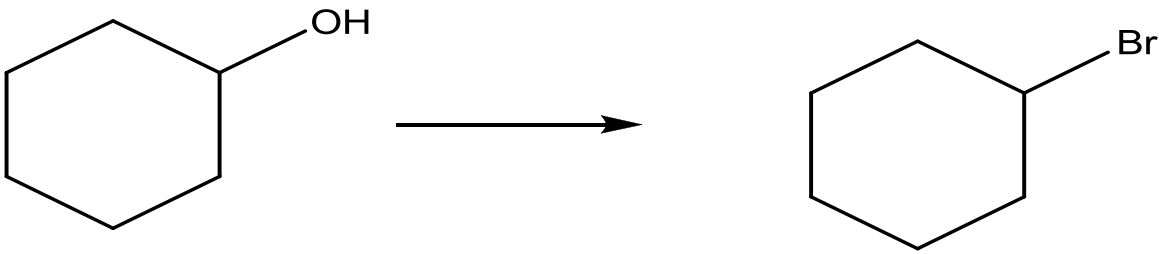
a)



b)



c)



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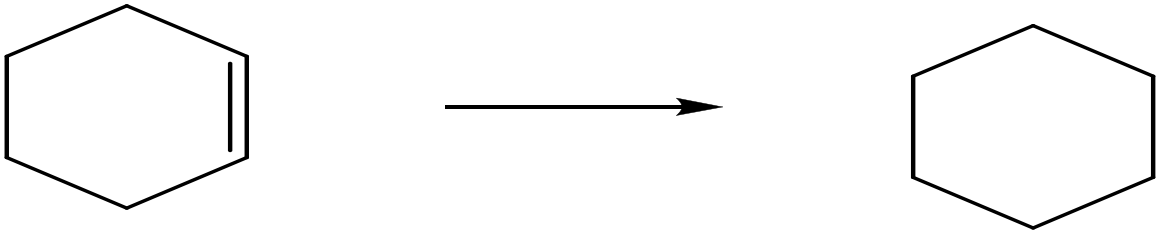
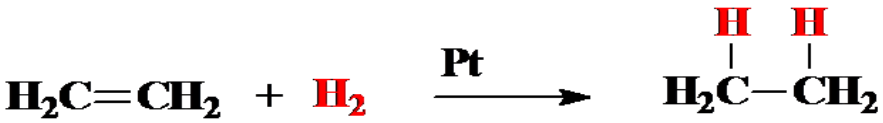
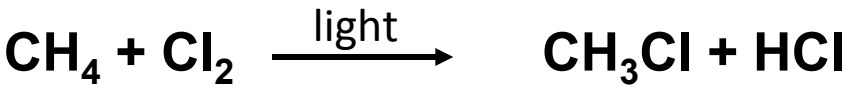
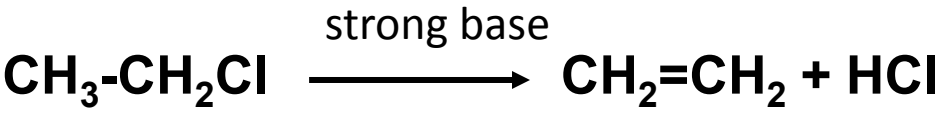
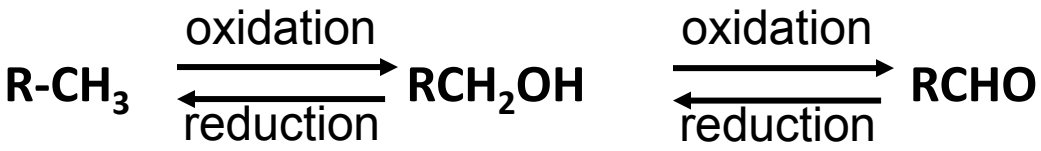


Types of reactions	Example
Addition: two molecules combine to give one molecule. Occurs in alkene & alkyne	
Substitution: one atom, ion or group is replaced (substituted) by another (S_N1, S_N2) Usually occurs in saturated compounds such as alkanes.	
Elimination: removal of a molecule from two adjacent carbon atoms.	
Oxidation –Reduction: Oxidation: gain of O, loss of H, or both Reduction: gain of H, loss of O, or both	
Rearrangement: molecule undergoes changes to be converted to another isomer.