

Objective 15

Develop synthesis strategies for organic synthesis

OChem Objectives

(1) GIVEN REACTANTS AND REACTION CONDITIONS ==> predict products.

(2) GIVEN PRODUCT ==> determine reactants and reaction conditions. In other words, **WORK BACKWARDS**. (1 step Synthesis)

(3) GIVEN A TARGET COMPOUND, design a Synthesis Synthesis Strategy:

Retrosynthetic Analysis involves **WORKING BACKWARDS** from the target compound (see #2).

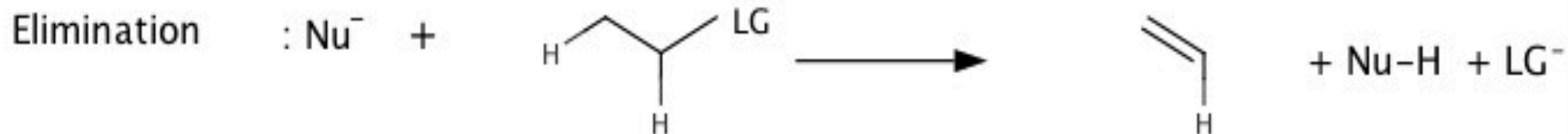
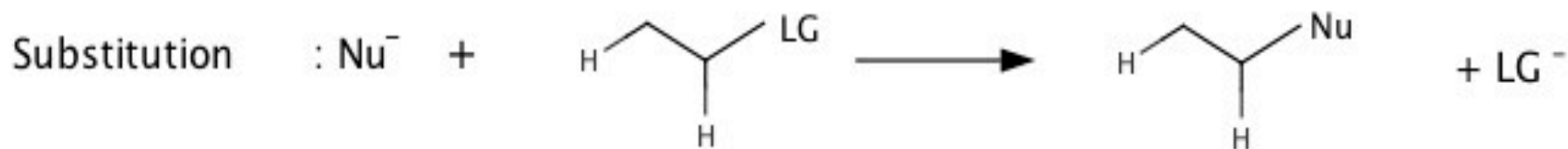
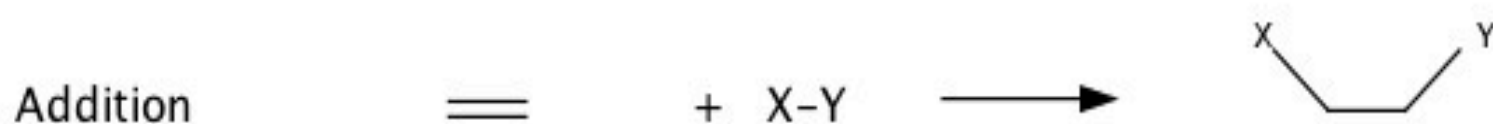
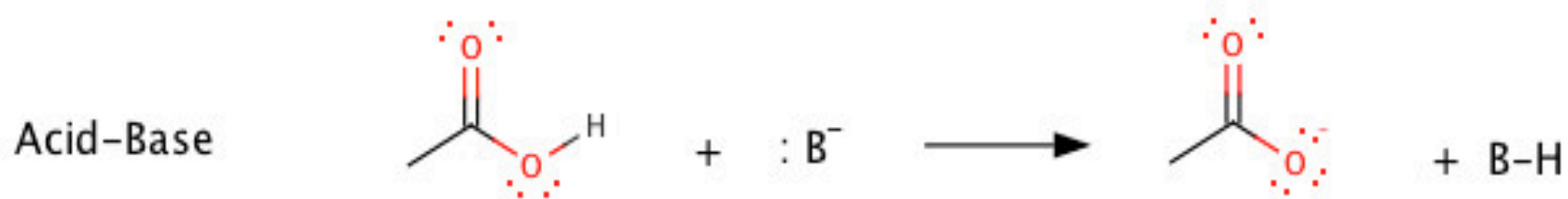
ID functional group.

How is this group made?

So far in Chem 12A, we know how to:

- convert one functional group to another on the same carbon, e.g., -Br to -OH
- make a pi bond
- convert a pi bond to a functional group

4 Types of Organic Polar Reactions



How can we use these reaction types in Synthesis?

How Can We Use These Reaction Types In Synthesis?

Reaction Type	Synthesis Use	
Acid-Base	Make acid or base	See pK _a table
Acid-Base	Make a better LG	For Sub/Elim
Substitution	Convert one functional group to another	RX → ROH
Substitution	Make C-C bond	Use HC≡C:-
Elimination	Make a pi bond	Need LG
Addition	Add atom/group to C=C	Reverse of Elim

Synthesis Strategies:

1. How to convert one functional group to another
2. How to move a functional group to adjacent C
3. How to make big molecules from small molecules
4. How to make small molecules from big molecules
5. How to make the product have the stereochemistry you want

For #1: see **Substitution** reaction

For #2: see **Elimination** and **Addition** reactions

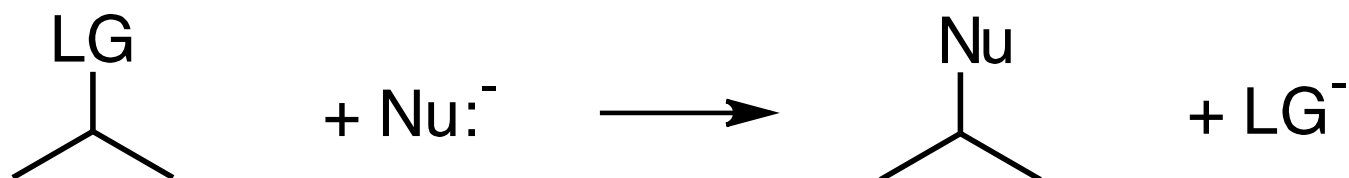
For # 3: see **Substitution** (w/ acetylide ion), **Addition**
(carbocation/ π bond (cationic polymerization)), or radical
polymerization

For #4: see O_3

For #5: see mechanism, e.g., S_N1 vs. S_N2

Synthesis: Convert one Functional Group to Another

Use Substitution Reaction

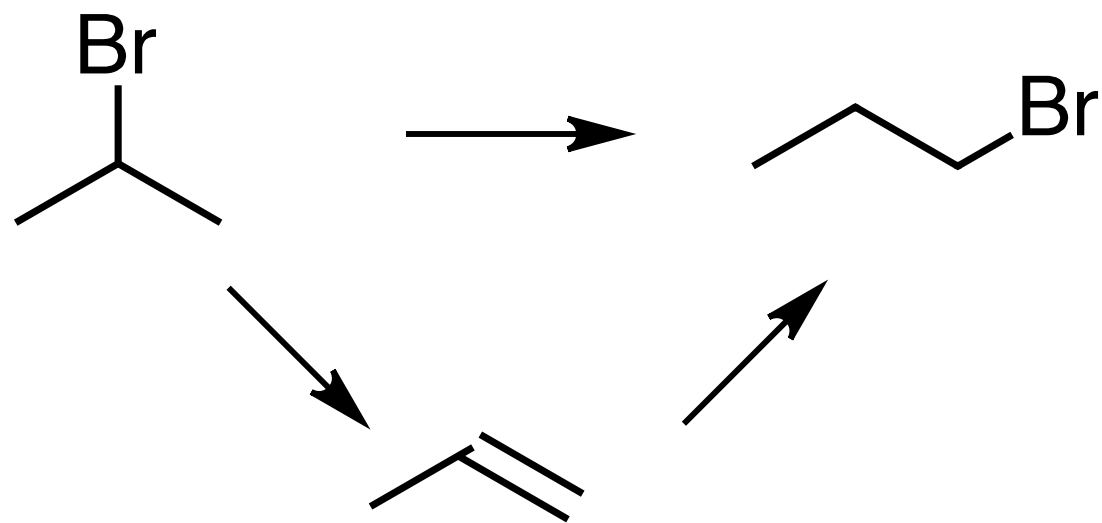


See pK_a table

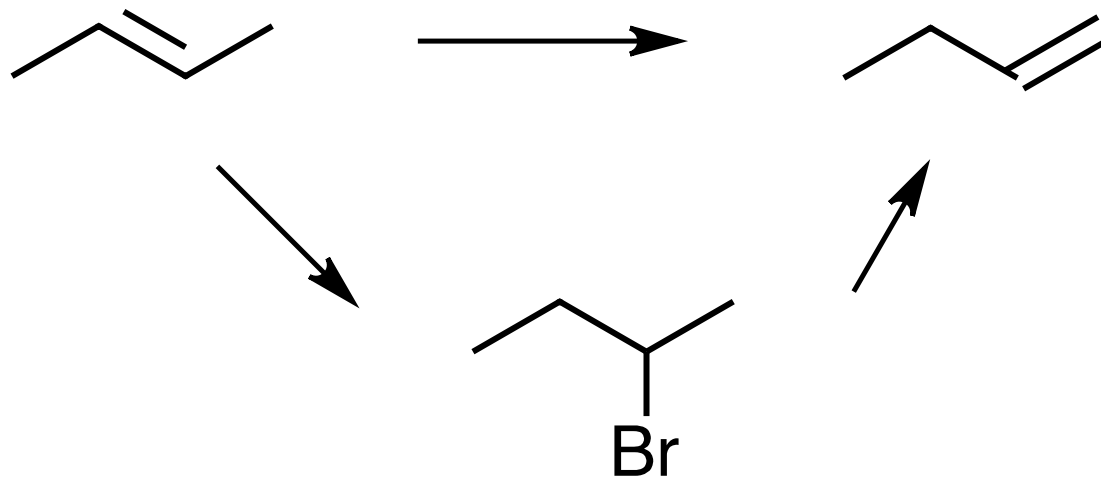
$\text{LG} = \text{X}^-, \text{OH}^-, \dots$

$\text{Nu:}^- =$

Synthesis: Move Functional Group to Adjacent C
Use Elimination and Addition Reaction

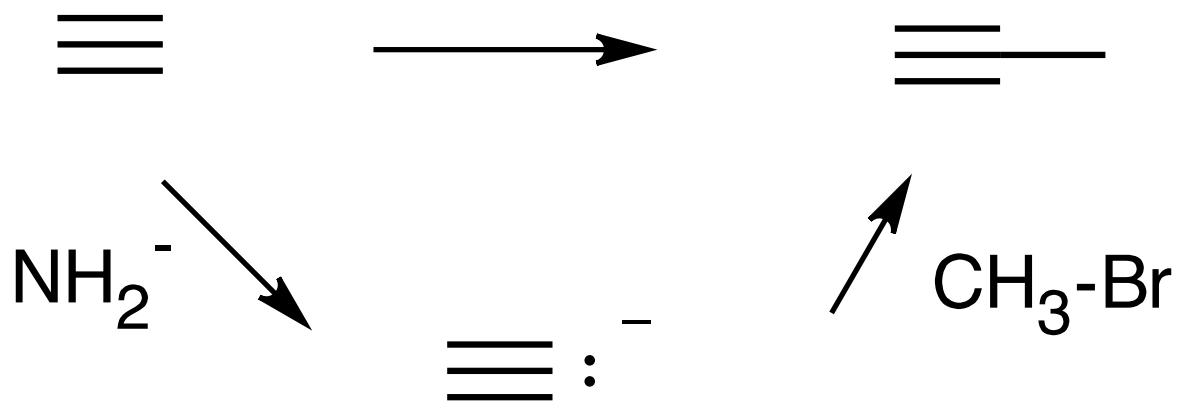


Synthesis: Convert one Functional Group to Adjacent C
Use Addition and Elimination Reaction

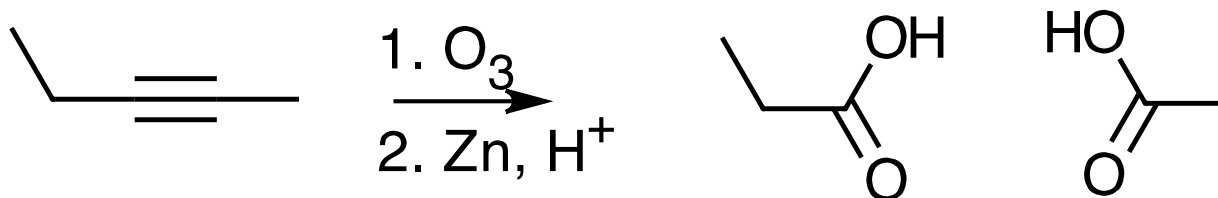
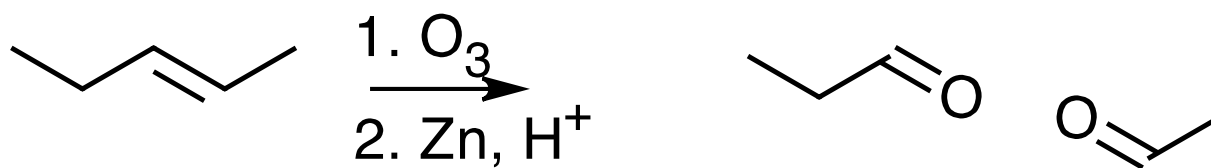


Synthesis: Make Big Molecules from Small Molecules

Use $\text{H-C}\equiv\text{C:}^-$ and Substitution Reaction



Synthesis: Make Small Molecules from BigMolecules
Use Ozonolysis Reaction



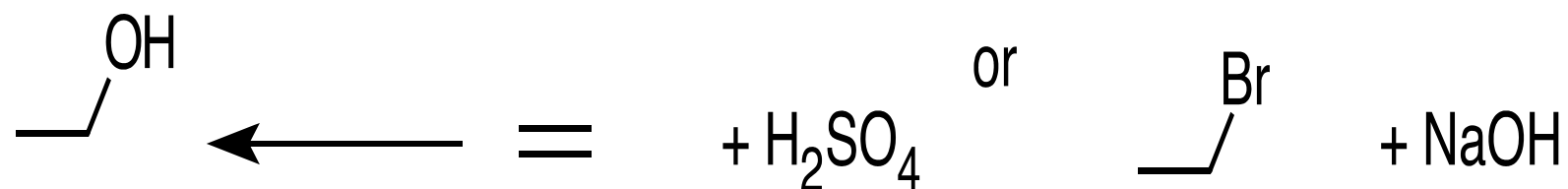
Target Compound: Ethanol
Starting Material: Acetylene



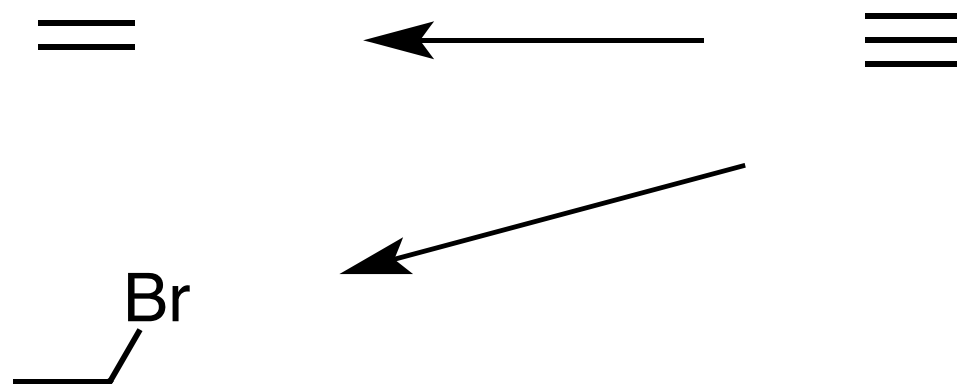
What functional group makes an alcohol?

2. If this functional group is not acetylene, how do I make this group from acetylene?

2 ways to make ROH



Can I make ethylene or ethyl bromide from acetylene?

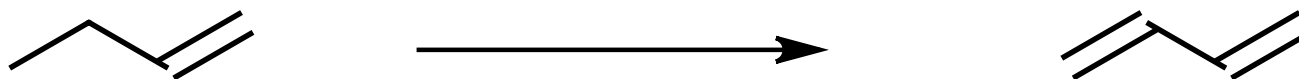


Example: 1-bromobutane to 2-bromobutane



What functional group is used to make RX?

Example: 1,3-butadiene is used to make rubber



What functional group is used to make a pi bond?

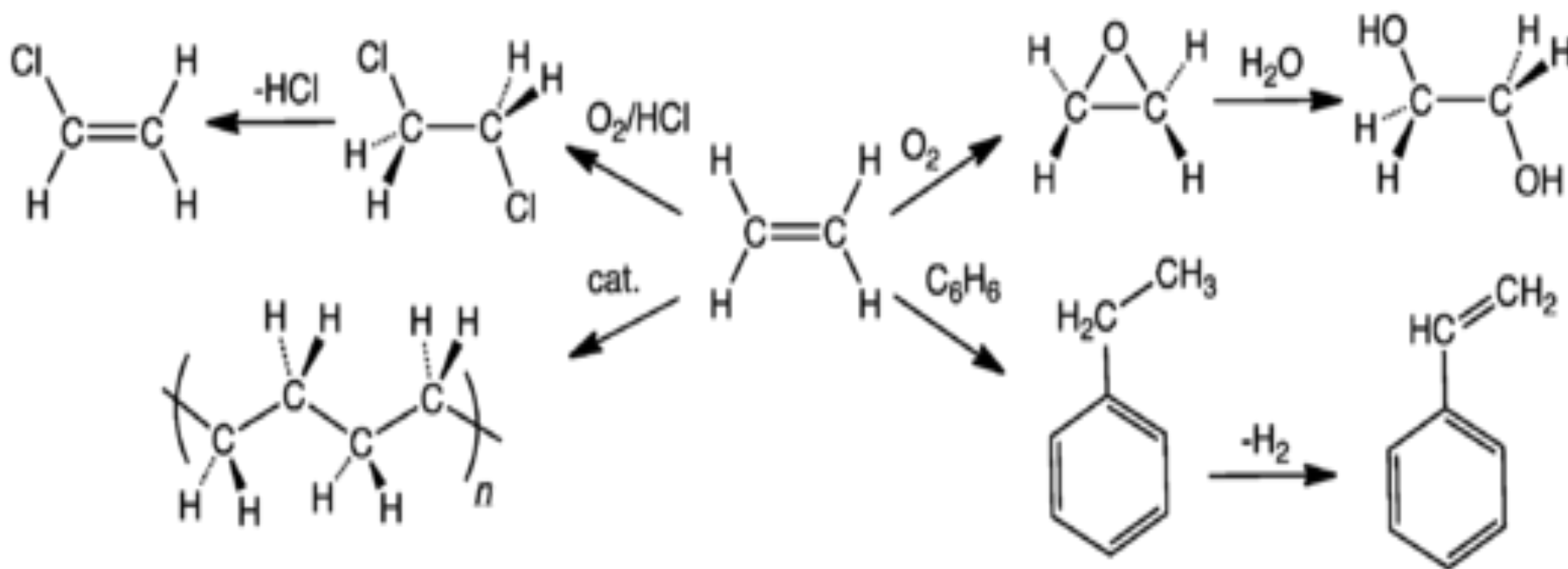
Chemical Industry uses

Ethylene = 150 million tons per year (mostly for plastics)

Propylene = 85 million tons per year (mostly for plastics)

Acetylene = 0.15 million tons per year

to make many different chemicals.



<https://en.wikipedia.org/wiki/Ethylene>