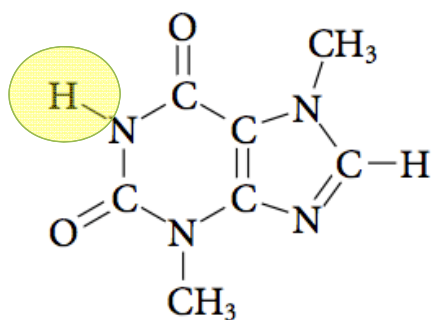


# Grade 12 Chemistry

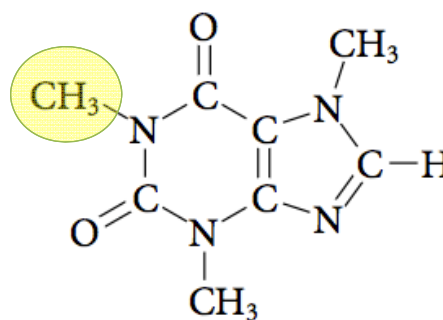
Organic Chemistry  
Class 3

## Organic Reactions

- Organic compounds are synthesized (man-made) in large quantities industrially by adding or removing key functional groups from available molecules
- Ex: Caffeine can be extracted from coffee beans and tea leaves but to meet the large demand, a compound called theobromine is obtained from cocoa fruits and modified by adding a methyl group to make caffeine



theobromine



caffeine

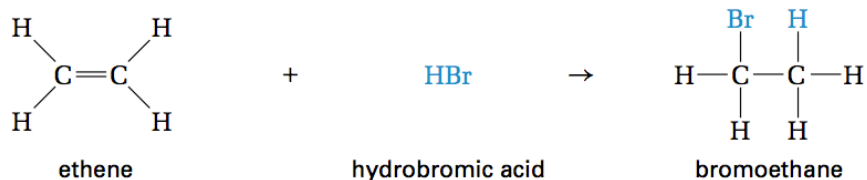


Beverage	Serving Size	Caffeine Content (mg)
Coffee, Brewed	8 oz	120 mg
Coffee, Decaffeinated	8 oz	5 mg
Starbucks Grande (medium) Coffee	8 oz	330 mg
Black Tea	8 oz	45 mg
Green Tea	8 oz	20 mg
White Tea	8 oz	15 mg
Diet Coke	12 oz	47 mg
Coca-Cola Classic	12 oz	35 mg

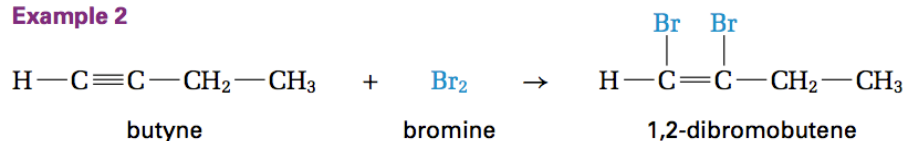
## Reaction Types

- **Addition Reaction** – atoms are added to a double or triple bond OR a C=O bond

### Example 1

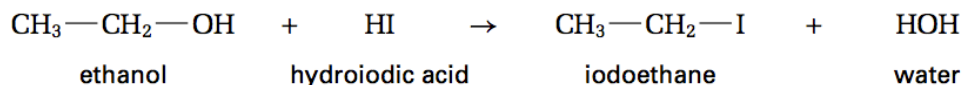


### Example 2

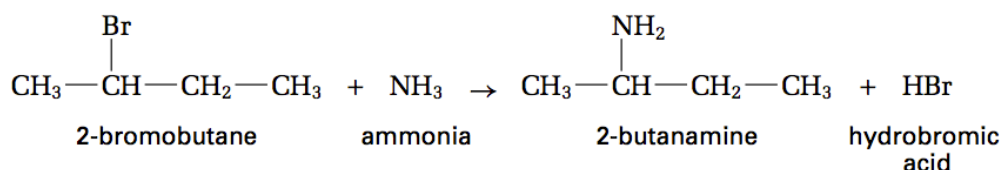


- **Substitution Reaction** – A hydrogen atom or functional group is replaced by a different functional group
- Commonly found in alcohols, alkyl halides and aromatic compounds

**Example 1**

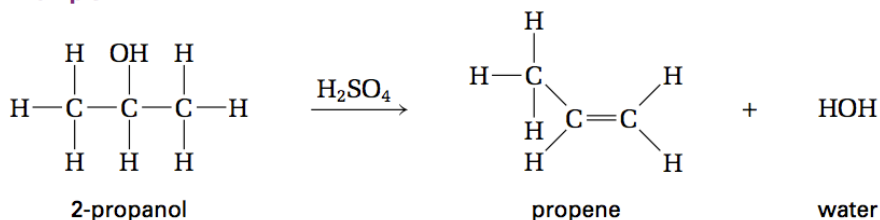


**Example 2**

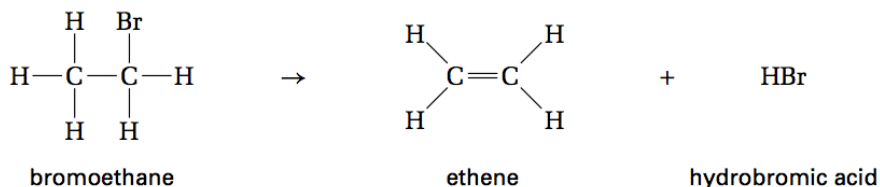


- **Elimination Reaction** – Atoms are removed from a molecule to form a double bond
- Commonly found in alcohols, alkyl halides

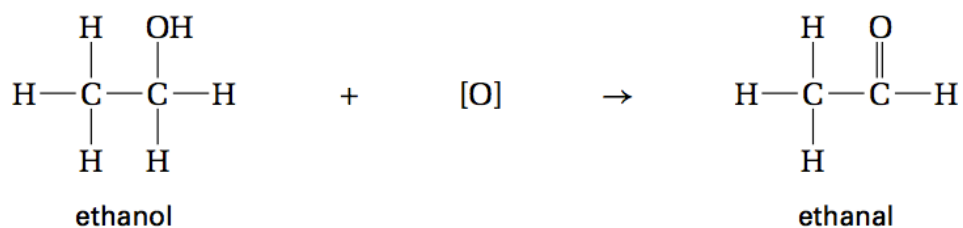
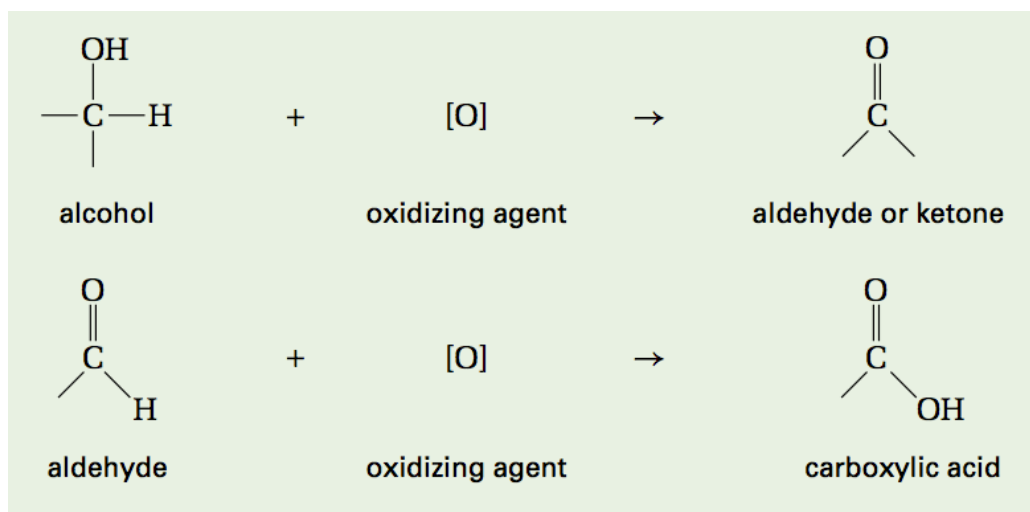
**Example 1**



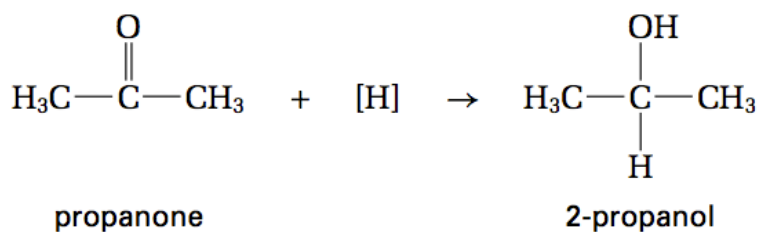
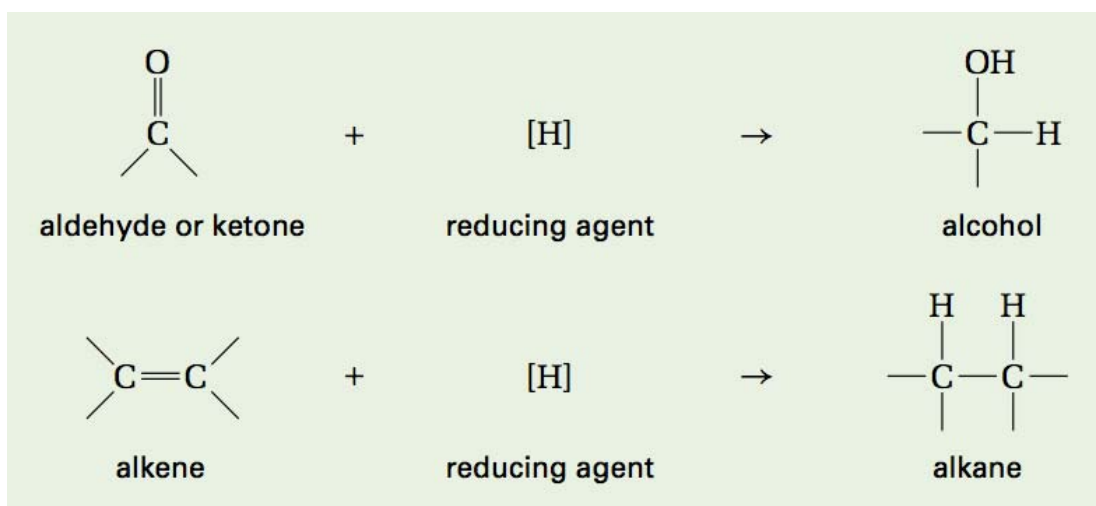
**Example 2**



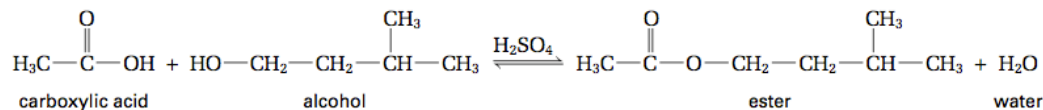
- **Oxidation** – reaction in which carbon forms more bonds to oxygen
- Commonly found to produce aldehydes and ketones in the presence of an oxidizing agent such as  $\text{KMnO}_4$ ,  $\text{K}_2\text{Cr}_2\text{O}_7$  and  $\text{O}_3$
- Symbol is  $[\text{O}]$
- Identify an oxidation by counting and comparing the number of C-H and C-O bonds



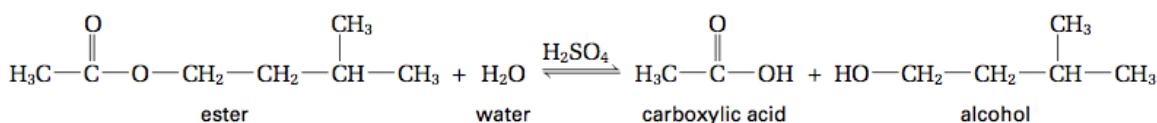
- **Reduction** – reaction in which carbon forms fewer bonds to oxygen
- Commonly found in aldehydes, ketones, carboxylic acids, alkenes, and alkynes
- Requires a reducing agent such as  $\text{LiAlH}_4$  and  $\text{H}_2/\text{Pt}$
- Symbol is  $[\text{H}]$
- Identify reduction by counting and comparing the number of C-H and C-O bonds



- **Condensation Reactions** – two molecules combine to form one molecule with the production of water



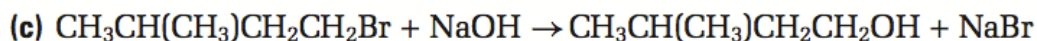
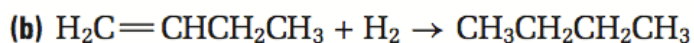
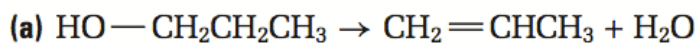
- **Hydrolysis Reactions** – water is added to a bond, splitting it into two.



## Checkpoint



Identify the types of reaction:

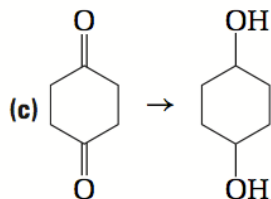
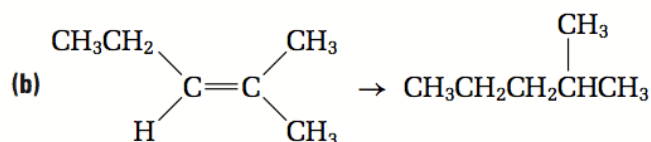
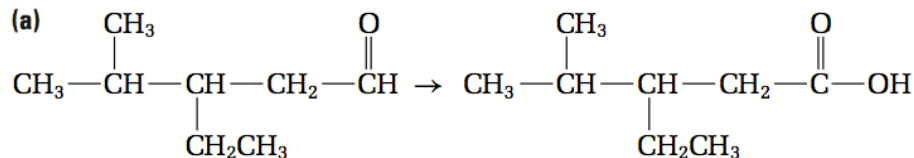




## Checkpoint



Identify the types of reaction:

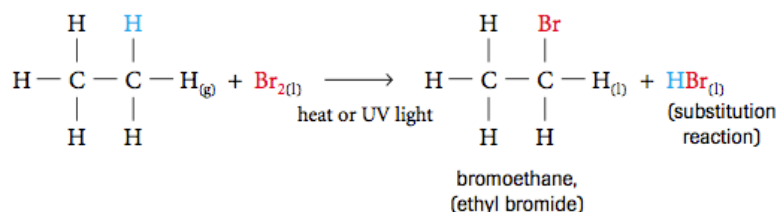


## Reactions of Alkanes

- Combustion Reactions



- Halogenation – replacement of hydrogen atoms with halogen atoms

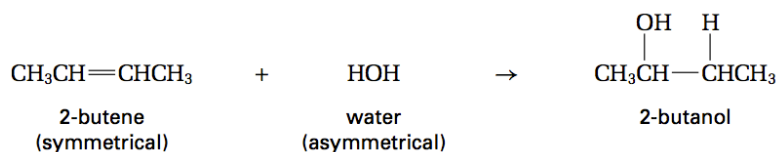


– Uses a free radical substitution reaction

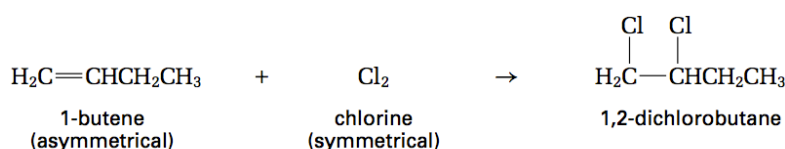
# Reactions of Alkenes

- Addition:

- Symmetrical alkene – identical groups on either side of the double bond



**Figure 2.3** The addition of water to 2-butene

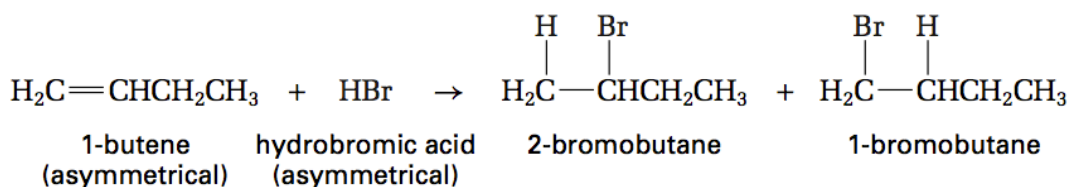


**Figure 2.4** The addition of chlorine to 1-butene

Alkenes can add:

- $\text{X}_2$
- $\text{H}_2$
- $\text{HX}$
- $\text{H}_2\text{O}$

- Asymmetrical alkene – different groups on either side of the double bond



**Figure 2.5** The addition of hydrobromic acid to 1-butene

- **Markovnikov's Rule** – the halogen atom or OH group is usually added to the more substituted carbon atom
- “The rich get richer” – the H binds to the side with more H

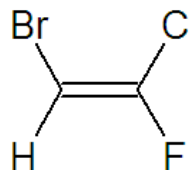
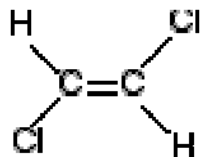




## Checkpoint



Name the following:



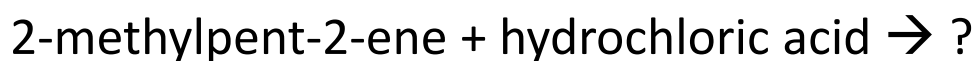
Draw structural diagrams to represent the elimination reaction of 2-chloropentane to form an alkene. Name the products.



## Checkpoint



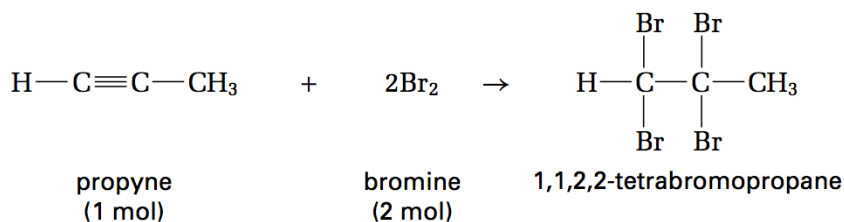
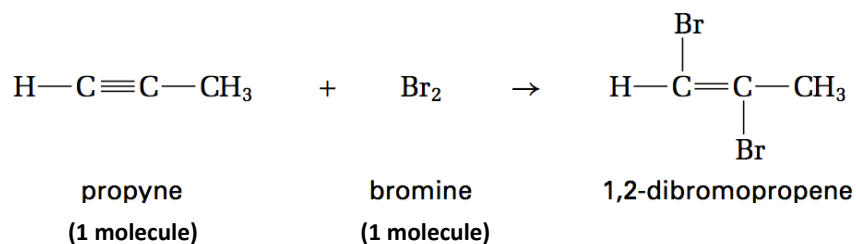
Draw the reactants and products of the following incomplete reaction:



Use Markovnikov's rule to predict which of the two isomeric products will form in a greater amount.

# Reactions of Alkynes

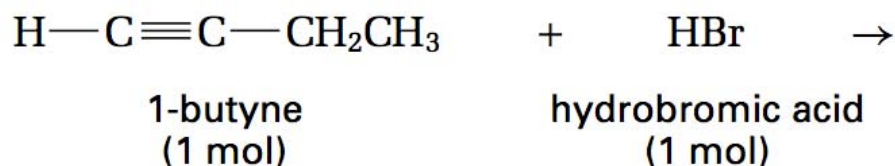
- Addition Reaction: Alkyne  $\rightarrow$  Alkene  $\rightarrow$  Alkane



## Checkpoint

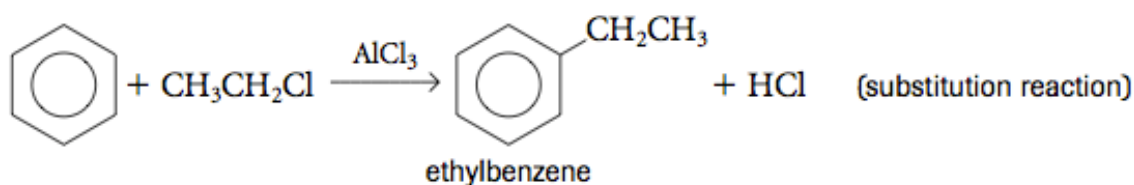
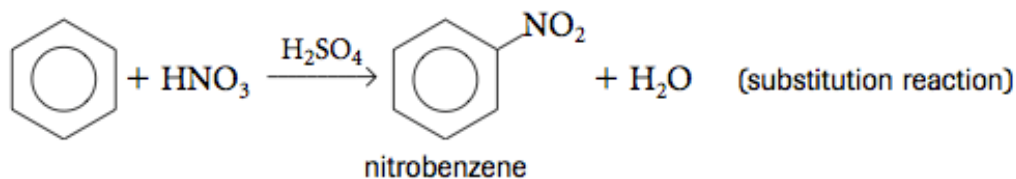
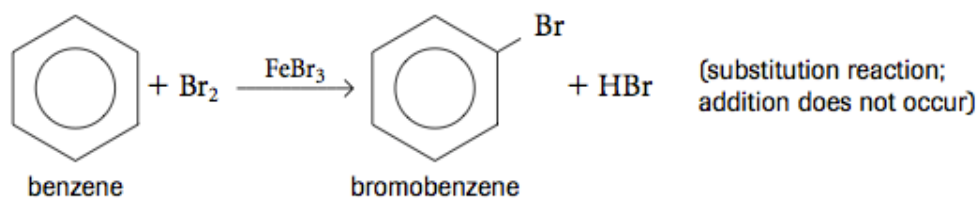
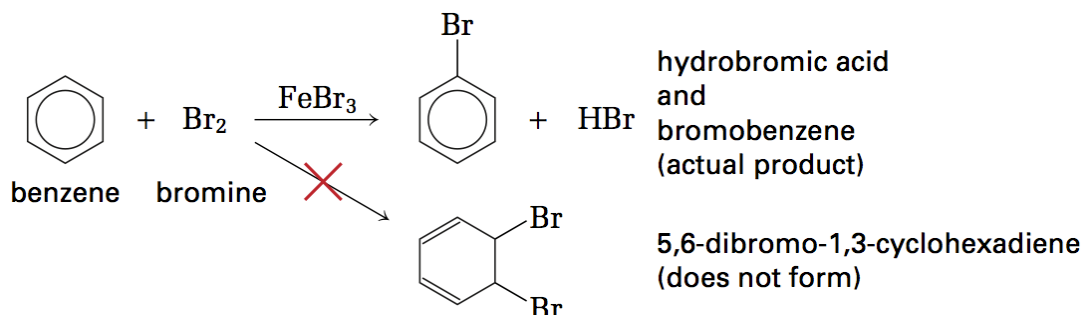


Predict the products from the following reaction:



# Reactions of Aromatic Compounds

- Substitution Reactions – one of the hydrogen atoms are replaced by a functional group
  - Addition reactions DO NOT occur since the product would be less stable than benzene





## Checkpoint

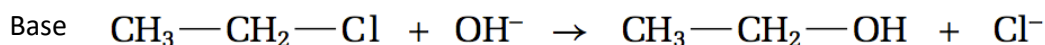
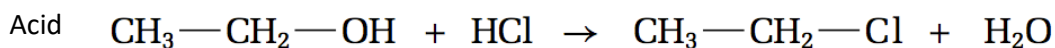


Predict and name the products of reactions involving the following reactants:

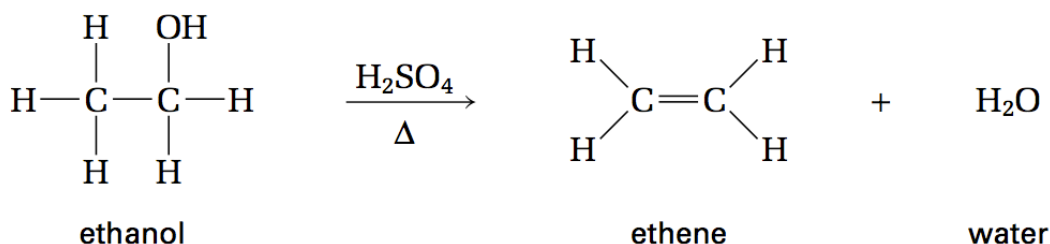
- a) Cyclohexene and hydrogen bromide
- b) Benzene and chloroethane

## Reactions of Alcohols

- Substitution Reactions – When a halogen acid (HCl, HBr, HI) reacts with alcohol, the halogen is substituted for the OH group
- Reverse occurs with  $\text{OH}^-$  in a basic solution

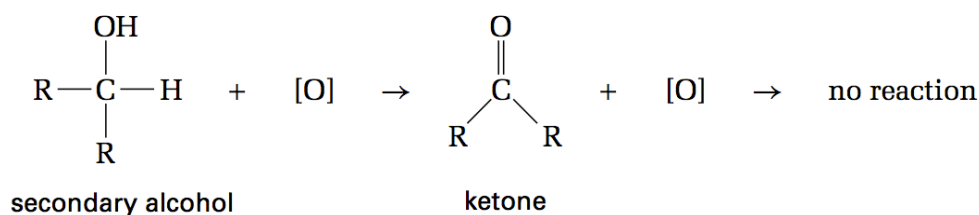
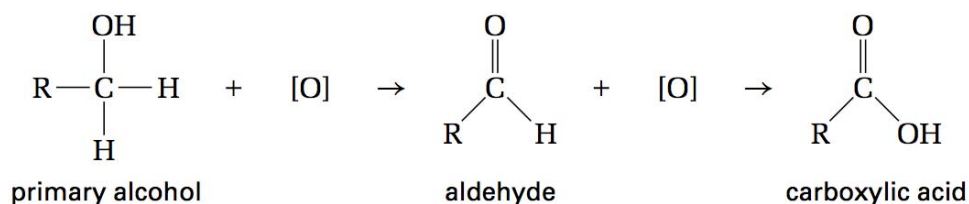


- Elimination Reaction (Dehydration Reaction) – when an alcohol is heated in the presence of the strong acid and a dehydrating agent  $\text{H}_2\text{SO}_4$

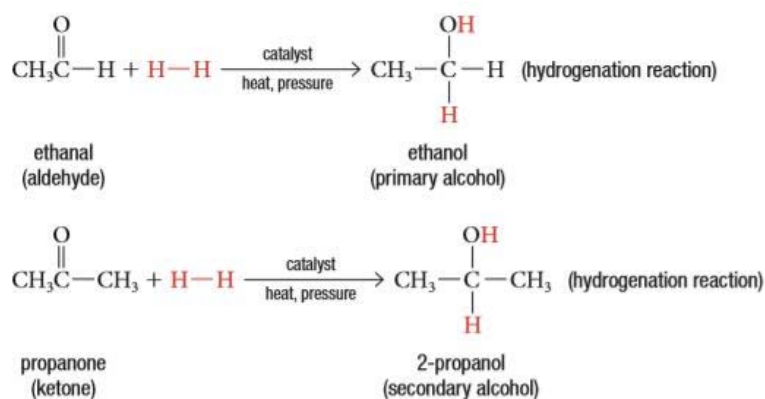


- $\Delta$  means heat

- Oxidation – in the presence of an oxidizing agent, alcohols can be oxidized to form an aldehyde or a ketone



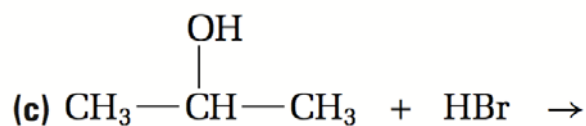
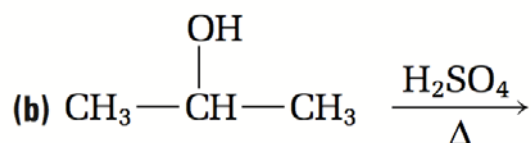
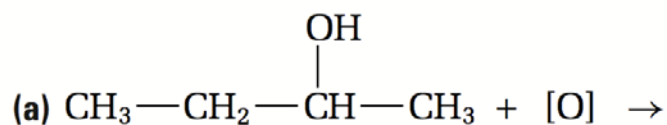
- Aldehydes and ketones can also undergo reduction (hydrogenation) at high temperatures and pressures and in the presence of a catalyst
- The product is its corresponding alcohol



## Checkpoint

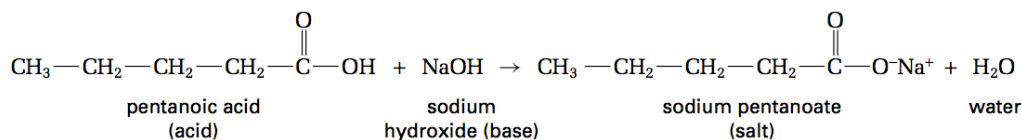


Name each type of reaction. Then predict and name the products.

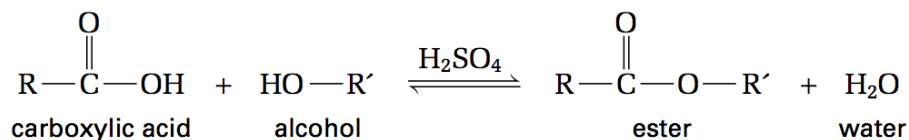


# Reactions of Carboxylic Acids

- Neutralization – Carboxylic acid reacts with a base to produce a salt and water

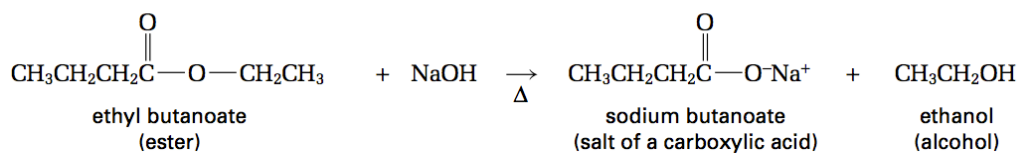
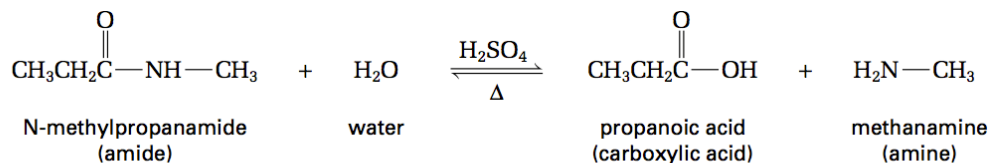


- Esterification Reaction – Carboxylic acid reacts with an alcohol to produce an ester and water



# Reactions of Esters and Amides

- Hydrolysis – ester or amide bond is cleaved or split in two to form two products
  - Amide → Carboxylic Acid and Amine
  - Ester → Carboxylic Acid and Alcohol

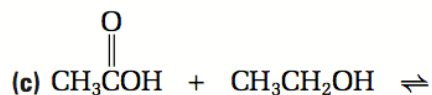
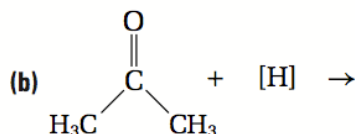
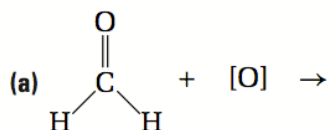




## Checkpoint

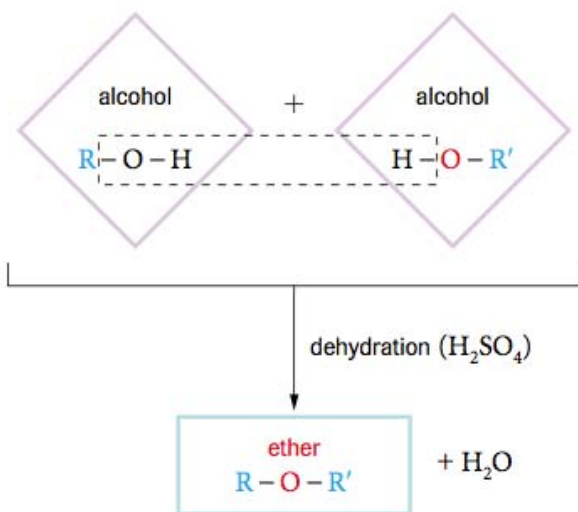


Name each type of reaction. Then predict and name the products.

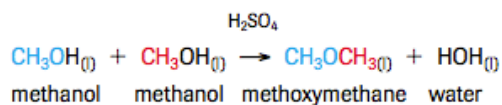


## Reactions of Ethers

- Condensation Reactions (requires catalyst)



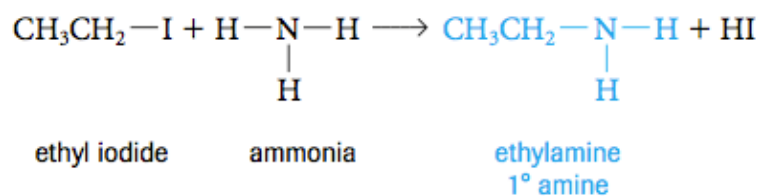
Example:





# Reactions of Amines

- Alkyl Halide + Ammonia



- The 1° amine can be further reacted with alkyl halides to form 2° and 3° amines

