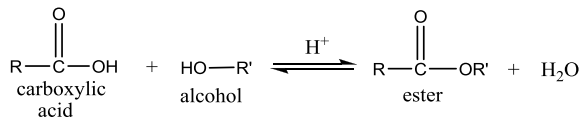


## ESTERS

### Introduction

- The product of the reaction between a carboxylic acid and an alcohol is called an ester.



Esterification reaction is very similar to neutralization reaction.

### 1. Esters

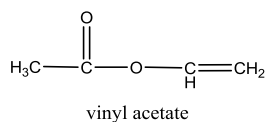
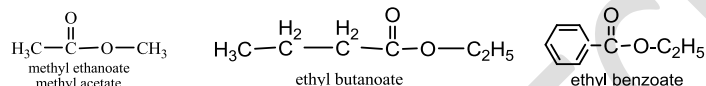
- Esters are alkyl salts of carboxylic acids.
- RCOOR is general formula of esters.
- General representation is  $\text{R}-\overset{\text{O}}{\parallel}{\text{C}}-\text{O}-\text{R}'$
- Esters with low molecular weight are commonly used as fragrances found in essential oils.
- The preparation of an ester is known generally as an esterification reaction.

### Example 1

- What is the formula of an ester which has a molecular weight of 116 g? Assume that the alcohol and acid portions of the ester contain equal number of carbon atoms.

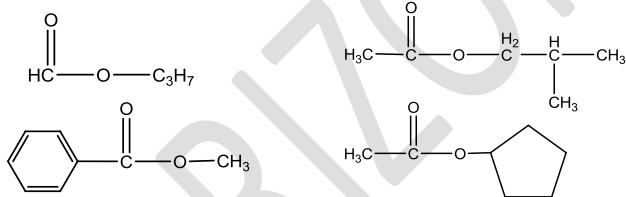
### 2. Nomenclature of Esters

- Alcohol group is named first, followed by the name of corresponding acid.
- The “-ic acid” ending is changed to “-oate”.



### Example 2

Name the following compounds



### Example 3

Draw the structures of following esters.

- n-pentyl acetate
- propyl benzoate
- isopropyl butanoate
- cyclopropyl methanoate

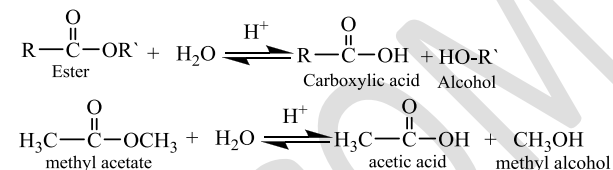
### 3. Physical Properties of Esters

- Low molecular weights have pleasant smelling.
- They are obtained from flowers and fruits.
- They are responsible for the flavor and fragrances of many fruits and flowers.

- They are used as perfumes and artificial flavors in foods and drinks. For example, ethyl acetate gives apple flavor and propyl acetate smells like pears.
- They cannot form hydrogen bond so they have low boiling points.
- They are soluble in water.
- Liquid esters are good organic solvents, such as nitrocellulose, it is used to dissolve resins and plastics.

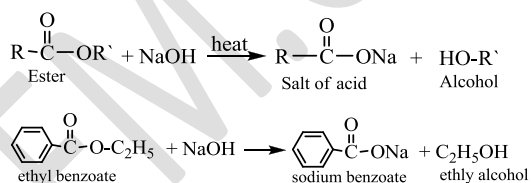
## 4. Chemical Properties of Esters

### 1. Hydrolysis of Esters

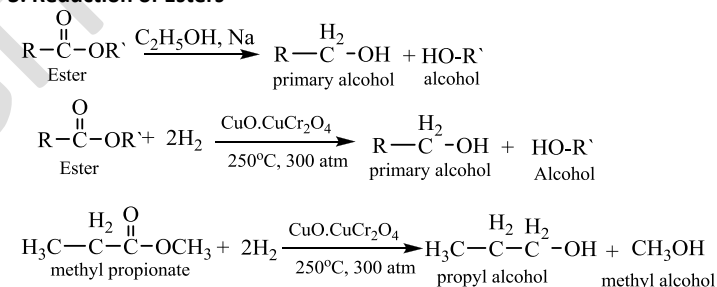


### 2. Saponification of Esters

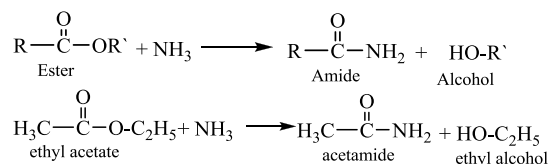
- When esters are heated with aqueous solutions of strong bases such as NaOH and KOH, salts of carboxylic acids are produced, of which reaction is called saponification.



### 3. Reduction of Esters



### 4. Reaction with Ammonia



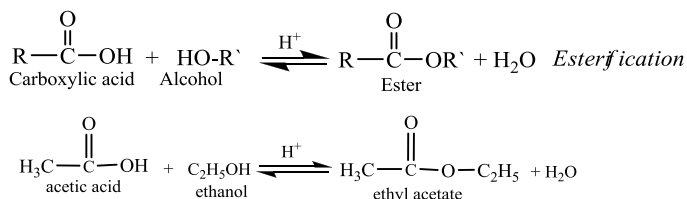
### Example 4

What products would result from treating ethyl propanoate With

- H<sub>2</sub>O
- NaOH
- NH<sub>3</sub>
- H<sub>2</sub> (in the presence of copper chromide catalyst)

## 5. Preparation of Esters

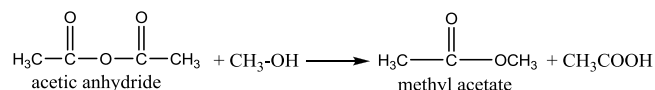
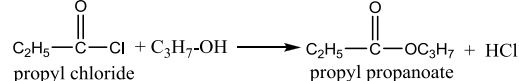
### 1. From Carboxylic Acid and Alcohols



### Example 5

How many mL of 0.5 M acetic acid solution are required to produce 17.6 g ethyl acetate?

### 2. From Carboxylic Acid Derivatives



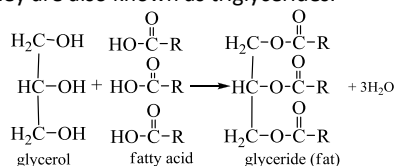
### Example 6

Give the structure and name of the ester formed from

- butyl alcohol and benzoic acid
- benzyl alcohol and butyric acid
- allyl alcohol and acetic anhydride
- isopropyl alcohol and propionyl chloride
- benzoyl chloride and ethyl alcohol

### 6. Fats

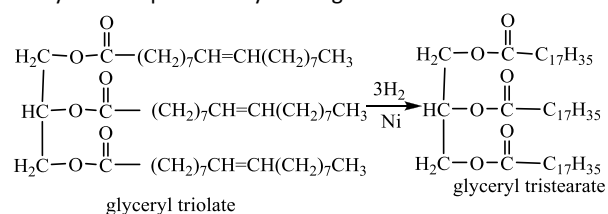
- Fats are esters of fatty acids and glycerine.
- They are also known as triglycerides.



- Fats and oils, carbohydrates, and proteins are the three major kinds of foodstuff, but fats and oils provide the most calories per gram.
- They have many uses in industry for the manufacture of soaps, synthetic detergents, glycerol, drying oils, oilcloth, paints, and varnishes.
- Fats are solid esters of glycerol, and oils are liquid esters of glycerol (at room temperature).
- If the R groups are saturated the glycerol esters are mostly solids. In contrast, oils contain many double bonds.
- If the acid parts of fat are all the same it is called simple glyceride. If they are different it is known as complex.
- Pure fats contain around 95% triglycerides. The remaining are mono and diglycerides, glycerine, some free fatty acids, vitamins and minerals to give color and taste.
- According to source there are animal fats extracted from suet and fish, and vegetable fats from olive, corn, cotton, sunflower, soybean, sesame, peanut, hazelnut, dates almonds, and coconuts.

### 7. Hydrogenation and Margarines

- Vegetable oils, which are highly unsaturated, can be converted into solid vegetable oils, called margarines, by catalytically hydrogenating some or all the double bonds. This process is called hardening. It is carried by passing hydrogen through them in the presence of Ni catalyst under pressure by heating.



### 8. Saponification

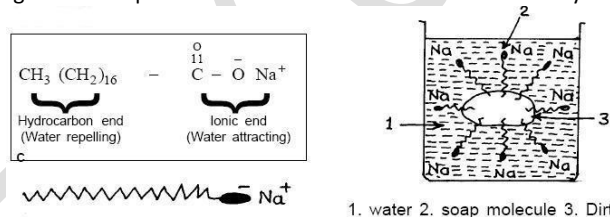
- Hydrolysis of glycerides in basic medium leads glycerol and a mixture of salts of long chained carboxylic acids. This mixture is soap and the process is called saponification.
- The most widely used ordinary soaps are sodium salts. Potassium salts form soaps which are softer and more soluble. Aluminum salts are gels which can be used as thickeners for lubricating greases.

### 9. Cleaning Process of Soaps

- In the soap molecule, one end is highly polar or ionic, whereas the other end is highly non polar. The ionic end has a great tendency to dissolve in water. It is hydrophilic (water loving). The carbon chain tends to be very insoluble in water but soluble in fats and oils. It is hydrophobic (water hating).



- Soap micelles absorb grease molecules into their interiors so that the grease is suspended in the water and can be washed away.



- The  $\text{Ca}^{+2}$  and  $\text{Mg}^{+2}$  salts of fatty acids are insoluble in water, they are called marble salts.
- Magnesium oleate is insoluble in water and soluble in organic solvents, hence it can be used for dry cleaning.
- Lead stearate is used in the production of salve.
- Aluminum stearate is used in the production of water resistant clothes.

### 10. Detergents

- Detergents are artificial soaps.
- The most common detergent is alkyl benzene sulfanates (ABS) and alkyl sulfates (AS).
- Synthetic detergents are more active cleaners than soaps. They do not precipitate with  $\text{Ca}^{+2}$  and  $\text{Mg}^{+2}$  ions in hard water.
- They do not have basic character like soaps.

