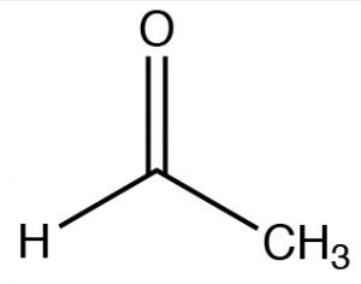
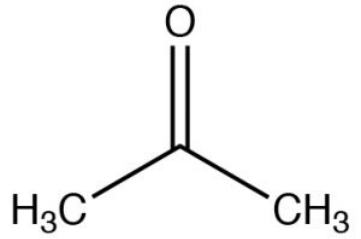
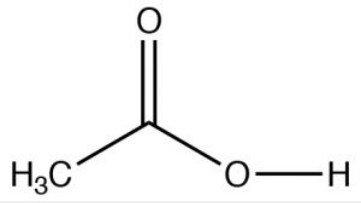
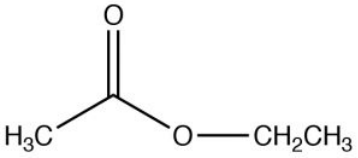
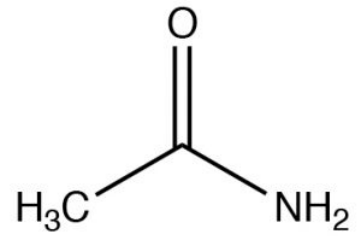
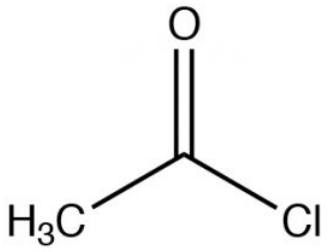
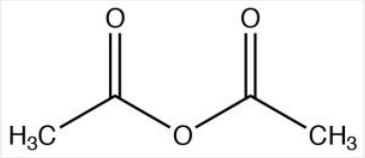
CHAPTER OVERVIEW

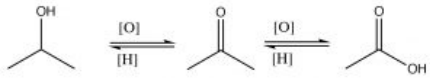
7: Nucleophilic attack at the carbonyl carbon-

There is a set of organic compounds that incorporates the carbonyl group ($C=O$) which includes aldehyde ketones, carboxylic acids, and carboxylic acid derivatives such as: esters, amides, acid anhydrides, and acid chlorides (as shown in Table $7.0.1$).

Table $7.0.1$: Functional groups that contain a carbonyl group

Functional Group	Example	Name
Aldehyde		Longest chain with aldehyde: remove -ane, add -al Ethanal (IUPAC)[1] Acetaldehyde
Ketone		Longest chain: remove -e, add -one 2-propanone (IUPAC) Acetone
Carboxylic Acid		Longest chain with CO_2H: remove -e, add -oic acid Ethanoic acid (IUPAC) Acetic acid
Ester		Named as a derivative of the CO_2H, remove -icacid and -ateEthyl ethanateEthyl acetate
Amide		Named as a derivate of the CO_2H, remove -icacid, add -amideEthanamideAcetamide

Acid chloride		Named as a derivate of the CO_2H, remove -icacid, add -yl chloride (or other halide)Ethanoyl chlorideAcetyl chloride
Acid anhydride		Named as a derivative of the CO_2H, remove “acid” and add “anhydride” Ethanoic anhydride Acetic anhydride



These functional groups have a number of similarities and some notable differences in their properties, which can be predicted on the basis of our understanding of structure and function relationships. These carbonyl compounds can be classified into two broad groups:

1. ketones and aldehydes and
2. carboxylic acids and derivatives (amide, chloride, ester, and anhydride).

These two, broad groups differ in the oxidation level of the carbonyl carbon: aldehydes and ketones have two bonds to the electronegative oxygen; acids and derivatives have three bonds to electronegative atoms (O, N or Cl); and, of course, alcohols only have one bond. Interconverting between alcohols, ketones, and carboxylic acids involves some kind of redox reaction. We have already discussed the alcohol to ketone (or aldehyde) transformation and, later, we will discuss further oxidation to the acid level.

As we discussed in Chapter 6, the carbonyl carbon is highly polarized; the large σ^+ on the carbon makes it susceptible to nucleophilic attack. There are a large number of reactions that begin by the attack of a nucleophile on a carbonyl group. To make understanding these reactions more manageable (intelligible), we will consider these reactions in a sequence of increasing complexity, beginning with reactions of aldehydes and ketones.[2] We will then cycle back around and visit similar reactions involving acids and their derivatives.