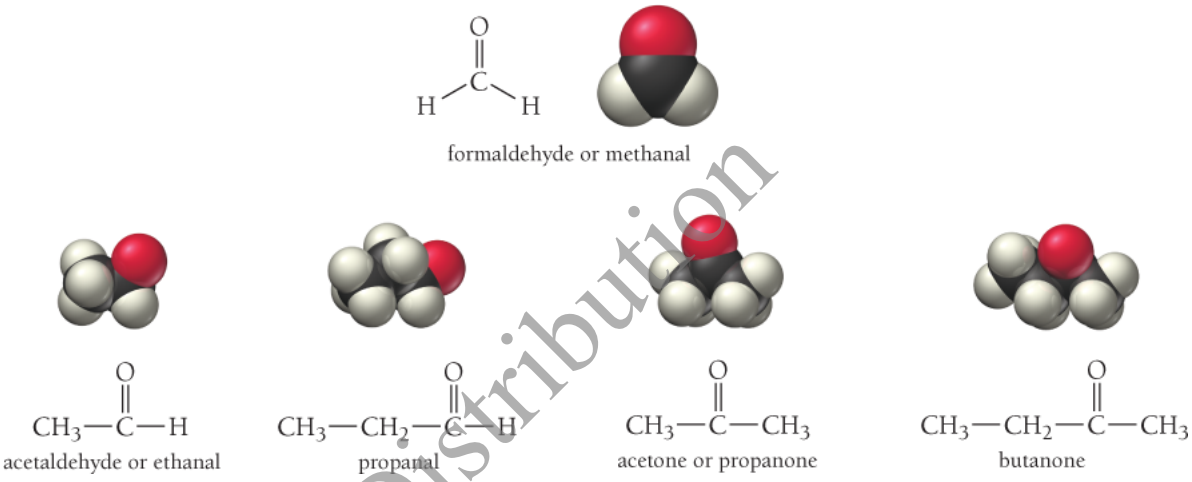
Pearson

21.10: Aldehydes and Ketones

Aldehydes and **ketones** (shown in Figure 21.6) have the following general formulas:

The condensed structural formula for aldehydes is RCHO; for ketones it is RCOR.

Figure 21.6 Common Aldehydes and Ketones



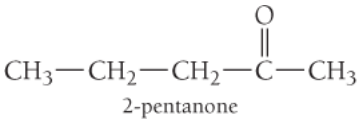
The functional group for both aldehydes and ketones is the **carbonyl group**:

Ketones have an R group attached to both sides of the carbonyl, while aldehydes have one R group and a hydrogen atom. (An exception is formaldehyde, which is an aldehyde with two H atoms bonded to the carbonyl group.)

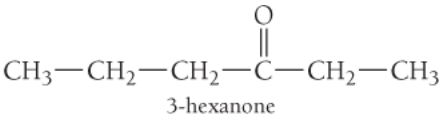
Naming Aldehydes and Ketones

Many aldehydes and ketones have common names that we can learn only by becoming familiar with them, but we can systematically name simple aldehydes according to the number of carbon atoms in the longest continuous carbon chain that contains the carbonyl group. We form the base name from the name of the corresponding alkane by dropping the *-e* and adding the ending *–al*:

We name simple ketones according to the longest continuous carbon chain containing the carbonyl group, forming the base name from the name of the corresponding alkane by dropping the letter *-e* and adding the ending *-one*. For ketones, we number the chain to give the carbonyl group the lowest possible number:



2-pentanone



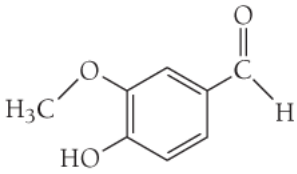
3-hexanone

About Aldehydes and Ketones

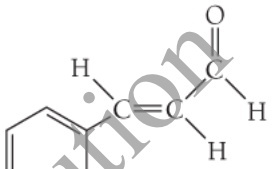
The most familiar aldehyde is probably formaldehyde, shown earlier in this section. Formaldehyde is a gas with a pungent odor. It is often mixed with water to make *formalin*, a preservative and disinfectant. Formaldehyde is also found in wood smoke, which is one reason smoking is an effective method of food preservation—the formaldehyde kills bacteria. Aromatic aldehydes, those that also contain an aromatic ring, have pleasant aromas. For example, vanillin causes the smell of vanilla, cinnamaldehyde is the sweet-smelling component of cinnamon, and benzaldehyde accounts for the smell of almonds (Figure 21.7).

Figure 21.7 The Nutty Aroma of Almonds

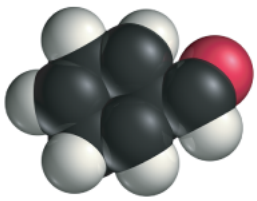
Benzaldehyde is partly responsible for the smell of almonds.

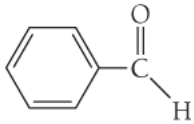


vanillin



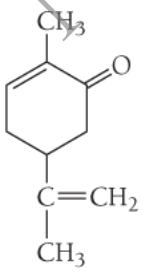
cinnamaldehyde



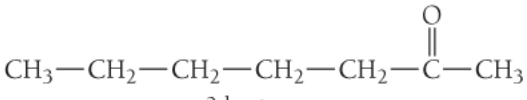


benzaldehyde

The most familiar ketone is acetone, the main component of nail polish remover. Other ketones have more pleasant aromas. For example, carvone is largely responsible for the smell of spearmint, 2-heptanone (among other compounds) for the smell of cloves, and ionone for the smell of raspberries (Figure 21.8).



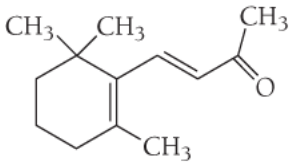
carvone



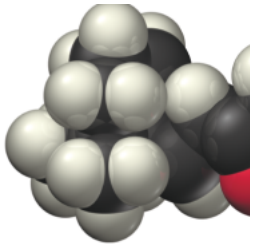
2-heptanone

Figure 21.8 The Fragrance of Raspberries

Ionone is partly responsible for the smell of raspberries.

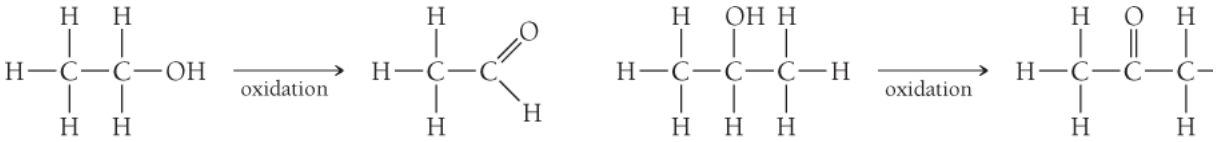


ionone



Aldehyde and Ketone Reactions

Aldehydes and ketones can form from the *oxidation* of alcohols. For example, ethanol can be oxidized to ethanal, and 2-propanol can be oxidized to 2-propanone (or acetone):



ethanol ethanal 2-propanol 2-propanone

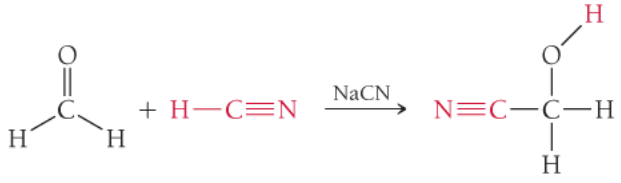
In the reverse reaction, an aldehyde or ketone is reduced to an alcohol. For example, 2-butanone can be reduced to 2-butanol in the presence of a reducing agent:

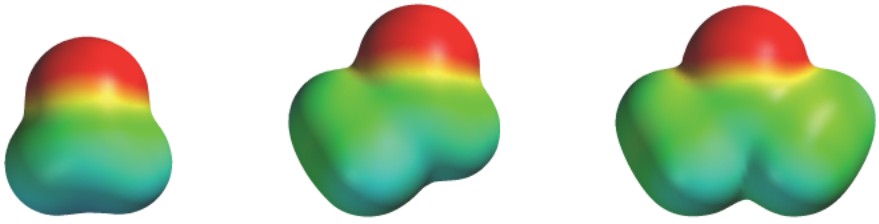
2-butanone 2-butanol

The carbonyl group in aldehydes and ketones is unsaturated, much like the double bond in an alkene. Because of this feature, the most common reactions of aldehydes and ketones are addition reactions. However, in contrast to the carbon–carbon double bond in alkenes, which is nonpolar, the double bond in the carbonyl group is highly polar (Figure 21.9). Consequently, additions across the double bond result in the more electronegative part of the reagent bonding to the carbon atom and the less electronegative part (often hydrogen) bonding to the oxygen atom. For example, HCN adds across the carbonyl double bond in formaldehyde.

Figure 21.9 Electrostatic Potential Maps of the Carbonyl Group

Members of the carbonyl group are highly polar, as shown in these plots of electrostatic potential.




formaldehyde acetaldehyde acetone