







UV-Vis spectroscopy provides information about compounds with conjugated double bonds. Ultraviolet light and visible light have just the right energy to cause an electronic transition—the promotion of an electron from one orbital to another of higher energy. Depending on the energy needed for the electronic transition, a molecule will absorb either ultraviolet or visible light. If it absorbs ultraviolet light, a UV spectrum is obtained; if it absorbs visible light, a visible spectrum is obtained. Ultraviolet light is electromagnetic radiation with wavelengths ranging from 180 to 400 nm (nanometers); visible light has wavelengths ranging from 400 to 780 nm. (One nanometer is  $10^{-9}$  m, or 10 Å.) Wavelength ( $\lambda$ ) is inversely related to the energy: The shorter the wavelength, the greater is the energy. Ultraviolet light, therefore, has greater energy than visible light.

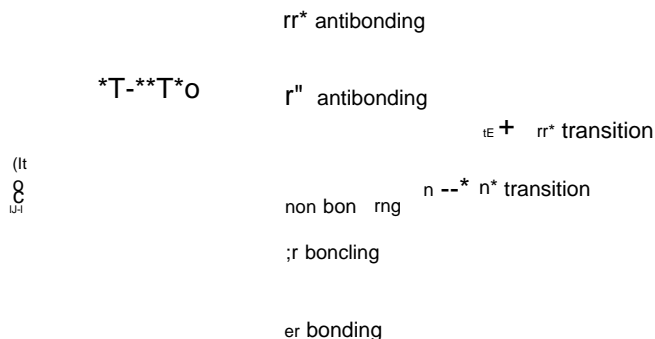
The shorter the wavelength, the greater is the energy of the radiation.

$$E = \frac{hc}{\lambda}$$

$h$  = Planck's constant  
 $c$  = velocity of light  
 $\lambda$  = wavelength

The normal electronic configuration of a molecule is known as its ground state—all the electrons are in the lowest-energy molecular orbitals. When a molecule absorbs light of an appropriate wavelength and an electron is promoted to a higher energy molecular orbital, the molecule is then in the excited state. Thus, an electronic transition is the promotion of an electron to a higher energy MO. The relative energies of the bonding, nonbonding, and antibonding molecular orbitals are shown in Figure 8.5.

Figure 8.5 Relative energies of the bonding, nonbonding, and antibonding orbitals.



Ultraviolet and visible light have sufficient energy to cause only the two electronic transitions shown in Figure 8.5. The electronic transition with the lowest energy is the promotion of a nonbonding (lone-pair) electron ( $n$ ) into a  $\pi^*$  antibonding molecular orbital. This is called an  $n \rightarrow \pi^*$  (stated as "n to pi star") transition. The higher energy electronic transition is the promotion of an electron from a  $\pi$  bonding molecular orbital into a  $\pi^*$  antibonding molecular orbital, known as a  $\pi \rightarrow \pi^*$  (stated as "pi to pi star") transition. This means that only organic compounds with  $\pi$  electrons can produce UV-Vis spectra.

The UV spectrum of acetone is shown in Figure 8.6. Acetone has both  $\pi$  electrons and lone-pair electrons. Thus, there are two absorption bands: one for the  $n \rightarrow \pi^*$

Figure 8.6 The UV spectrum of acetone.

