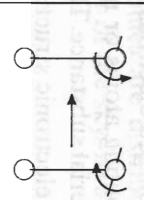
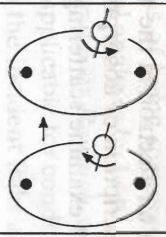
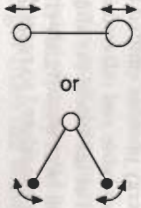
Table 2.1 The major regions of the electromagnetic spectrum and their interactions with matter

Change of spin		Change of atomic orientation	Change of atomic configuration	Change of electron distribution			Change of nuclear configuration
Nuclear magnetic resonance	Electron spin resonance	Microwave	Infra-red	Visible and ultra-violet		X-ray	γ-ray
							
	10^{-2}	1	100	Wavenumber	10^{4}	cm^{-1}	10^{6}	10^{8}
10^{77}	10^{9}	10^{7}	10^{5}	Wavelength	10^{3}	nm	10	0.1
3×10^{6}	3×10^{8}	3×10^{10}	3×10^{12}	Frequency	3×10^{14}	s^{-1}	3×10^{16}	3×10^{18}
10^{-3}	10^{-1}	10	10^{3}	Energy	10^{5}	joules/mole	10^{7}	10^{9}
10^{-4}	10^{-3}	10^{-2}	0.1	Energy	1	electron/volts	10	100

(Modified from Branwell, McCash, 1994)

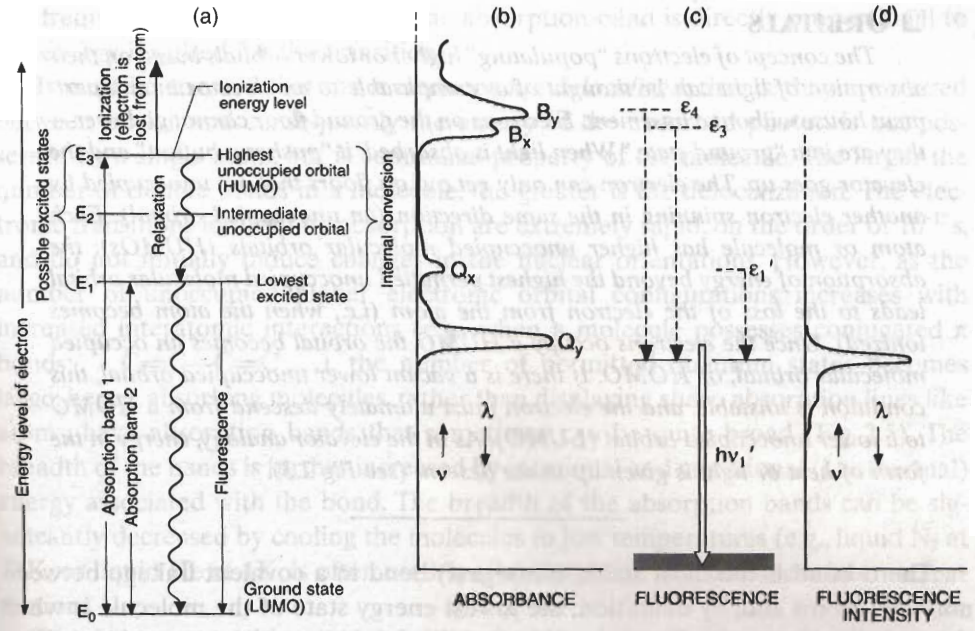


Figure 2.3 Energy-level diagram showing excited states of an electron. Upon absorption of a photon, an electron populates an unoccupied orbital to form an excited state. There are numerous possible excited states (ϵ_1, ϵ_2, ϵ_3, etc.); the specific one induced is dictated by the energy of the absorbed photon ($h\nu_1$, $h\nu_2$, $h\nu_3$, etc.). Absorption of a photon with energy in excess of nuclear attraction leads to a loss of the electron, in a process called *ionization*. Electrons brought to higher excited states but retained within the atom or molecule return to lower excited states via nonradiative relaxation processes, where the energy is lost as heat. Electrons may return from the lowest excited state to the ground state via the emission of a photon. If the spin direction of the electron is maintained from the ground state to the excited state, the photon emission is called *fluorescence*. If the spin direction is reversed, the electron must "flip" its spin state before it can return to the ground state. The spin reversal takes more time than that for a direct return, but, as with fluorescence, may be accompanied by the emission of a photon; this process is called *luminescence* or *phosphorescence*.

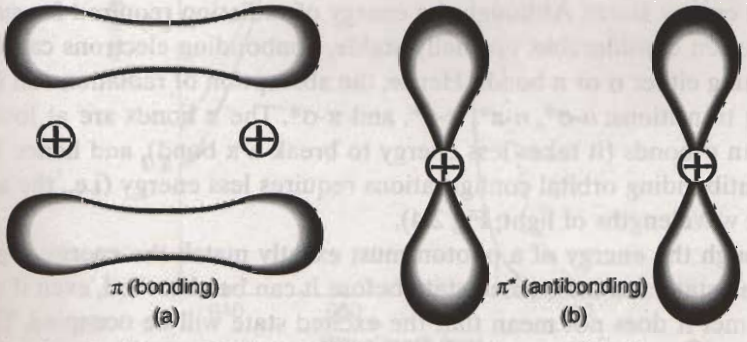


Figure 2.4 A schematic diagram showing bonding and antibonding π orbitals. The nuclei of the two atoms are represented by a + symbol, and the probability density distribution of the electrons is represented by the shaded cloud. A bonding configuration is represented in panel (a). Absorption of electromagnetic radiation by the molecule promotes antibonding configurations, represented by panel (b).