Ch. 11. Molecular Structure

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Bonding Mechanism

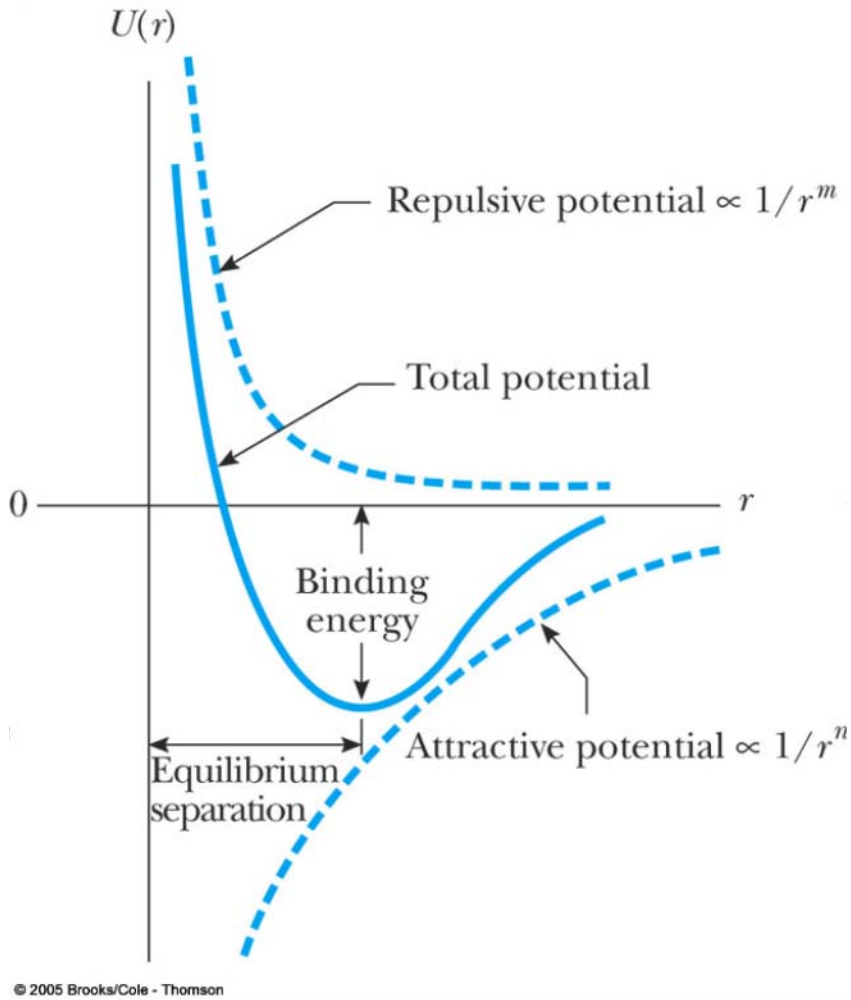


Fig. 11-1, p.373

Ionic Bonding

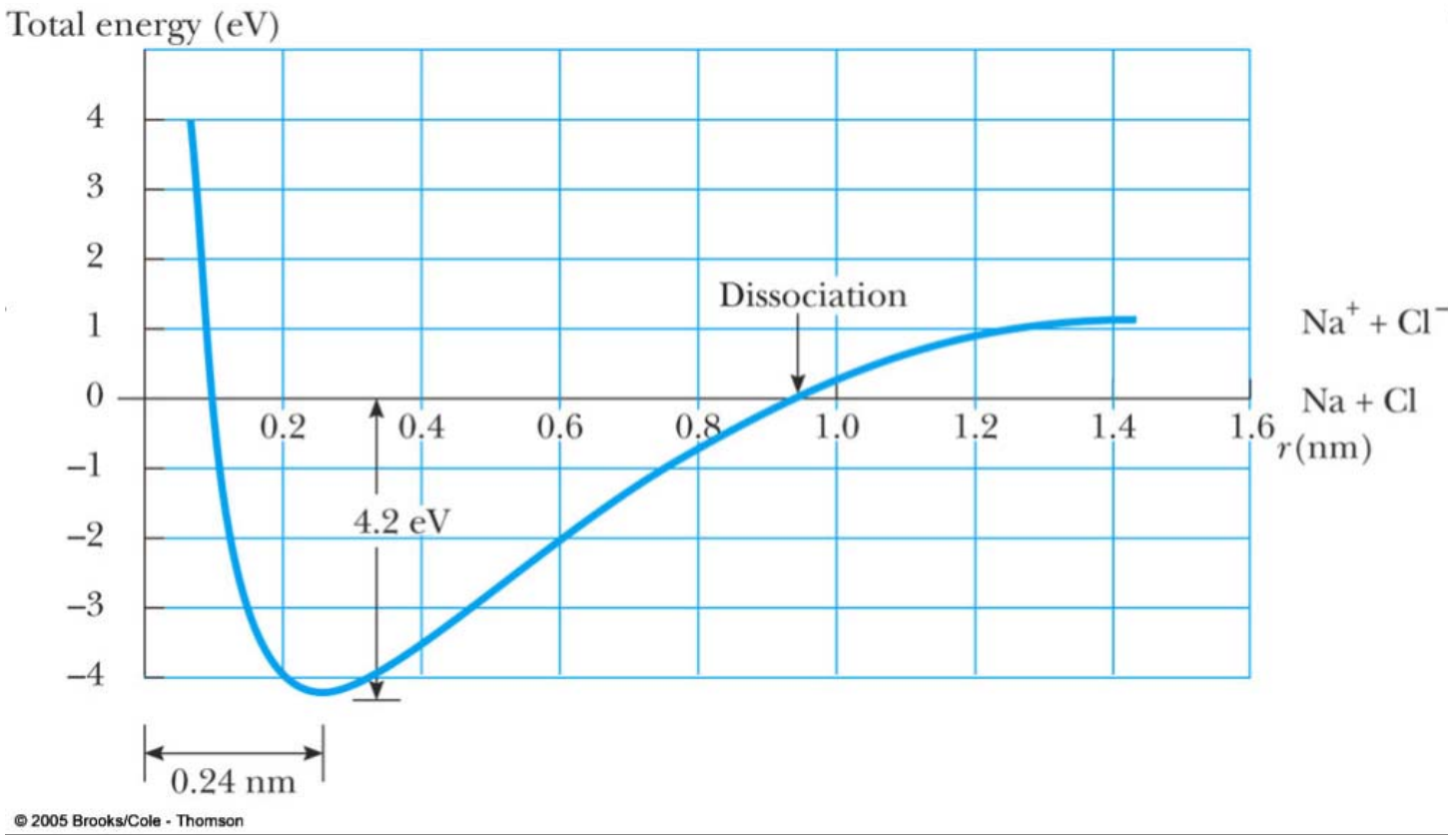


Fig. 11-2, p.375

Covalent Bonding

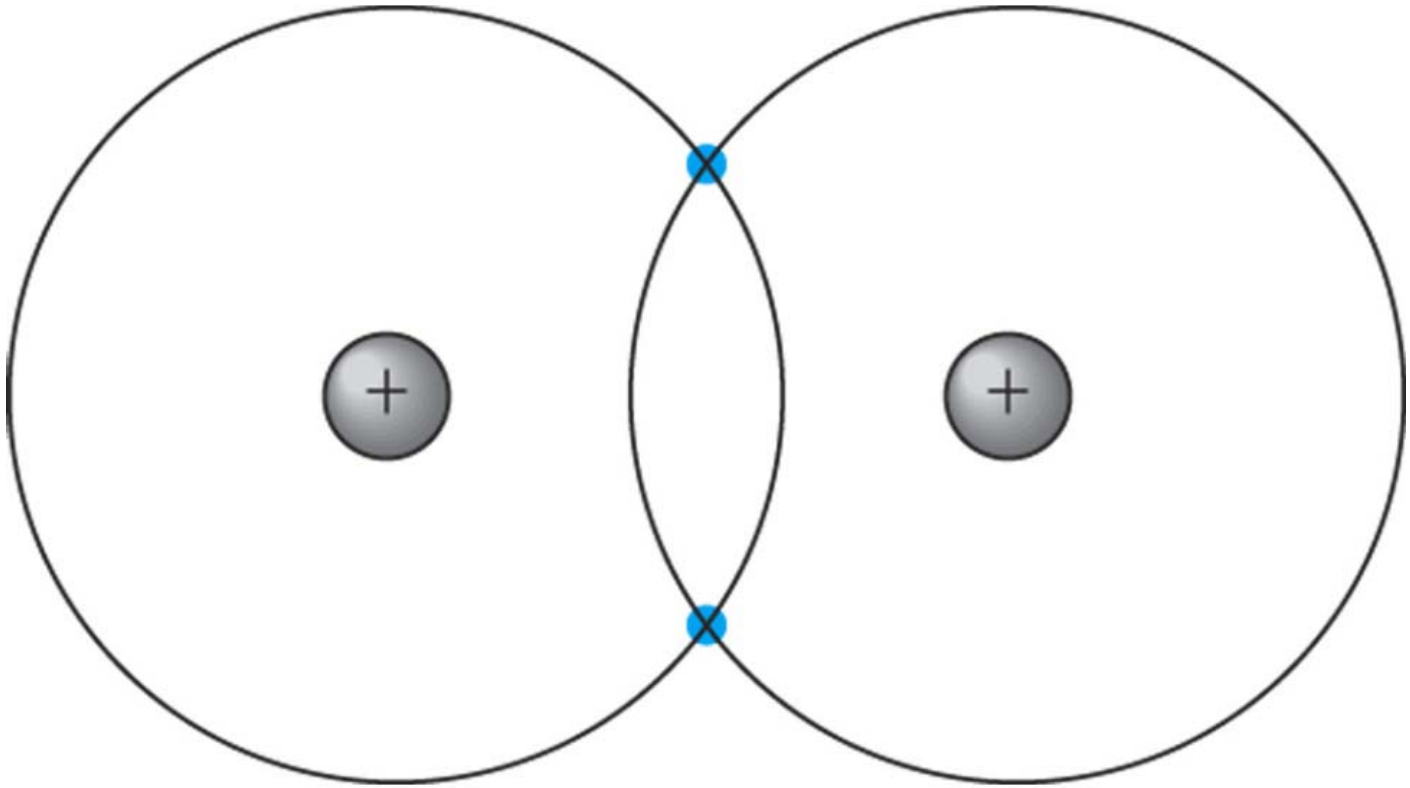


Fig. 11-3, p.375

Covalent Bonding

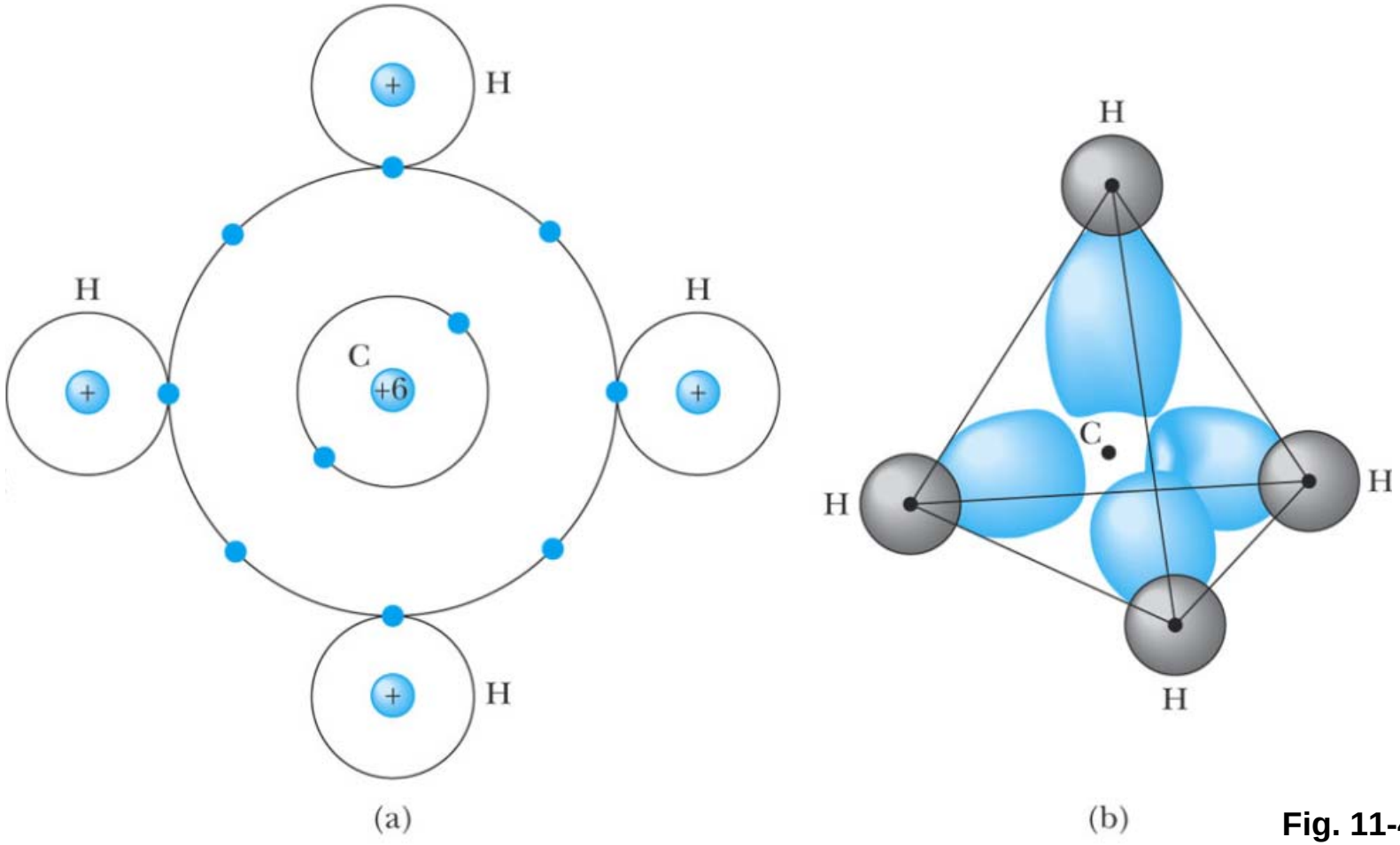


Fig. 11-4, p.376

Van der Waals Force

- Dipole-dipole force
- Dipole-induced force
- Dispersion force

Hydrogen Bonding

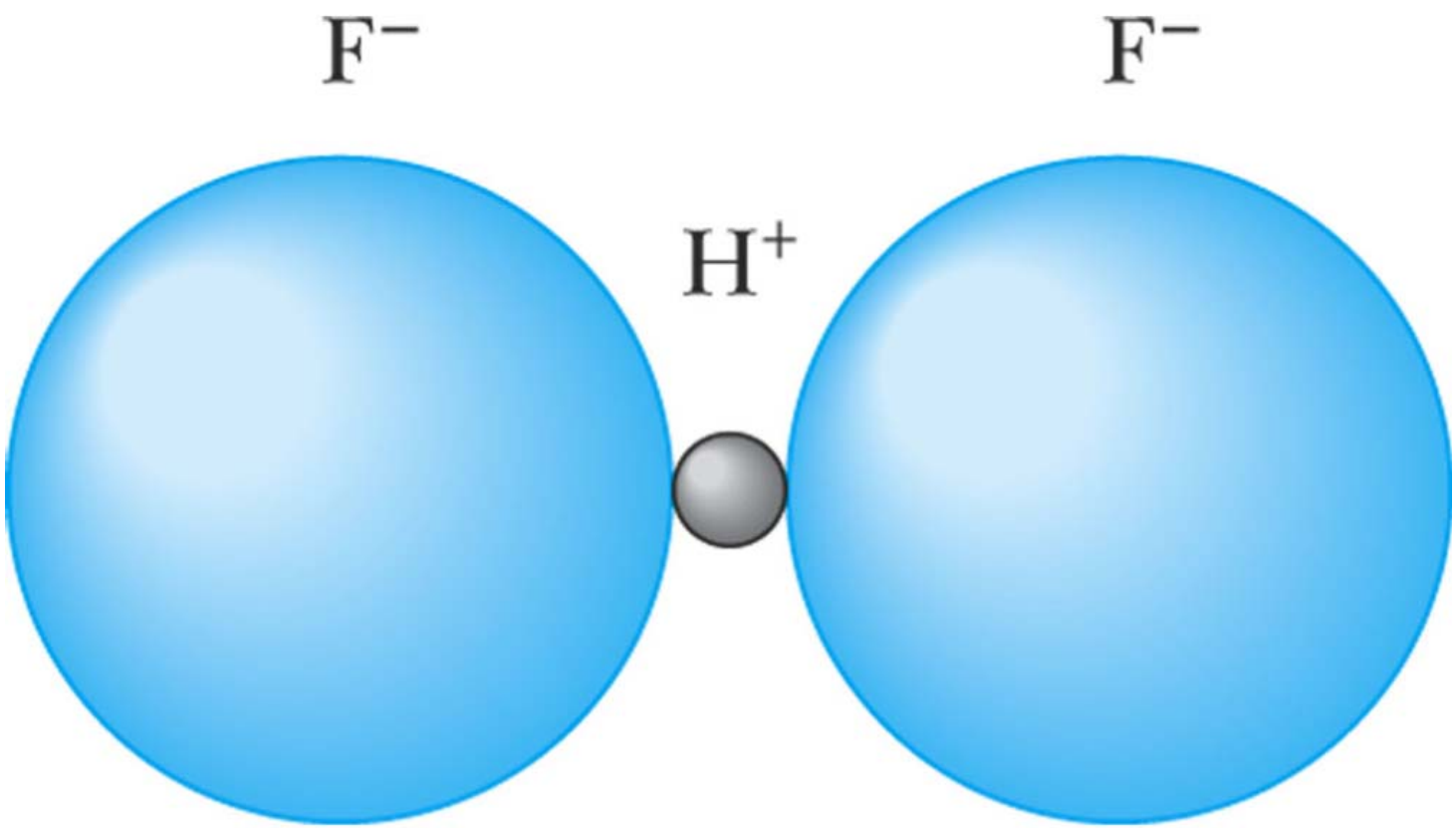
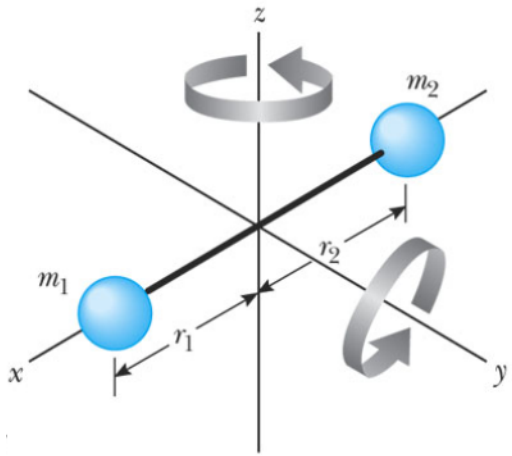


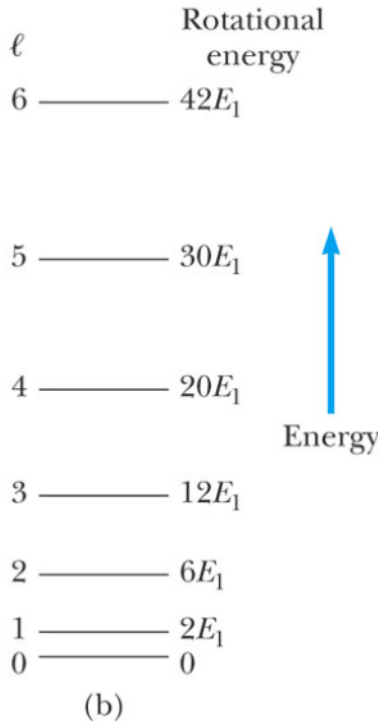
Fig. 11-5, p.377

Molecular Rotation

$$E_l = \frac{\hbar^2}{2I}$$



(a)



(b)

Fig. 11-6, p.378

Molecular Rotation

$$L = m_1 v_1 r_1 + m_2 v_2 r_2 = \left(m_1 r_1^2 + m_2 r_2^2 \right) \omega = I \omega$$

$$E_{rot} = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2} I \omega^2 = \frac{L^2}{2I}$$

$$I_{CM} = \frac{m_1 m_2}{m_1 + m_2} \left(r_1 + r_2 \right)^2 = \mu R_o^2$$

$$L^2 = l(l+1)\hbar^2 \qquad l = 0, 1, 2, \cdots$$

$$E_{rot} = \frac{\hbar^2}{2 I_{CM}} l(l+1)$$

Molecular Vibration

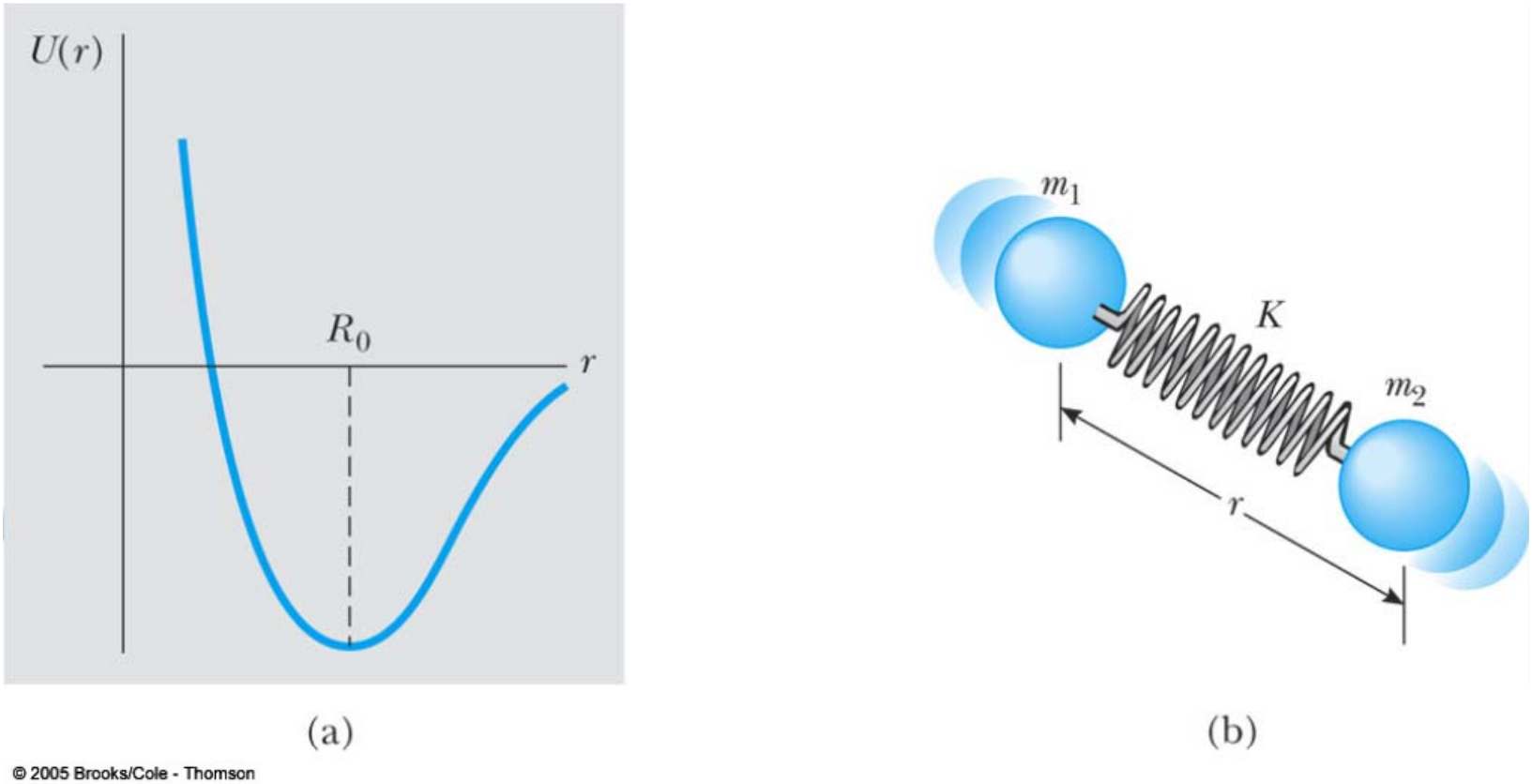


Fig. 11-7, p.381

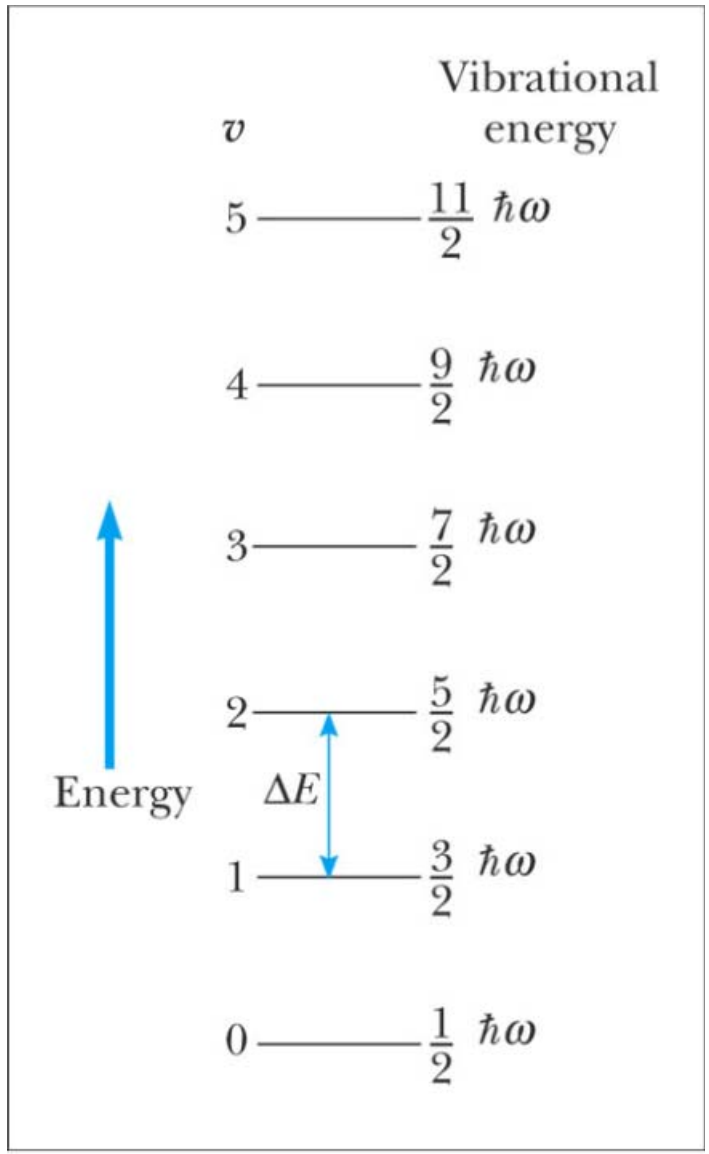


Fig. 11-8, p.382

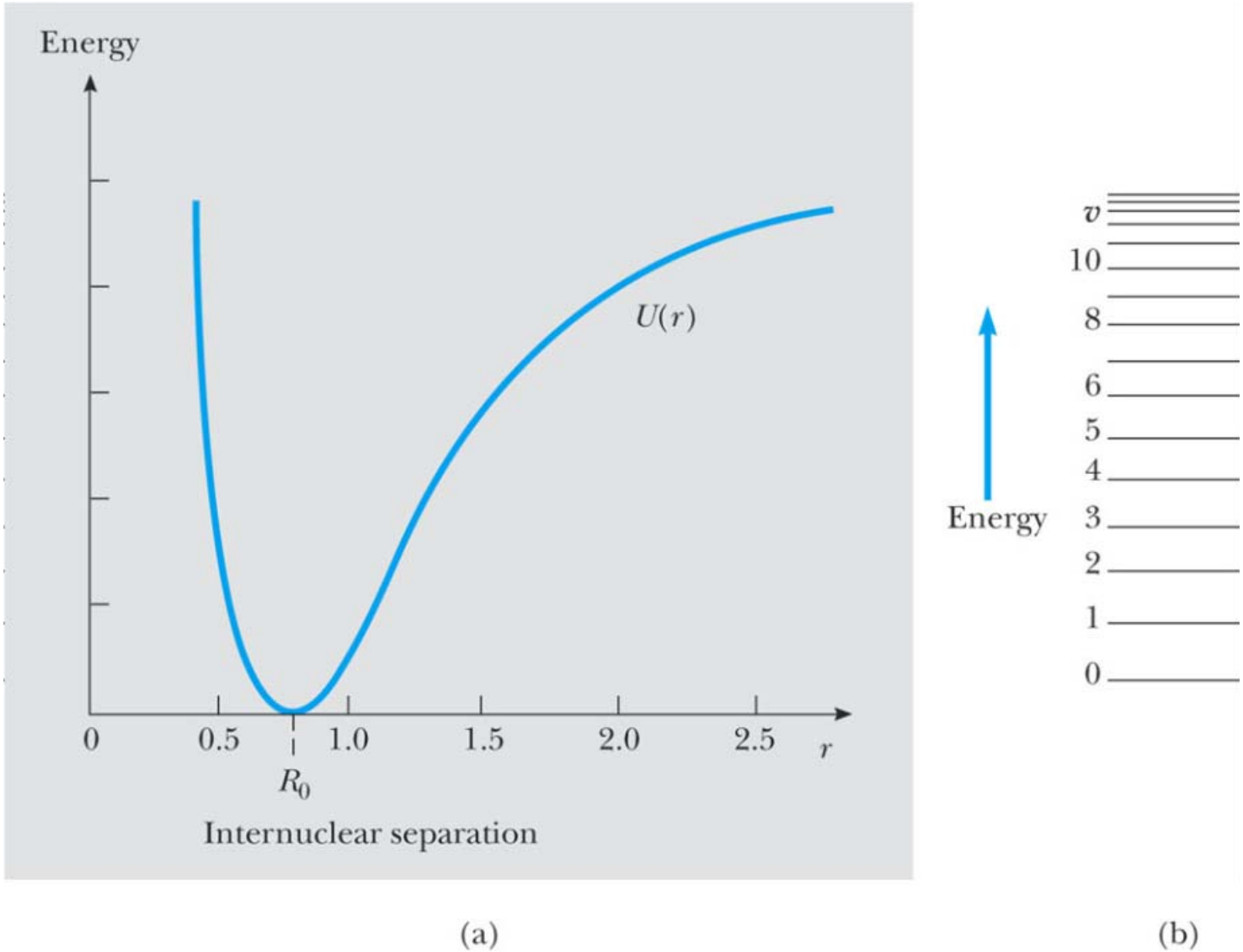


Fig. 11-9, p.384

Rotation + Vibration

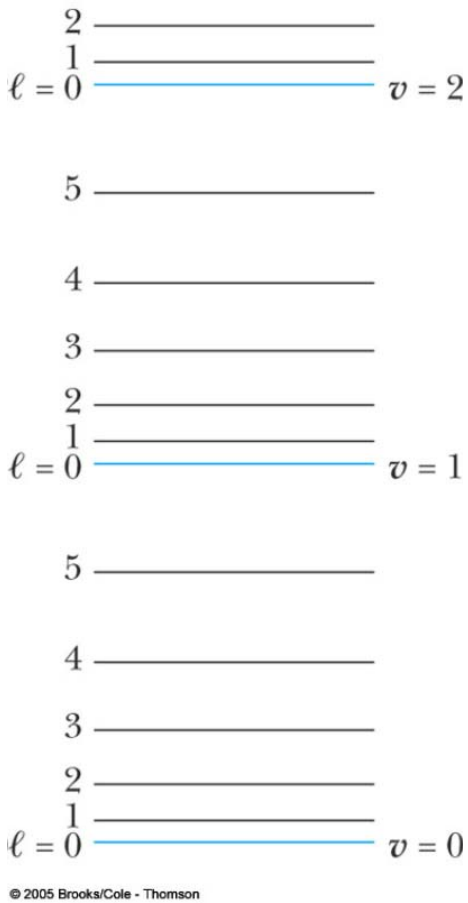


Fig. 11-10, p.385

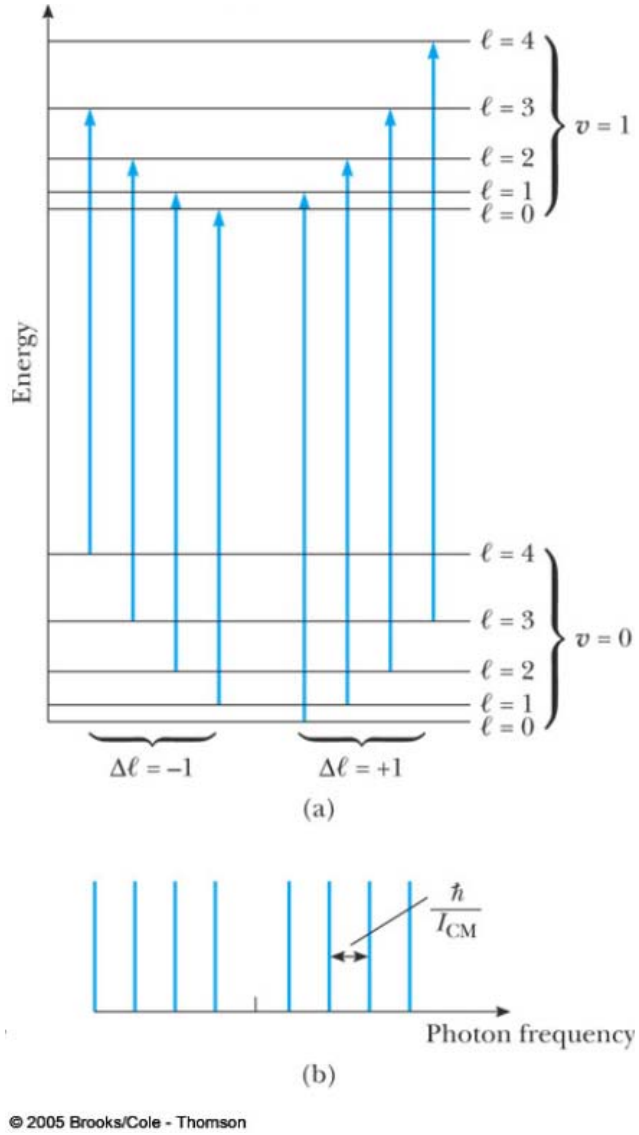


Fig. 11-11, p.387

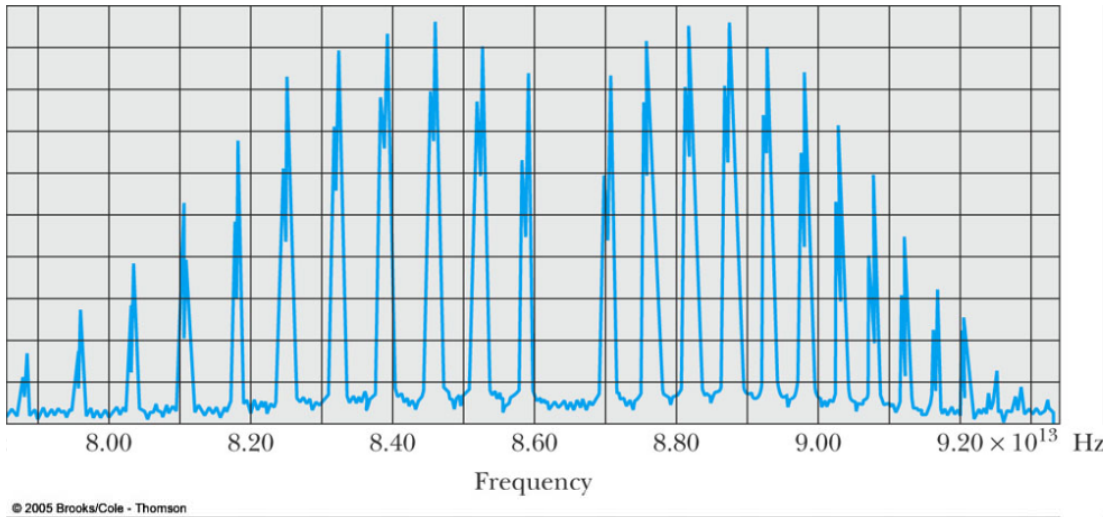
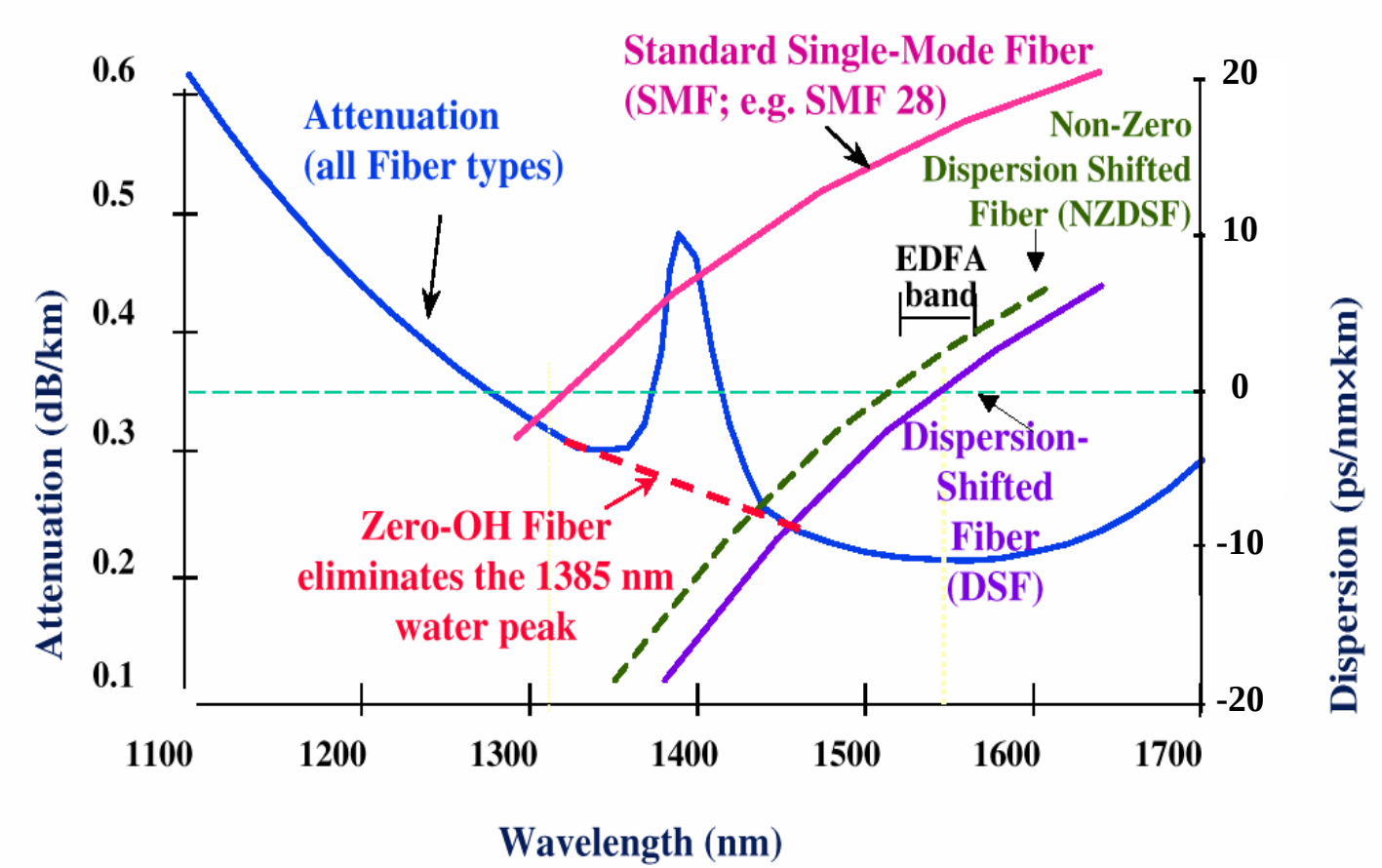


Fig. 11-12, p.387

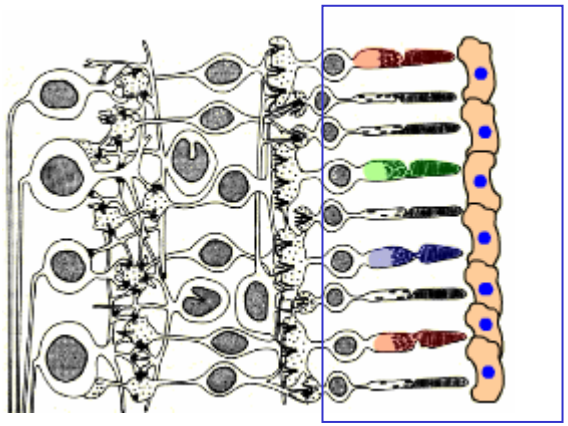
Rayleigh

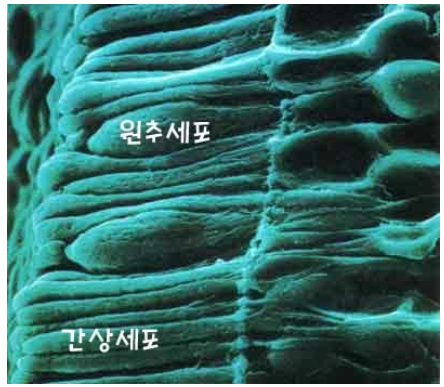
Lord Rayleigh
(John William Strutt)
(1842 - 1919)

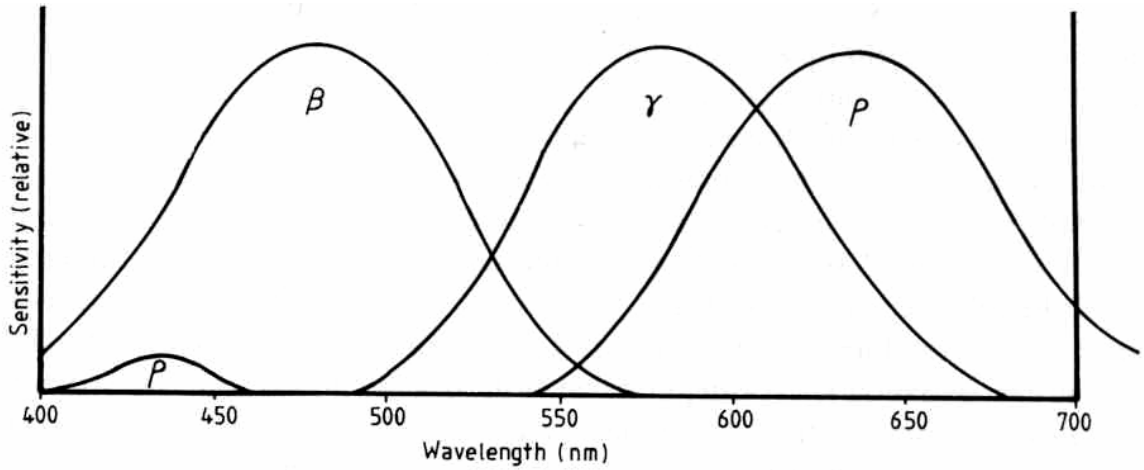
광섬유의 특성


Standard Single-Mode Fiber
(SMF; e.g. SMF 28)
Attenuation
(all Fiber types)
Non-Zero
Dispersion Shifted
Fiber (NZDSF)
EDFA
band
Dispersion-
Shifted
Fiber
(DSF)
Zero-OH Fiber
eliminates the 1385 nm
water peak
Attenuation (dB/km)
0.6
0.5
0.4
0.3
0.2
0.1
20
10
0
-10
-20
Dispersion (ps/nm×km)
1100
1200
1300
1400
1500
1600
1700
Wavelength (nm)

빛의 파장에 따른 사람 눈의 원추 세포의 반응도







Raman

Venkata Raman
(1888 - 1970)

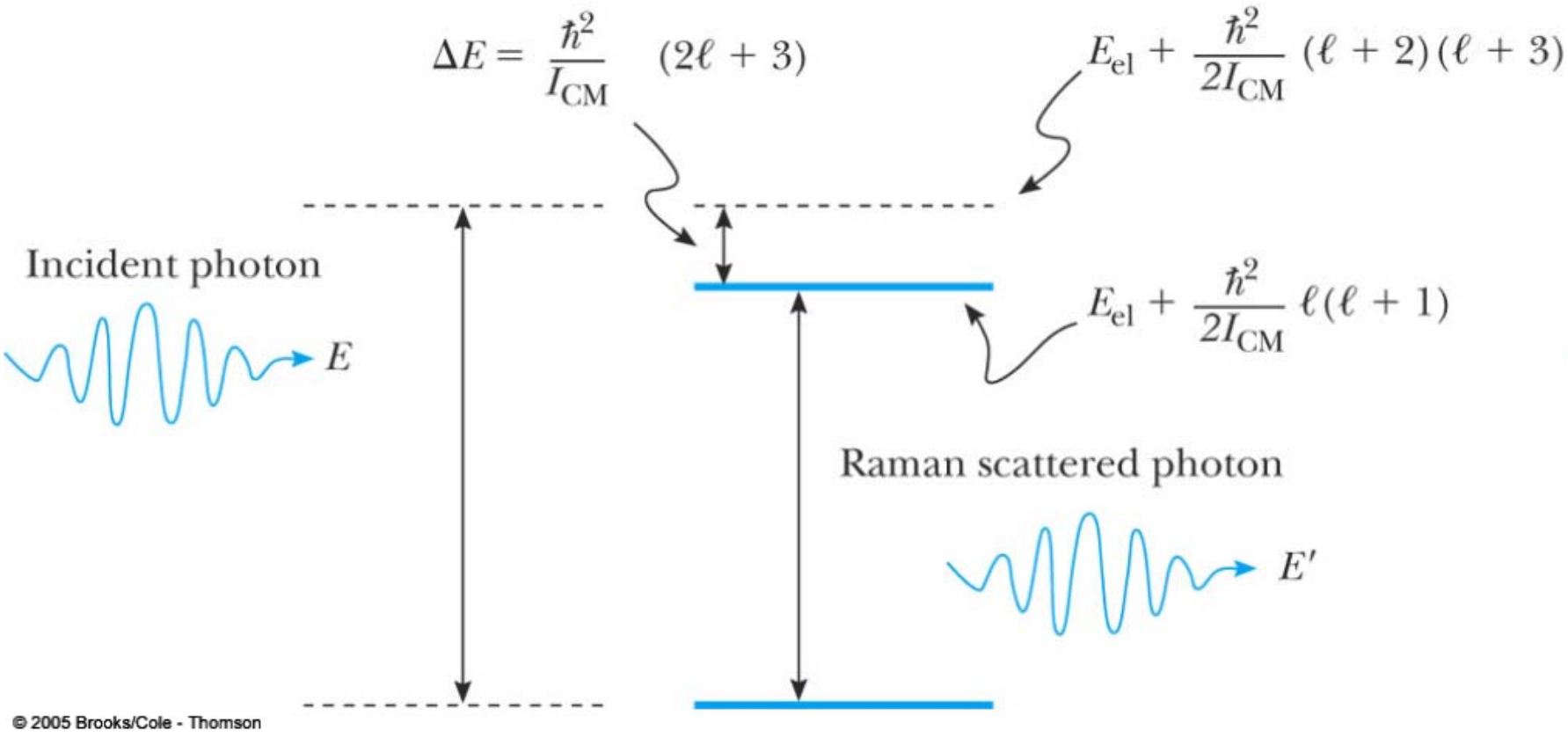
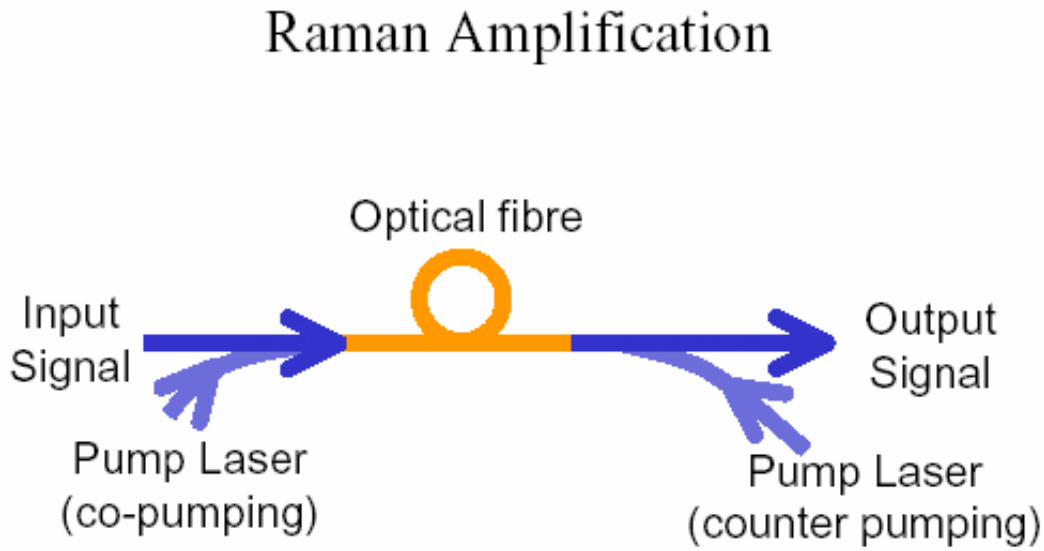


Fig. 11-13, p.388

Fiber Raman Amplifier



Raman amplification requires no special doping in the optical fiber.
It is usually accomplished as “distributed amplification”
- that is, it happens throughout the length of the actual transmission fiber, rather than all in one place in a small box.

Fluorescence

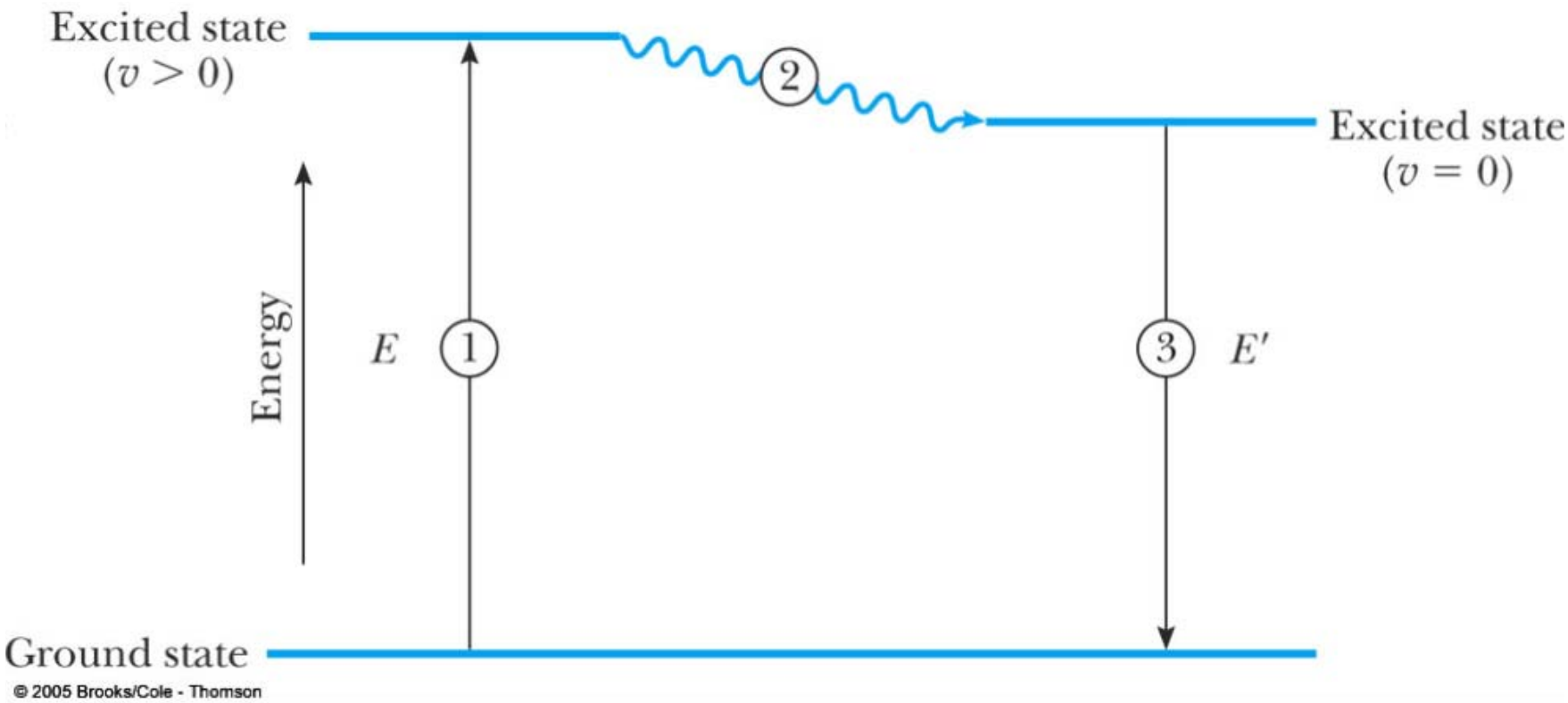


Fig. 11-14, p.390

H_2^+

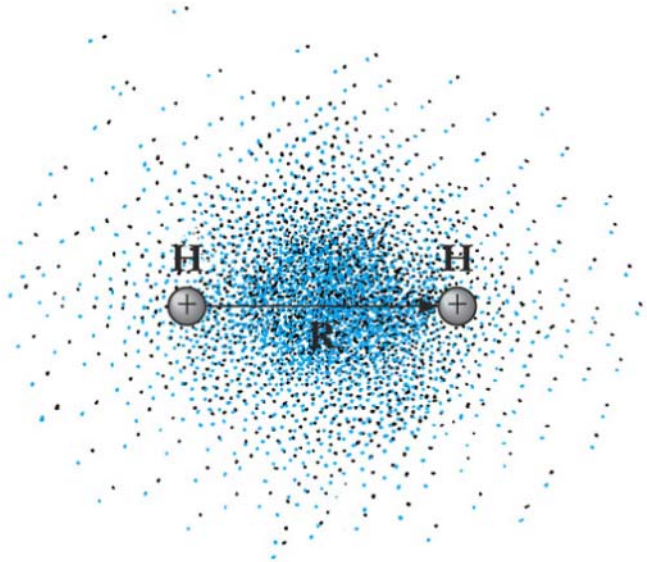
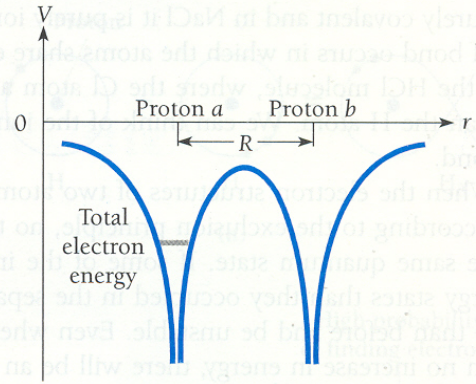
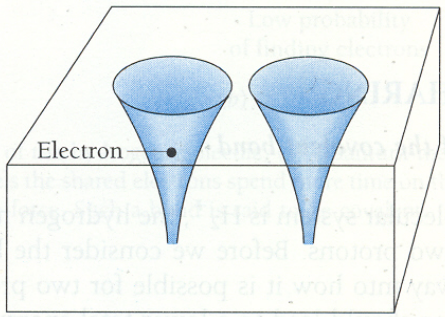


Fig. 11-15, p.390



(a)



(b)

Figure 8.4 (*a*) Potential energy of an electron in the electric field of two nearby protons. The total energy of a ground-state electron in the hydrogen atom is indicated. (*b*) Two nearby protons correspond quantum-mechanically to a pair of boxes separated by a barrier.

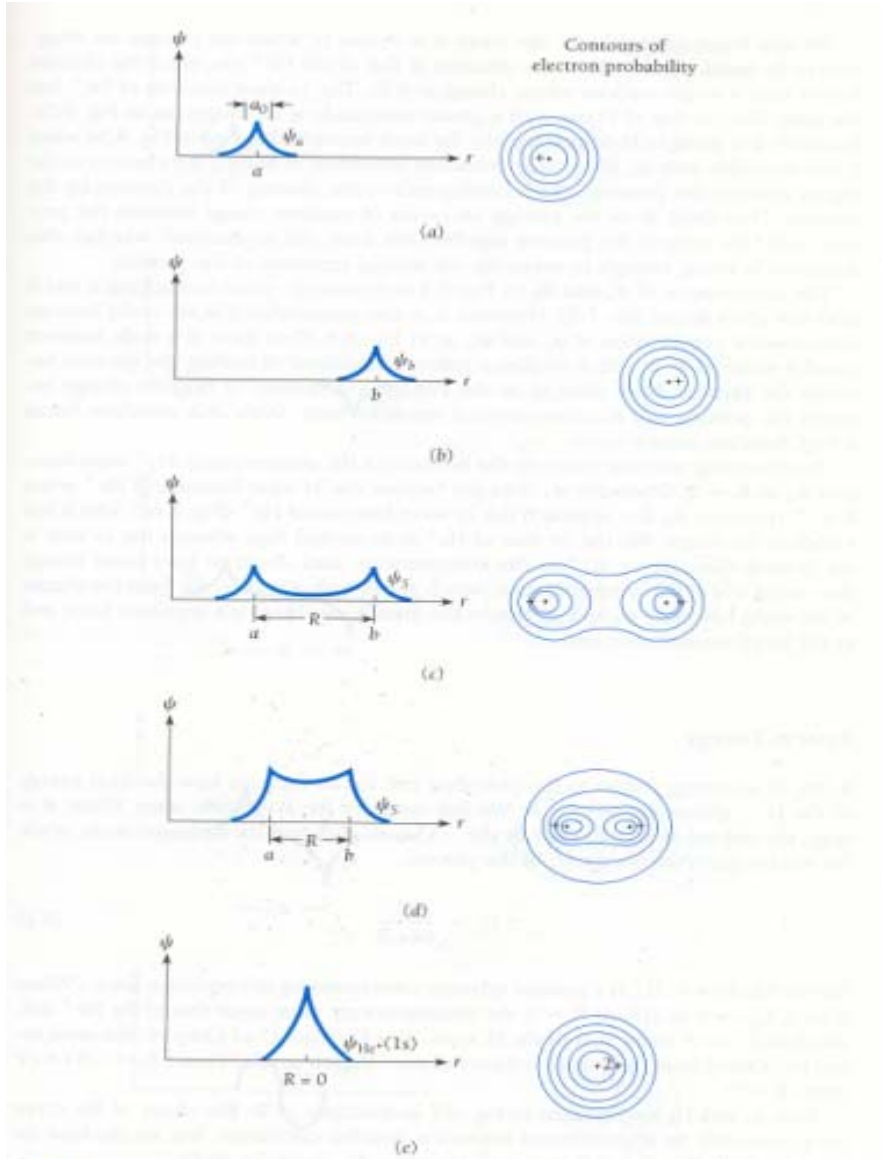


Figure 8.5 (a)–(d) The combination of two hydrogen-atom 1s wave functions to form the symmetric H_2^+ wave function ψ_S. The result is a stable H_2^+ molecular ion because the electron has a greater probability of being between the protons than outside them. (e) If the protons could join together, the resulting wave function would be the same as the 1s wave function of a He^+ ion.

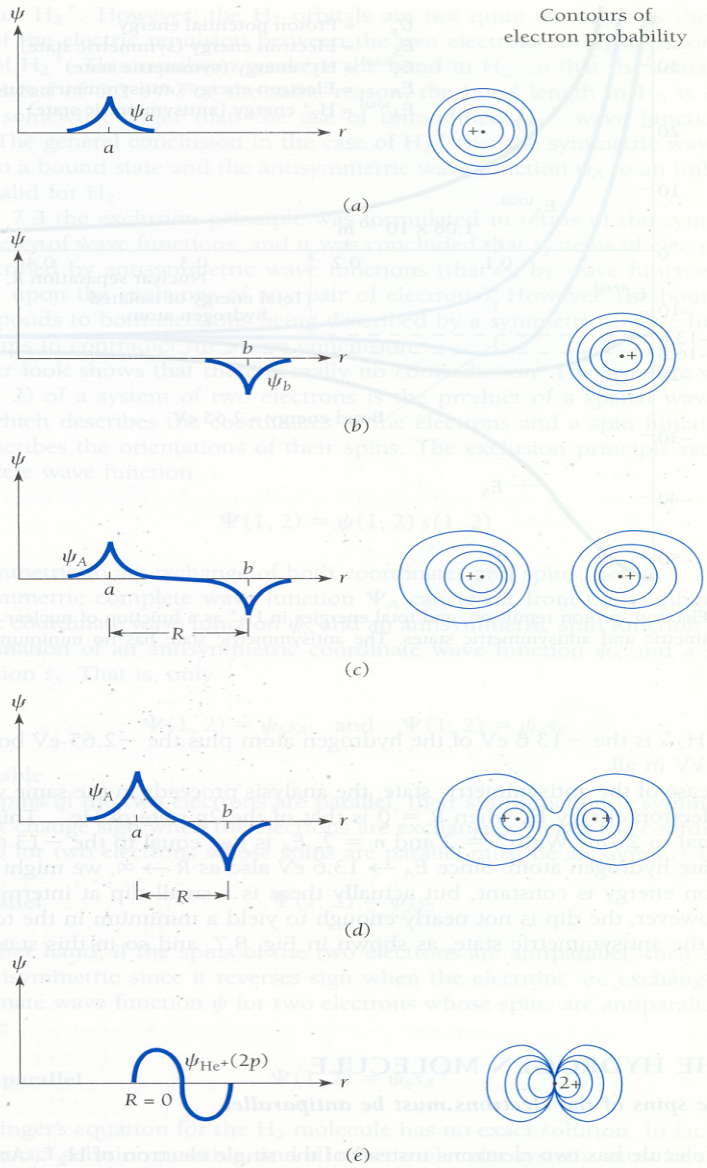


Figure 8.6 (*a*)–(*d*) The combination of two hydrogen-atom 1*s* wave functions to form the antisymmetric H_2^+ wave function ψ_A. A stable H_2^+ molecular ion is not formed because now the electron has a smaller probability of being between the protons than outside them. (*e*) If the protons could join together, the resulting wave function would be the same as the 2*p* wave function of a He^+ ion. In the 2*p* state a He^+ ion has more energy than in the 2*s* state.

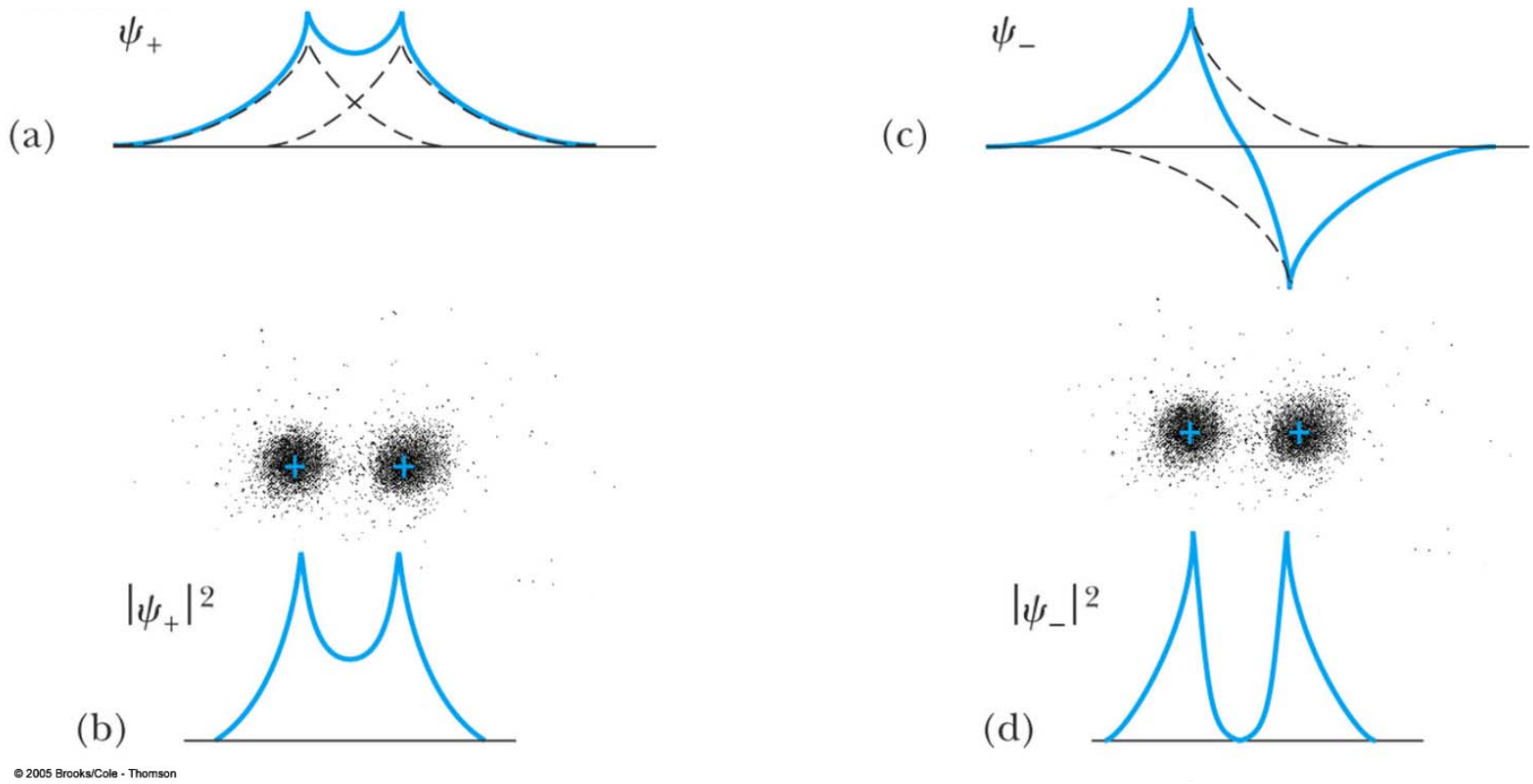


Fig. 11-17, p.393

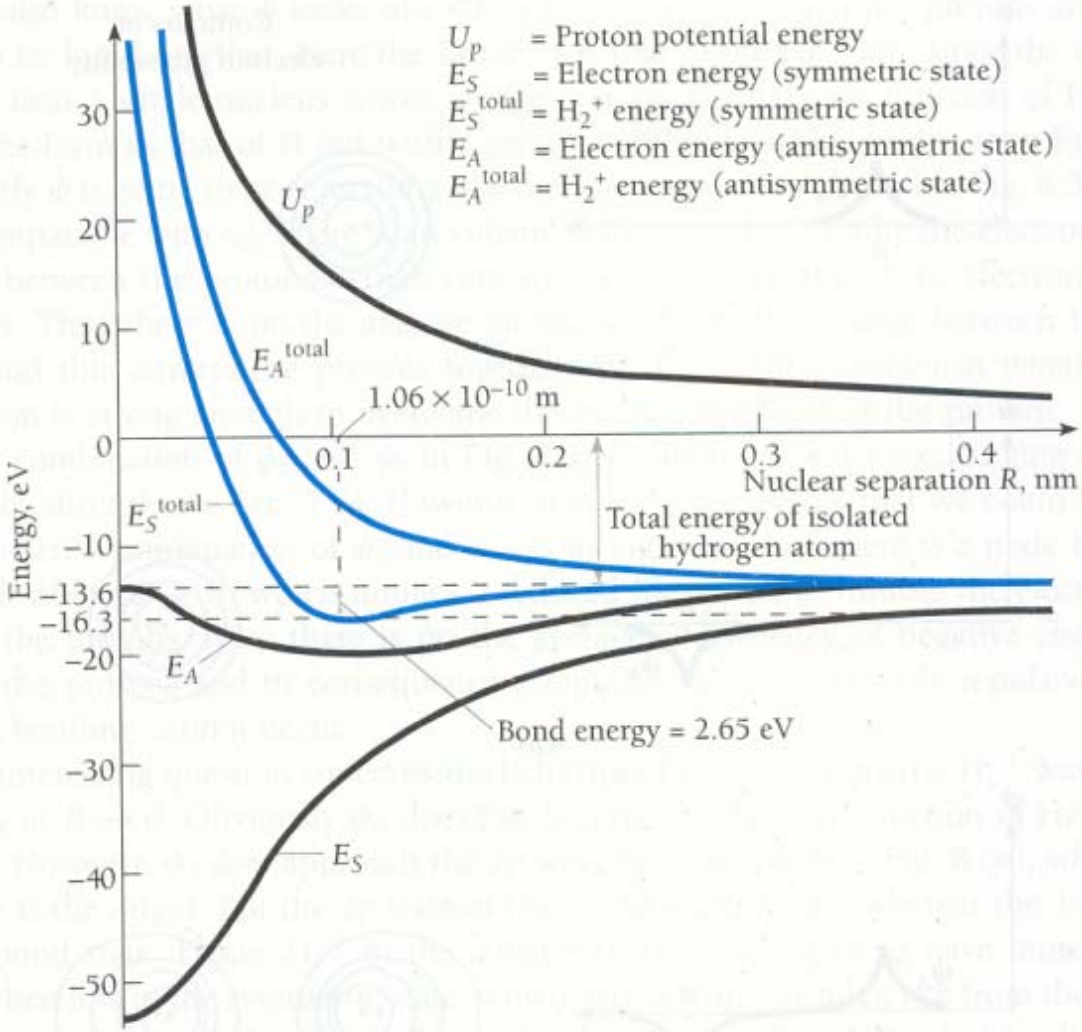
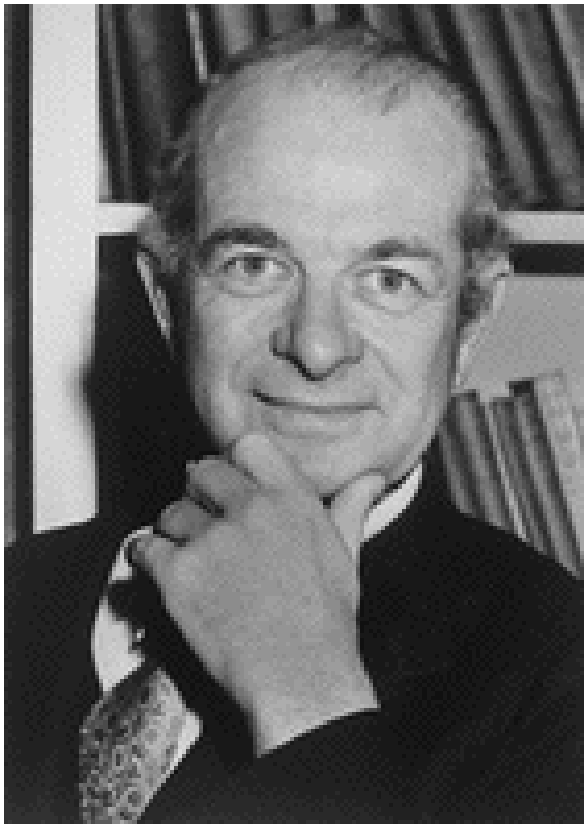


Figure 8.7 Electron, proton repulsion, and total energies in H_2^+ as a function of nuclear separation R for the symmetric and antisymmetric states. The antisymmetric state has no minimum in its total energy.

Pauling



Linus Carl Pauling
(1901 - 1994)

The Nobel Prize in Chemistry 1954
The Nobel Prize in Peace 1963

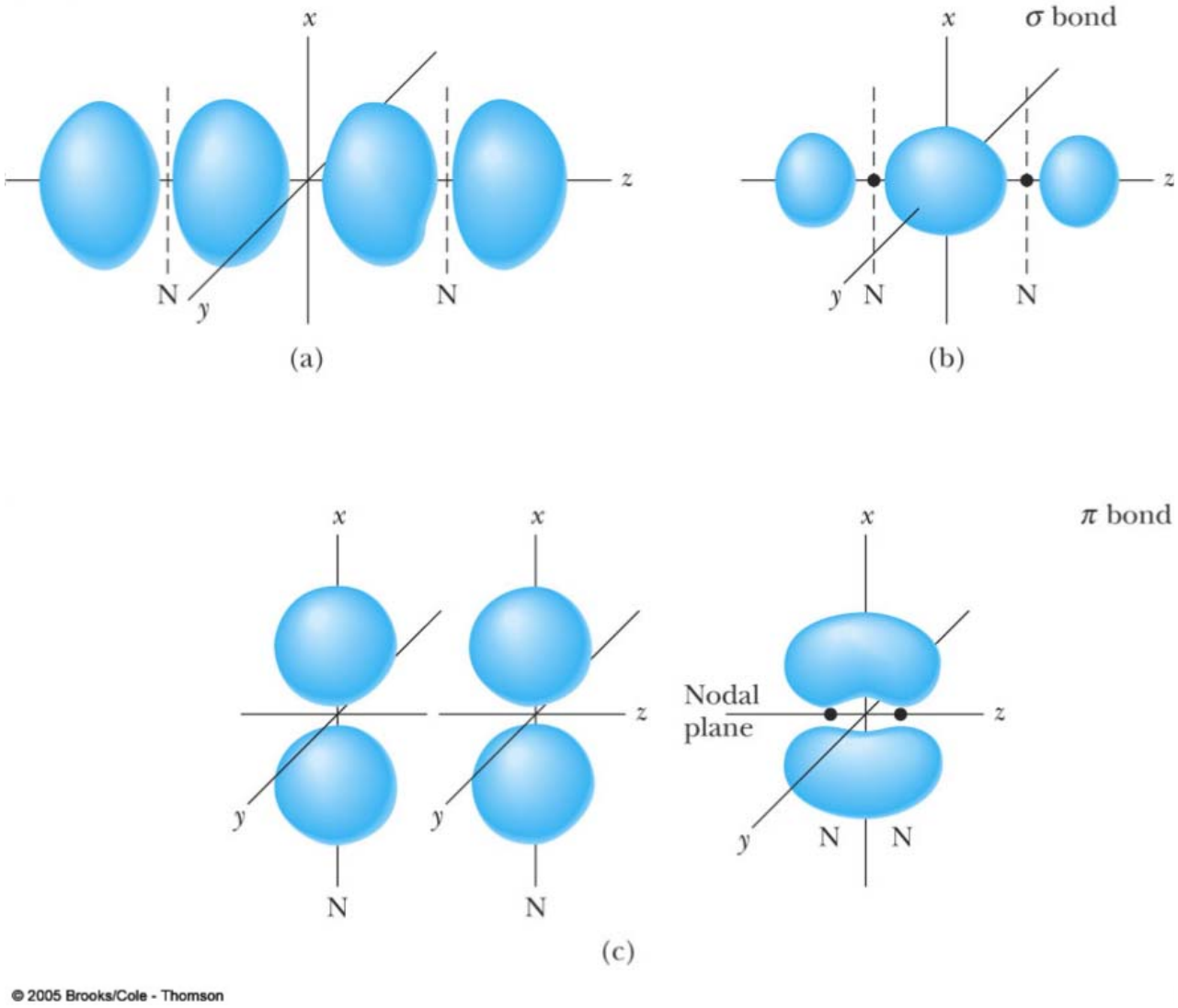


Fig. 11-20, p.398

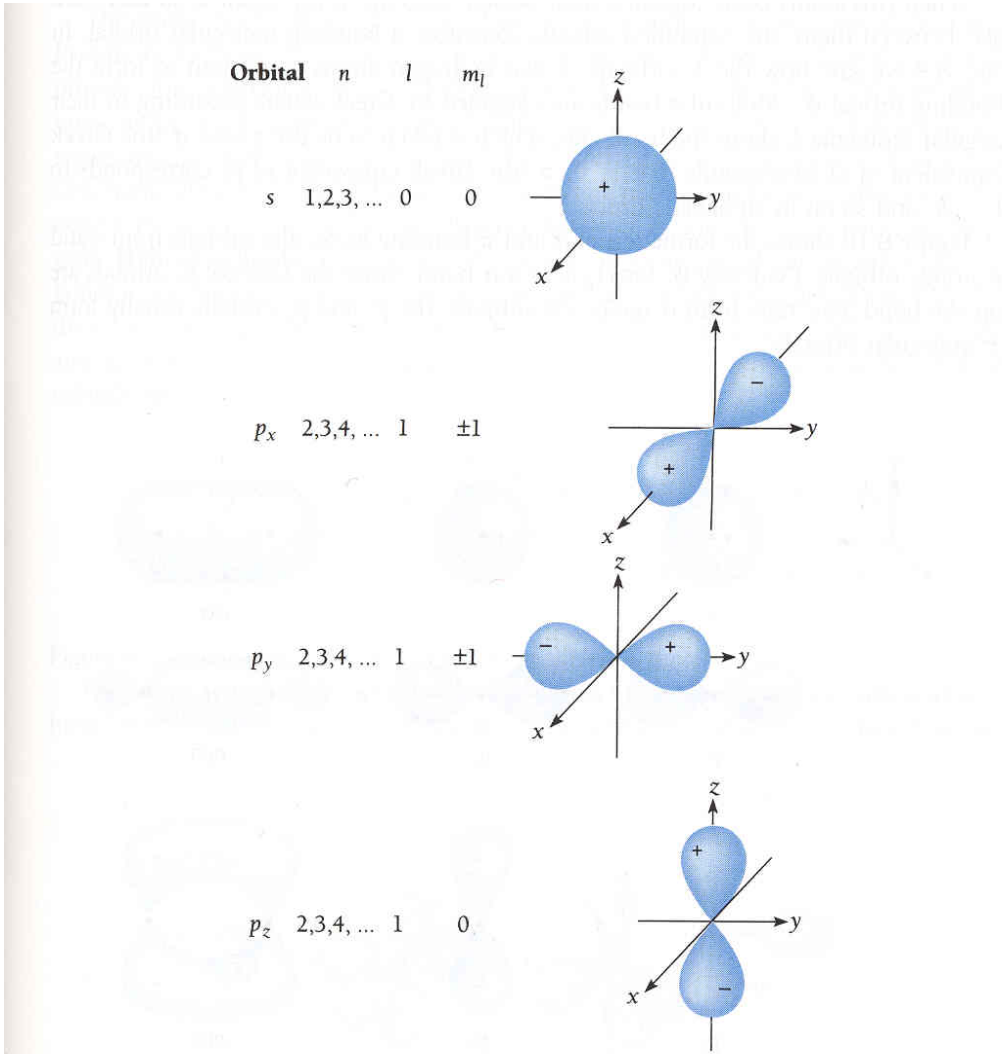


Figure 8.9 Boundary surface diagrams for *s* and *p* atomic orbitals. Each orbital can "contain" two electrons. There is a high probability of finding an electron described by one of these orbitals in the shaded regions. The sign of the wave function in each lobe is indicated.

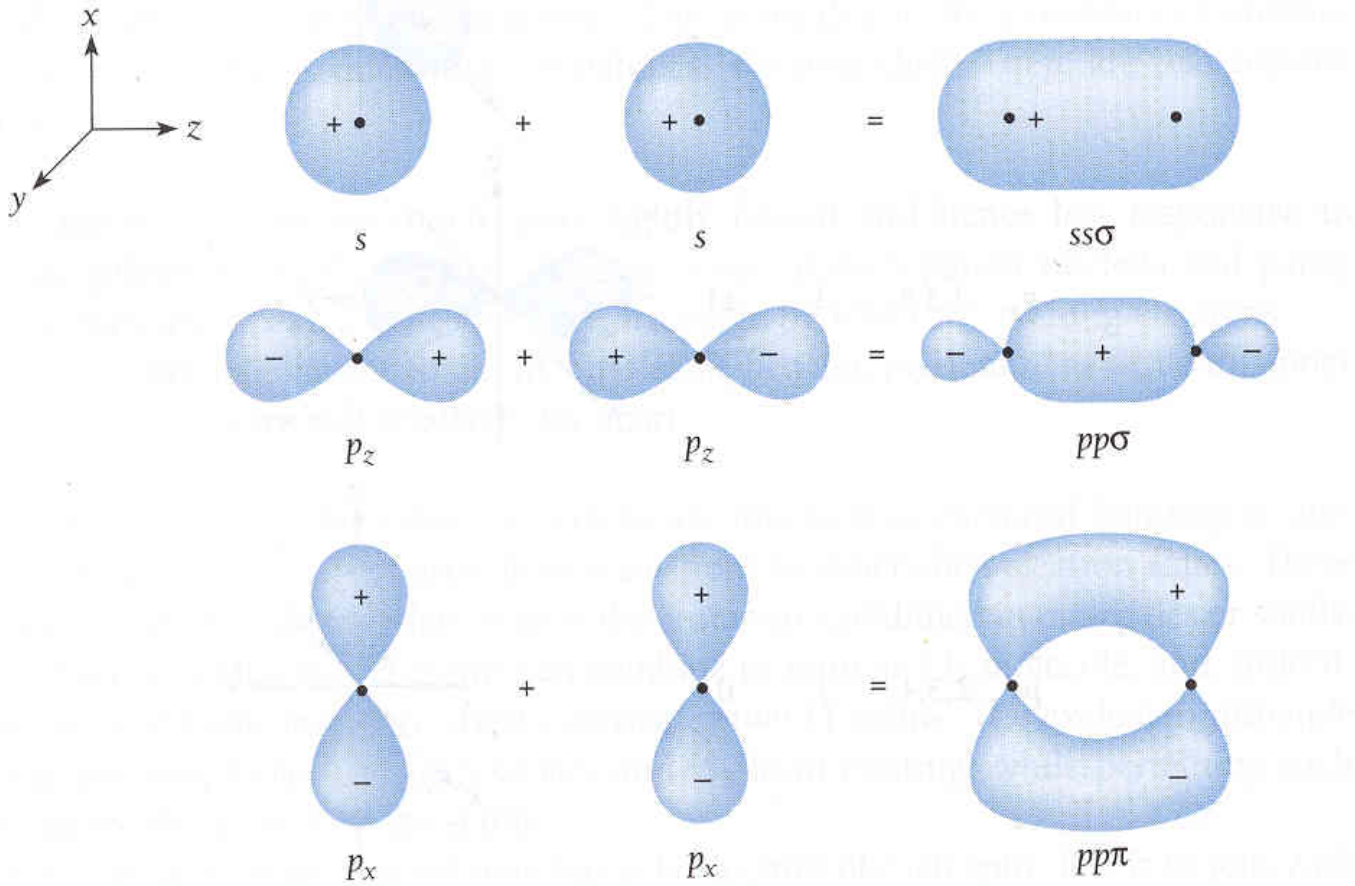


Figure 8.10 The formation of $ss\sigma$, $pp\sigma$, and $pp\pi$ bonding molecular orbitals. Two p_y atomic orbitals can combine to form a $pp\sigma$ molecular orbital in the same way as shown for two p_x atomic orbitals but with a different orientation.

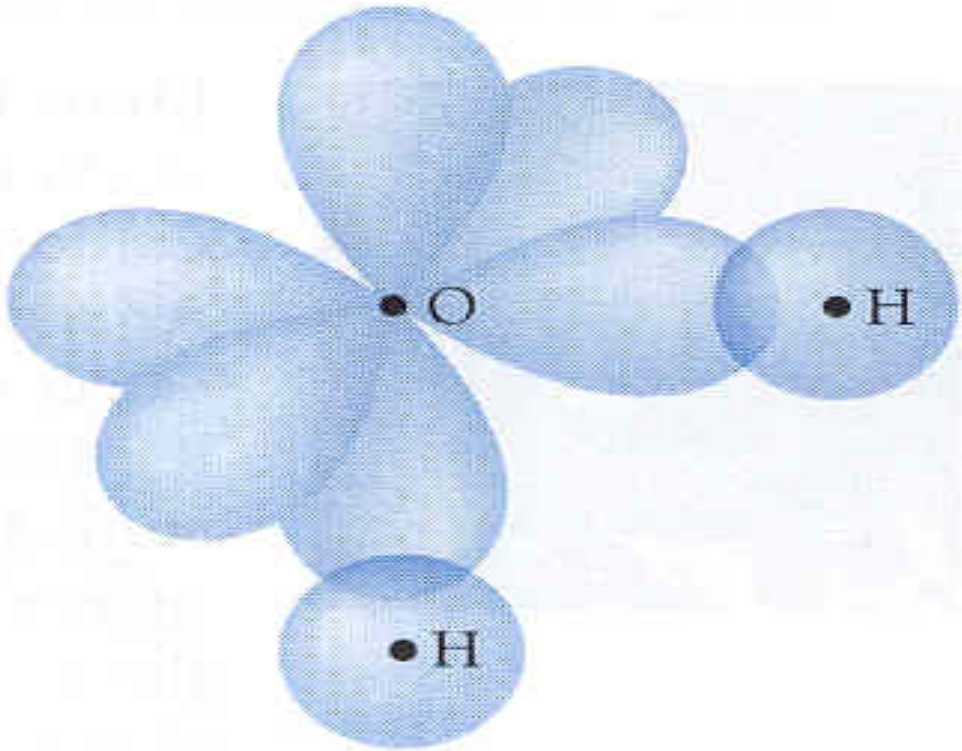


Figure 8.11 Formation of an H_2O molecule. Overlaps represent $sp\sigma$ covalent bonds. The angle between the bonds is 104.5°.

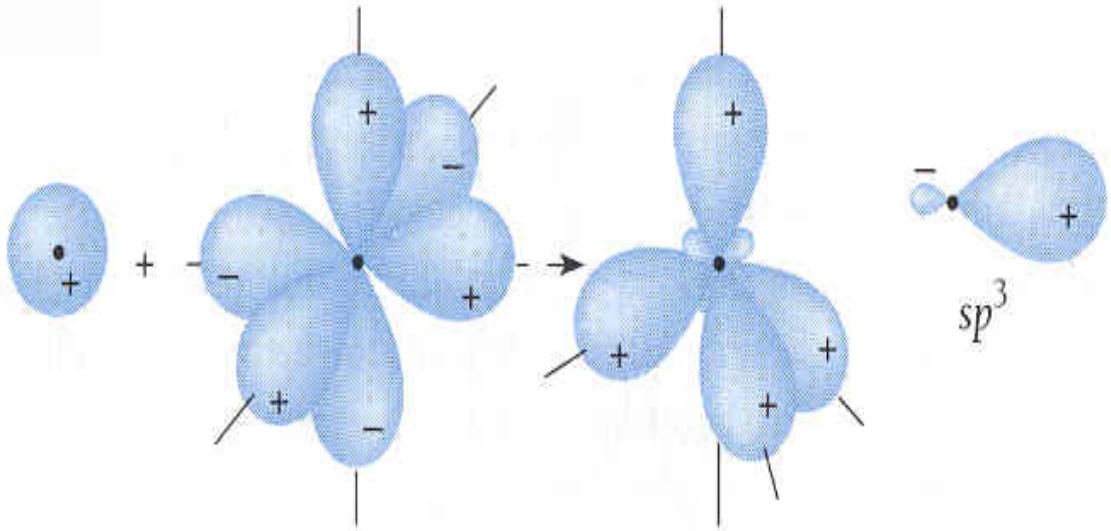
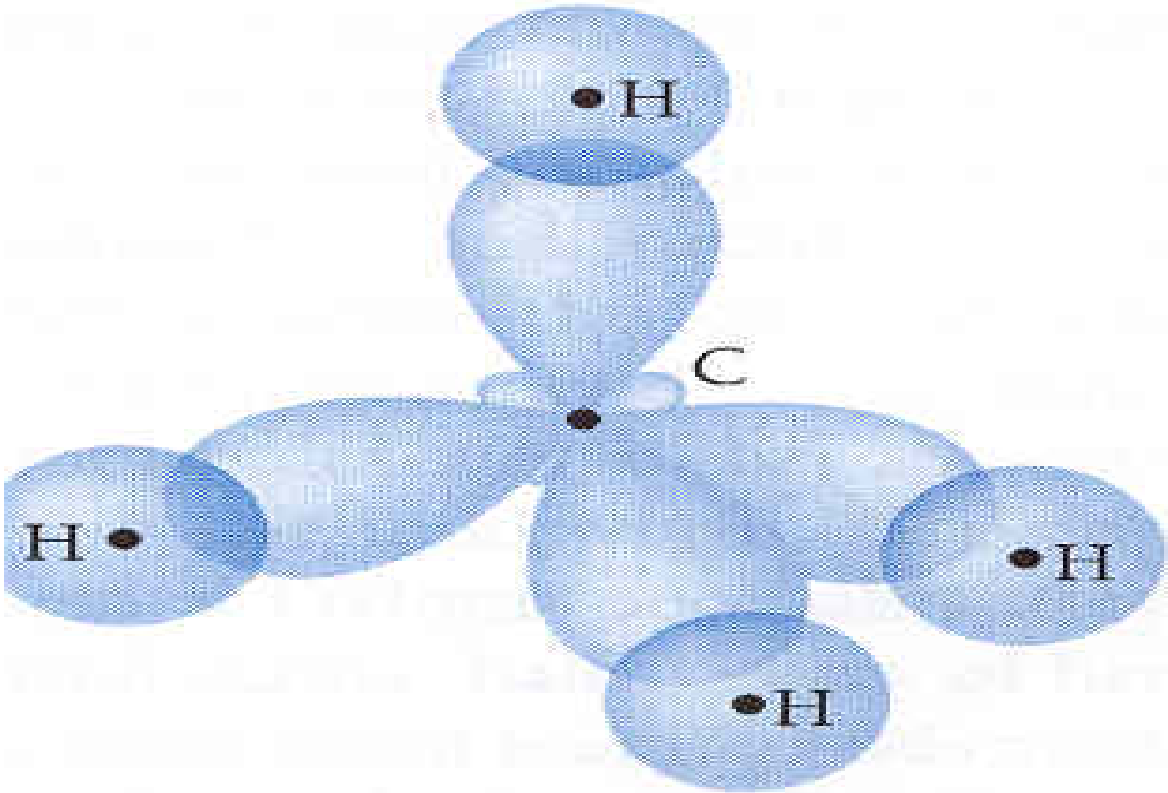
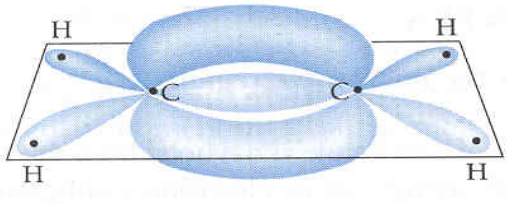


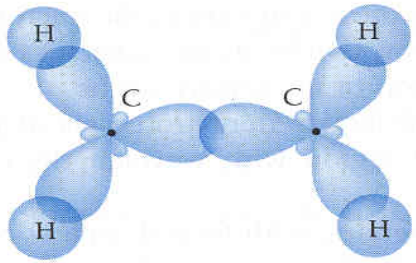
Figure 8.12 In sp^3 hybridization, an s orbital and three p orbitals in the same atom combine to form four sp^3 hybrid orbitals.



igure 8.13 The bonds in the CH_4 (methane) molecule involve p^3 hybrid orbitals.



(*a*)



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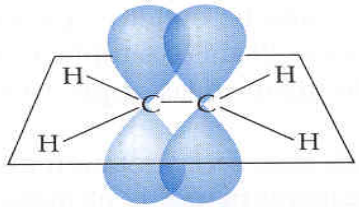
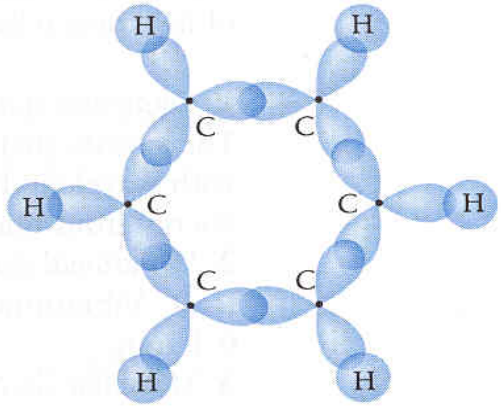
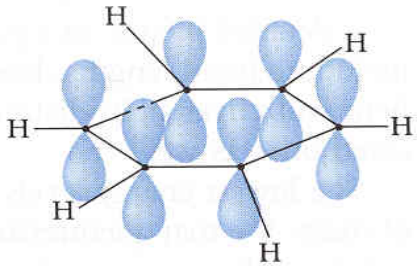


(*c*)

Figure 8.14 (*a*) The ethylene (C_2H_4) molecule. All the atoms lie in a plane perpendicular to the plane of the paper. (*b*) Top view, showing the sp^2 hybrid orbitals that form σ bonds between the C atoms and between each C atoms. (*c*) Side view, showing the pure p_x orbitals that form a π bond between the C atoms.



(*a*)



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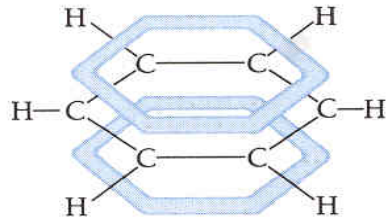

(*c*)

Figure 8.15 The benzene molecule. (*a*) The overlaps between the sp^2 hybrid orbitals in the C atoms with each other and with the *s* orbitals of the H atoms lead to σ bonds. (*b*) Each C atom has a pure p_x orbital occupied by one electron. (*c*) The bonding π molecular orbitals formd by the six p_x atomic orbitals constitute a continuous electron probability distribution around the molecule that contains six delocalized electrons.