1 Electrons in Atoms

wave function, Ψ: a function of all space coordinates containing all dynamic information about a particle.
Schrödinger equation: a differential equation modeling the evolution of a particle which the wave function is one of the set of solutions.

Permitted values of angular momentum

The possible values of angular momentum of the electron in a hydrogen atom are

$$L = \sqrt{l\,(l+1)}\frac{h}{2\pi} \quad (l = 0, 1, 2, ..., n-1).$$

the component of $\vec{L}$ in a given direction–say, the z component L_z, can have only the set of values

$$L_z = m_l \frac{h}{2\pi} \quad (|m_l| = 0, 1, 2, ..., l).$$

That is, m_l is a positive or negative integer or zero, with magnitude no greater than l.

Quantum numbers:

- ***principal quantum number***(n): energy level
- ***angular momentum,*** (l):
- ***magnetic quantum number*** (m_l): slight shifts (or splits) in energy levels when atom is placed in a magnetic field.
- ***electron spin*** (s): analogous to spinning on an axis

central-field approximation: modeling schemes assumes that each electron moves under the influence only of the electric field of the nucleus.
ground state: lowest energy state

The Pauli exclusion principle

No two electrons in an atom can occupy the same quantum-mechanical state. Alternatively, no two electrons in an atom can have the same values of all four of their quantum numbers.

Angular momentum

value	state
$l = 0$	s
$l = 1$	p
$l = 2$	d
$l = 3$	f
$l = 4$	g

shell: a region of space around the nucleus in the form of a spherical shell that corresponds with an energy level, n; states with the same n, but different l form subshells.
Mathematica Demonstrations: Atomic Electron Configurations
Mathematica Demonstrations: Periodic Table in 3D
Mathematica Demonstrations: Build Your Own Atoms

2 Atomic Structure

atomic number (Z): the number of electrons in an atom in its normal (electrically neutral) state.
periodic table of elements: a table organized to illustrate the properties of the known elements.
x-ray energy levels: corresponds to vacancies in the inner shells of a complex atom.

3 Diatomic Molecules

ionic bond: also called the electrovalent or heteropolar bond is and interaction between two ionized atoms.
ionization energy: energy required to remove an electron from an atom.
electron affinity: the energy available or attractive potential energy of an atom to attract an electron.
covalent bond: homopolar, nearly symmetric participation of the two atoms in sharing an electron.
molecular bonds: the spectrum of bonds between the two extremes of atomic bonding.
polar molecules: many molecules having dissimilar atoms may have electric dipole moments and are thus polar.
van der Waals bond: an interaction between the electric dipole moments of two atoms or molecules.
hydrogen bond: a weak bond, analogous to the covalent bond, in which an electron pair binds two positively charged structures.

4 Structure and Properties of Solids

long-range order: a recurring pattern of atomic positions that extends over many atoms; characteristic of a crystalline solid,
crystal structure or lattice structure: the particular pattern of a crystal.
short-range order: characteristic of a liquid; the correlations between neighboring atoms or molecules.
ionic crystals: crystals that contain ionic bonds.
covalent crystal: crystals that contain covalent bonds.
metallic crystal: a crystal in which the outermost electrons are not localized at individual atomic lattice sites, but are detached from their parent atoms and are free to move through the crystal.
close packing: the maximum number of atoms that can fit into a given volume.
resistivity: a property of a crystalline solid that is determined by the amount of freedom the electrons have to move within the crystal lattice.

5 Energy Bands

energy bands: the energy levels of a material further divided into groups.
band gap:a band between adjacent energy bands; also called forbidden regions where there are no allowed energy levels.
valence band:the highest *occupied* band; completely filled in insulators and semi-conductors–thus with no electrons to flow there is no conduction.
conduction band: the band above the valence band; completely empty.
energy gap: the energy difference between the valence band and conduction band; E_g.

6 Semiconductors

semiconductor: a material with an electrical resistivity that is intermediate between the resistivities of good conductors and those of good insulators.
hole: vacancy left by an electron that can serve as a current carrier; acts like a positive charge.
intrinsic conductivity: in a pure semiconductor, holes and electrons are always present in equal numbers, and when an electric field is applied, they move in opposite directions leading to a "natural" conductivity; conductivity not due to impurities.
n-type semiconductor: material with conductivity due almost entirely to negative-charge (electron) motion.
p-type semiconductor: material with conductivity due almost entirely to positive-charge (hole) motion.

7 Semiconductor Devices

p-n junction: the boundary layer between two regions of a semiconductor, one with p-type impurities and the other with n-impurities.
diode: a device that conducts much more readily in the direction from p to n than the reverse and the current I is not proportional to the potential difference V.
forward bias: in a diode, the positive potential difference in which holes in the p region flow into the n region and electrons in the n region move into the p region; this flow constitutes a forward current.
reverse bias: in a diode, when the polarity is reversed; the field tends to push electrons from p to n and holes from n to p.
light-emitting diode (LED): a p-n junction that emits light.
transistors: can be made by layering two p-n junctions–the resulting devices can act as power, current, or voltage amplifiers.

- ***emitter***: outer region of a transistor
- ***collector***: out region of a transistor
- ***base***: center region of a transistor

integrated circuit or chip: a small semiconductor device which typically includes the functions of transistors, capacitors, and resistors.

8 Superconductivity

superconductivity: a property of some materials including several metallic alloys and oxides; the complete disappearance of electrical resistance at low temperatures.
critical temperature: the temperature at which the resistivity suddenly drops to zero in a superconductor.

8.1 Links

A video on Superconductivity:
From ASTC
Videos on Superfluidity: Alfred Leitner, 1963
Part I: Introduction and equipment
Part II:Transition to superfluid
Part III: Zero viscosity
Part IV: Fountain Effect
Part V: Rollin Film
Part VI: Second Sound