Some Basic Definitions

- Matter: anything that has mass and occupies space
- Element: simplest form of matter with unique chemical properties
- Atom: single smallest unit of matter
- Molecule: two or more atoms bonded covalently

Periodic Table of the Elements

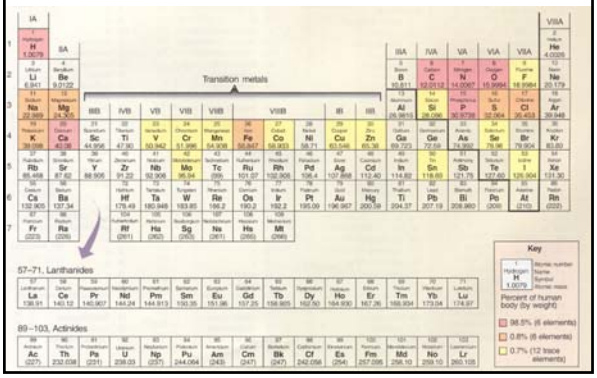


Table 2.1 Naturally Occurring Elements in the Human Body

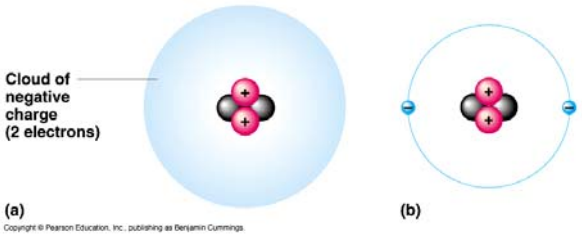
Symbol	Element	Atomic Number (See p. 29)	Percentage of Human Body Weight
O	Oxygen	8	65.0
C	Carbon	6	18.5
H	Hydrogen	1	9.5
N	Nitrogen	7	3.3
Ca	Calcium	20	1.5
P	Phosphorus	15	1.0
K	Potassium	19	0.4
S	Sulfur	16	0.3
Na	Sodium	11	0.2
Cl	Chlorine	17	0.2
Mg	Magnesium	12	0.1

Trace elements (less than 0.01%): boron (B), chromium (Cr), cobalt (Co), copper (Cu), fluorine (F), iodine (I), iron (Fe), manganese (Mn), molybdenum (Mo), selenium (Se), silicon (Si), tin (Sn), vanadium (V), and zinc (Zn).

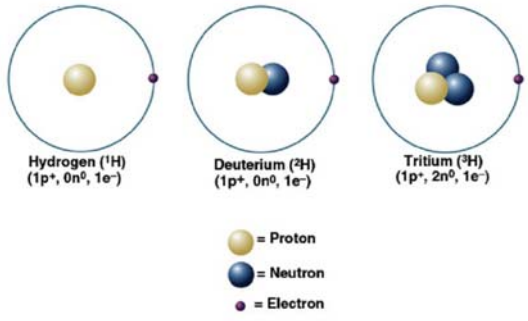
Planetary Model of Atom

- A simplification, but helps us understand
- Nucleus in center with protons and neutrons
- Electrons orbiting nucleus

Figure 2.5 Two simplified models of a helium (He) atom



Isotopes of Hydrogen



Electron Shells

- Electrons found in shells around nucleus
- First shell can hold maximum of 2 electrons
- Second shell can hold up to 8 electrons
- Third and higher shells can hold 18 electrons *but*:
- Outer shell (valence shell) only holds 8

Figure 2.9 Energy levels of an atom's electrons

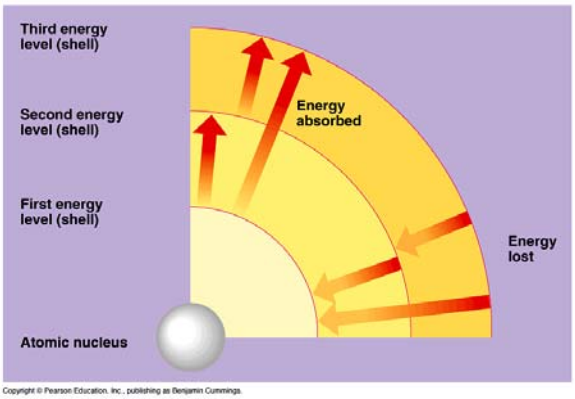
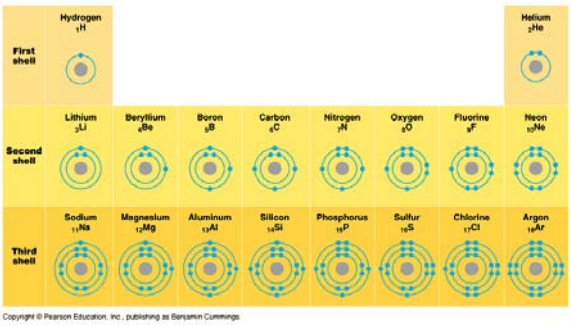


Figure 2.10 Electron configurations of the first 18 elements



Chemical Bonding

- Atoms with an incomplete outer shell will transfer or share electrons to complete shell
- Sharing electrons occurs in covalent bonds
- Covalent bonds are nonpolar if sharing is equal, polar if sharing is unequal
- Transferring electrons from one atom to another occurs in ionic bonding

Figure 2.12 Covalent bonding in four molecules

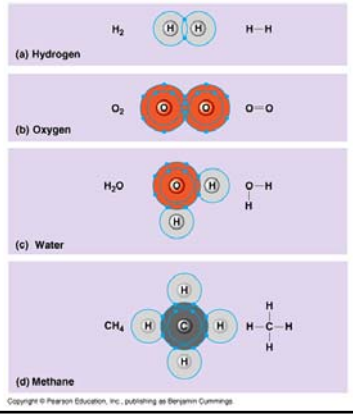


Figure 2.13 Polar covalent bonds in a water molecule

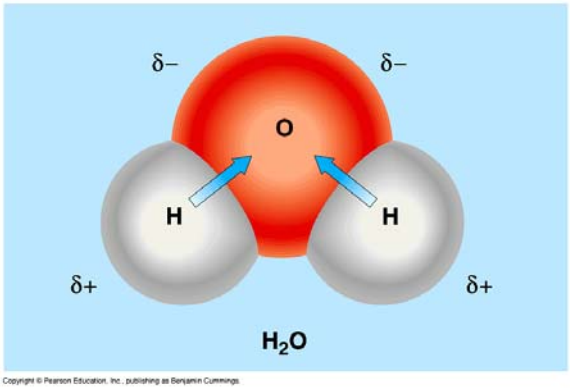


Figure 2.14 Electron transfer and ionic bonding

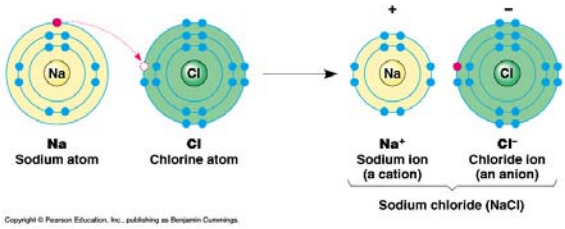
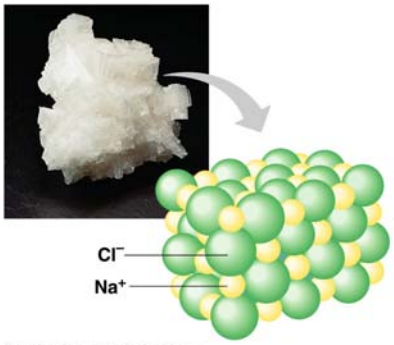


Figure 2.15 A sodium chloride crystal



Hydrogen Bonding

- With polar covalent bonds, sharing unequal, molecule becomes charged (δ+ and δ-)
- Oppositely charged ends of polar molecules attract each other, produce hydrogen bonds
- Hydrogen bonds are weak but important

Figure 2.13 Polar covalent bonds in a water molecule

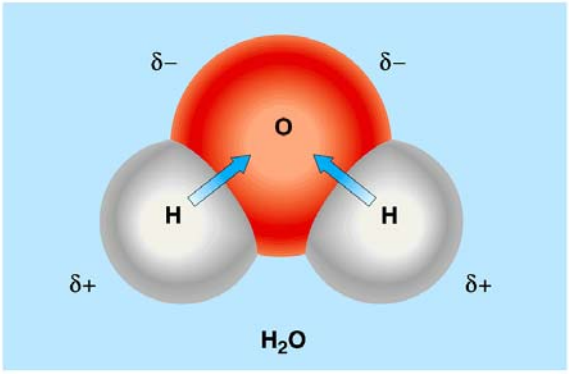
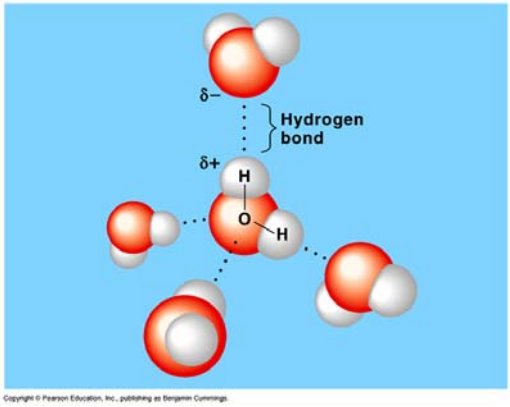


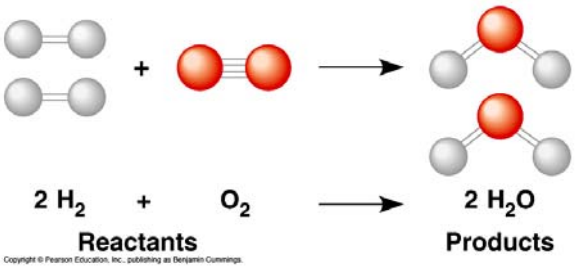
Figure 3.1 Hydrogen bonds between water molecules



Chemical Reactions

- Synthesis: A + B → AB
- Decomposition: AB → A + B
- Substitution: AB + CD → AC + BD

Unnumbered Figure (Page 38) Chemical reaction between hydrogen and oxygen



Properties of Water

- Many are due to hydrogen bonding
- Has cohesion and adhesion
- Becomes less dense as a solid → ice floats
- High specific heat, slow to heat and cool
- A polar liquid, dissolves polar substances: "the universal solvent"

Figure 3.1 Hydrogen bonds between water molecules

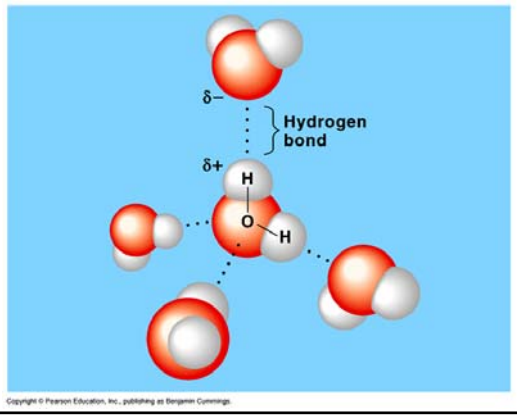


Figure 3.3 Walking on water

Figure 3.5x1 Ice, water, and steam

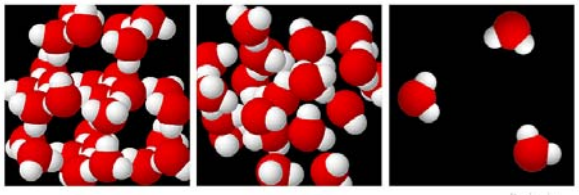


Figure 3.5 The structure of ice (Layer 2)

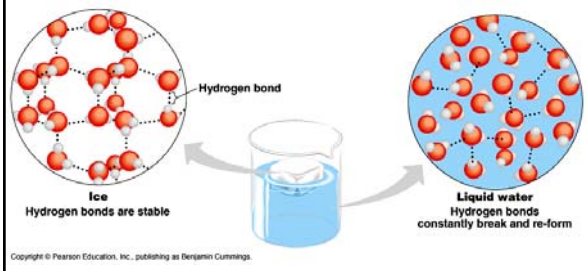


Figure 3.6 Floating ice and the fitness of the environment

Figure 3.4 Evaporative cooling

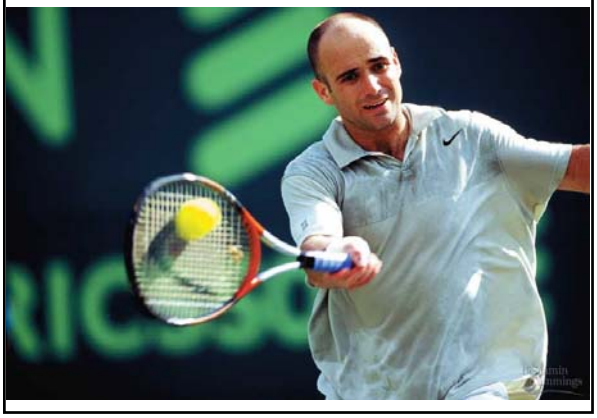


Figure 3.7 A crystal of table salt dissolving in water

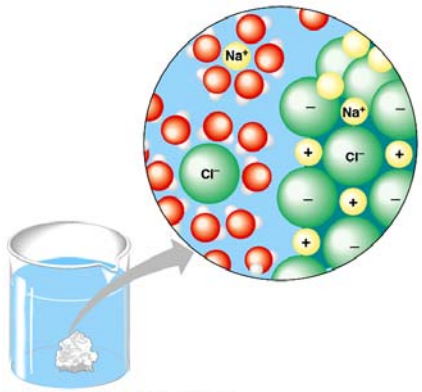
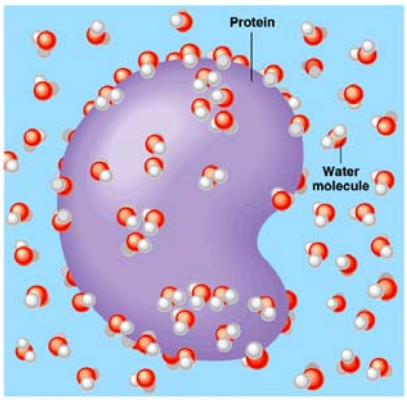


Figure 3.8 A water-soluble protein



pH Scale

- Acids release protons (H^+)
- Bases accept protons (H^+)
- pH measures concentration of H^+ (= [H+])
- pH = - log of [H+]
- Scale runs 0 – 14
- Smaller numbers more acid
- Each whole number interval = 10X increase

Figure 3.9 The pH of some aqueous solutions