Table 1-1. Summary of quantum numbers

Name	Symbol	Values
Principal	n	1, 2, 3, …. , ∞
Azimuthal	l	n - 1, n - 2, n - 3, ... ,0
Magnetic	m	0, ±1, ±2, ... , ±(l - 1), ±l
Spin	s	± 1/2

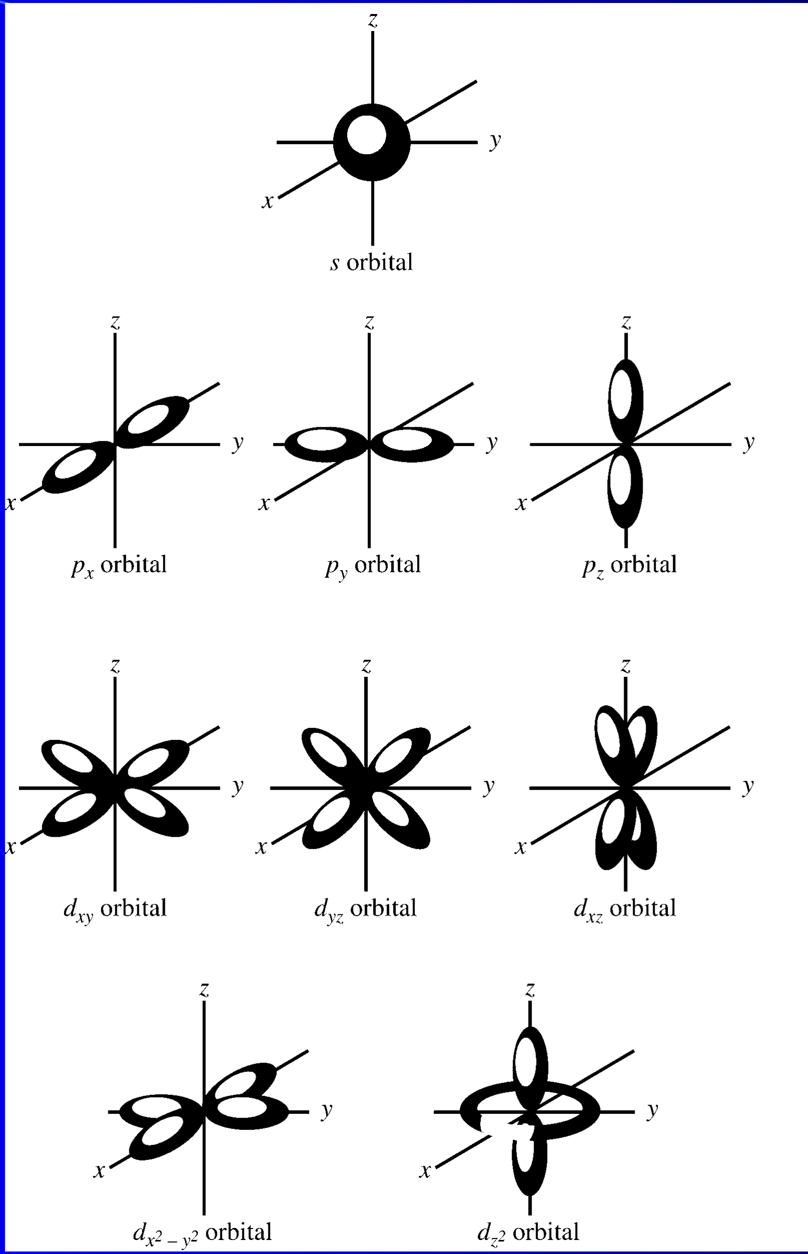


Figure 1-1. Shape of various electron orbitals. From Brownlow (1996).

Table 1-2. Relation between quantum numbers and electron orbitals

n	l	m	Number of subshells	Number of orbitals	Designation
1	0	0	1	1	1s
2	0	0	2	1	2s
	1	-1, 0, 1		3	2p
3	0	0	3	1	3s
	1	-1, 0, 1		3	3p
	2	-2, -1, 0, 1, 2		5	3d
4	0	0	4	1	4s
	1	-1, 0, -1		3	4p
	2	-2, -1, 0, 1, 2		5	4d
	3	-3, -2, -1, 0, 1, 2, 3		7	4f

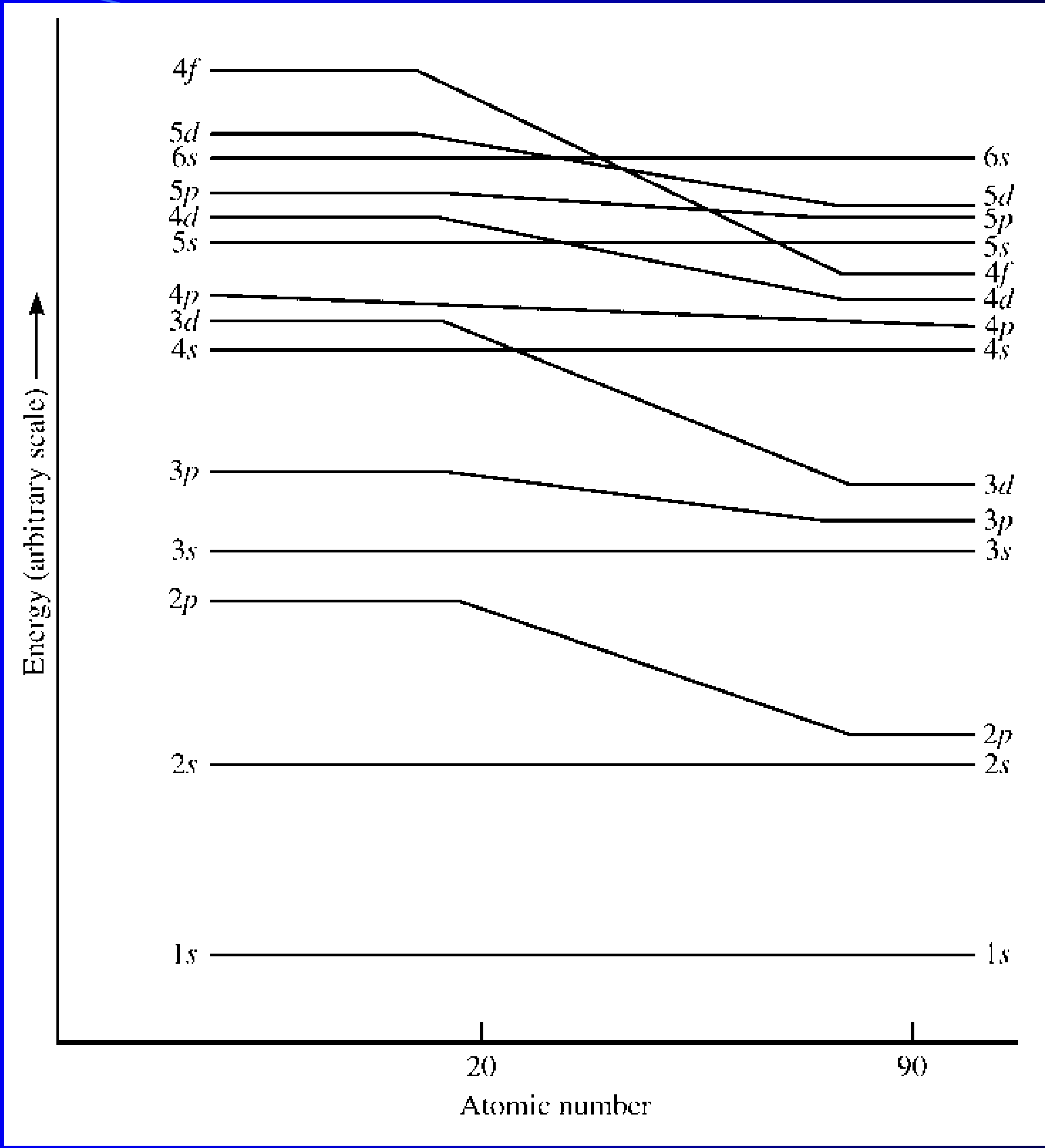


Figure 1-2. Variation of energy levels for the various subshells as a function of atomic number. From Brownlow (1996).

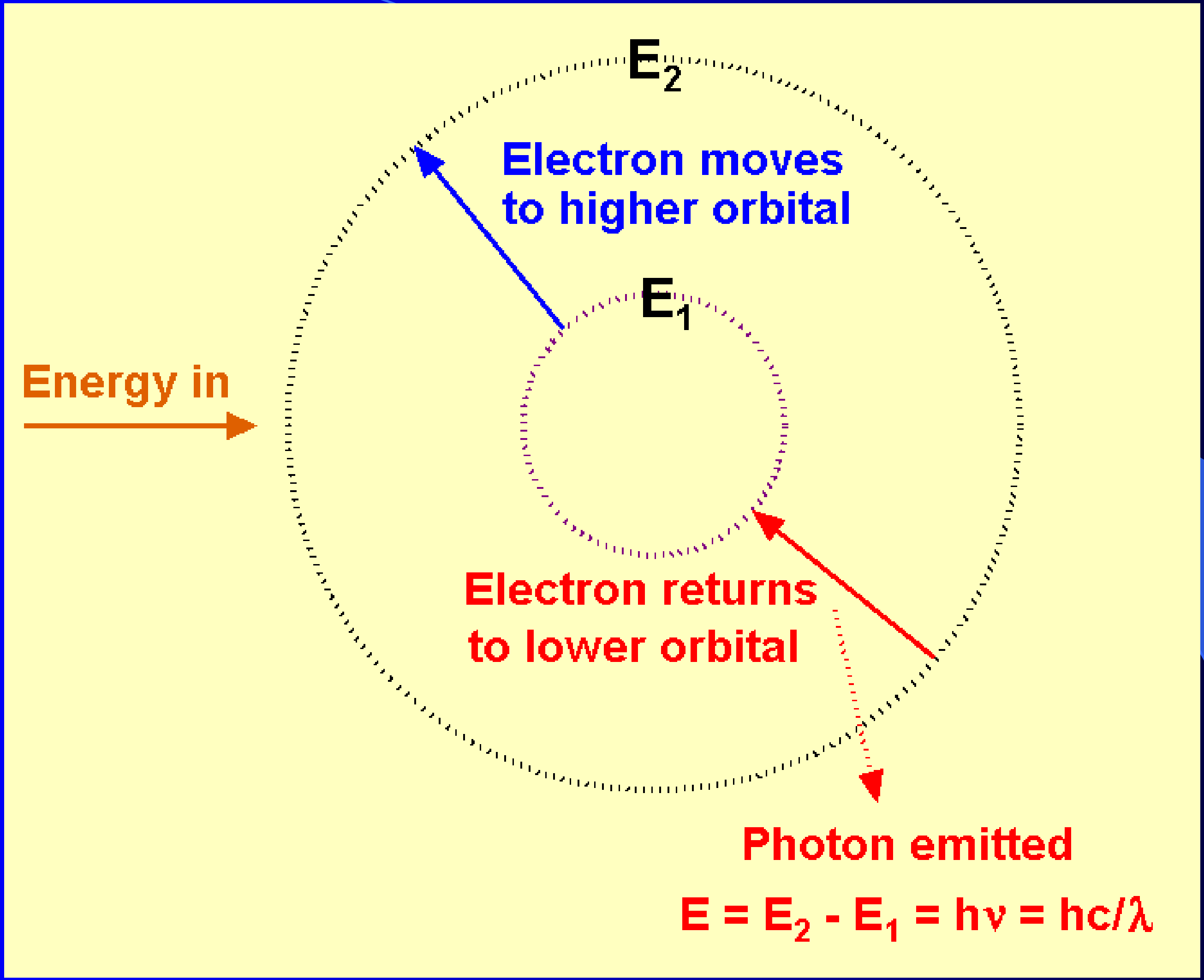


Figure 1-3. An emission spectrum occurs when energy applied to the atom causes an electron to move from a lower orbital to a higher orbital. The electron returns to a lower orbital and emits energy corresponding to the energy difference between the two orbitals (E_2 - E_1). Planck's constant is h, ν is frequency, and λ is wavelength.

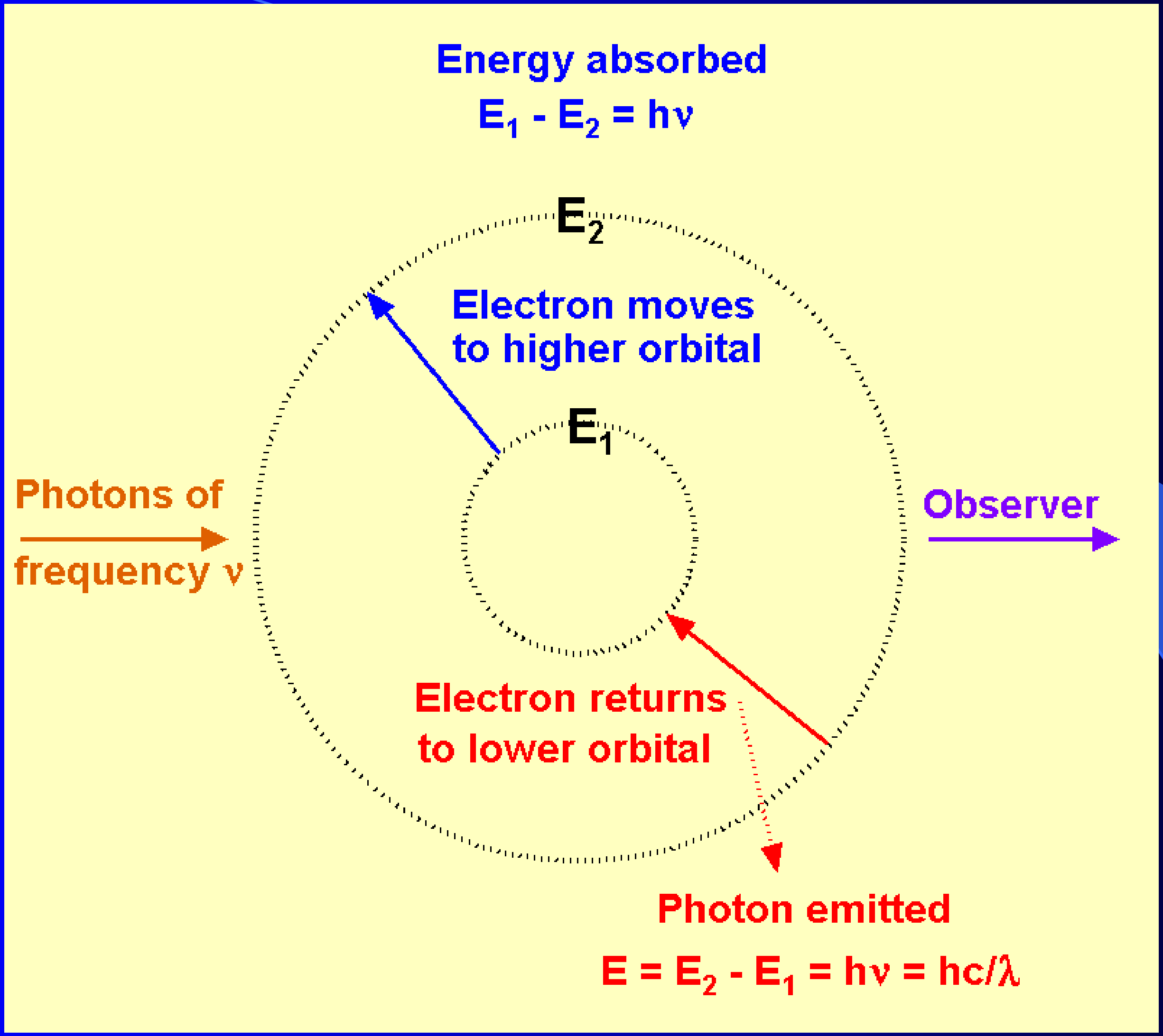


Figure 1-4. An absorption spectrum occurs when photons that have exactly the right energy to move an electron from one orbital to another interact with the atom. When the electron returns to the lower orbital, the emitted photon can travel in any direction. Thus, the observer notices a decrease in the number of photons of this energy (wavelength). Planck's constant is h, ν is frequency, and λ is wavelength.

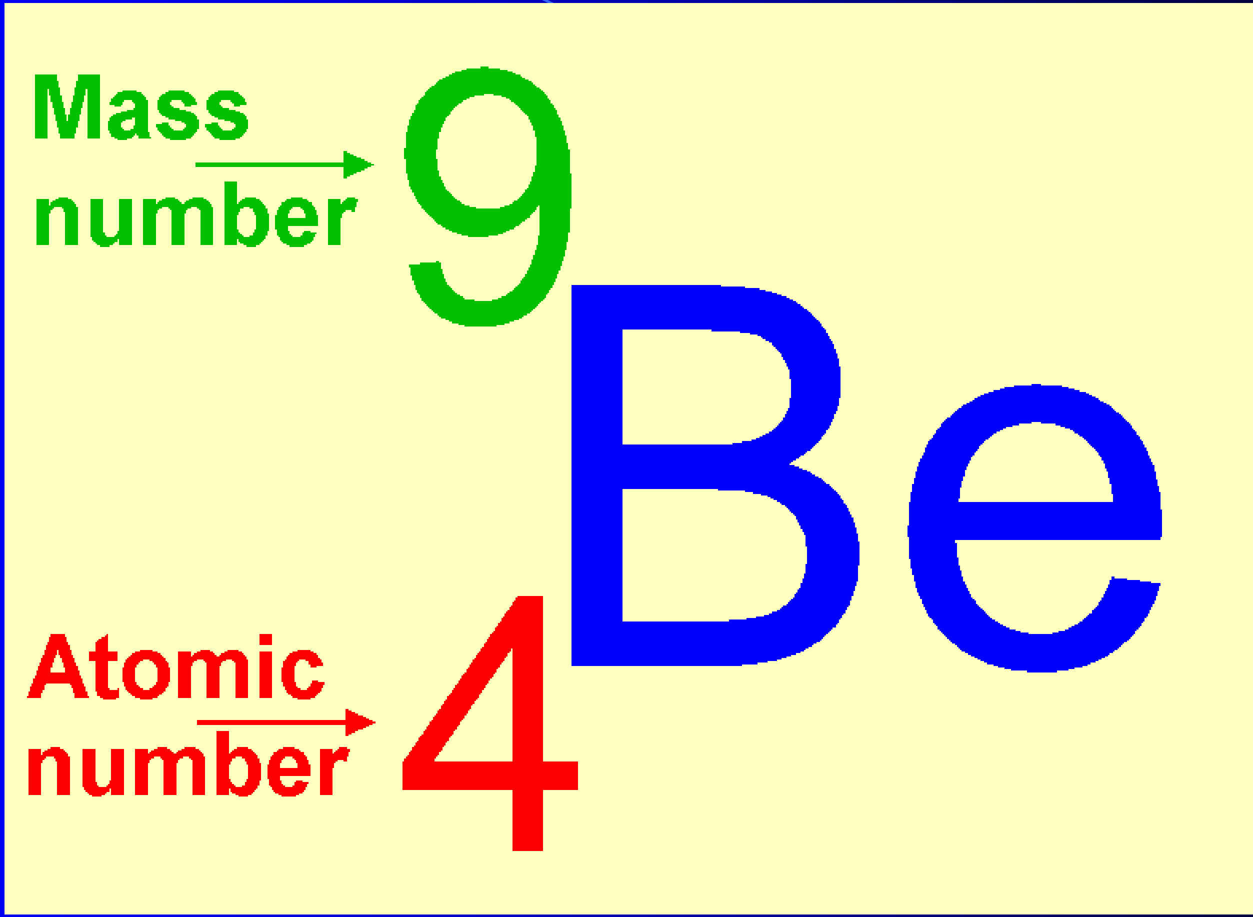


Figure 1-5. Standard format for reporting atomic number and mass number. This isotope of beryllium has four protons and five neutrons.

Table 1-3. Units of absolute mass relative to the kilogram

Unit	Abbreviation	Kilogram
Kilogram	kg	1
Gram	g	1×10^{-3}
Milligram	mg	1×10^{-6}
Microgram	µg	1×10^{-9}
Nanogram	ng	1×10^{-12}

Table 1-4. Relationship between molarity and normality for several acids and bases

Acid or base	Molecular weight	Gram-equivalent weight	Relationship between molarity and normality
HCl	36.5	36.5	1M = 1N
H_2SO_4	98.0	49.0	1M = 2N
H_3PO_4	98.0	32.6	1M = 3N
NaOH	40.0	40.0	1M = 1N
$Ca(OH)_2$	74.0	37.0	1M = 2N

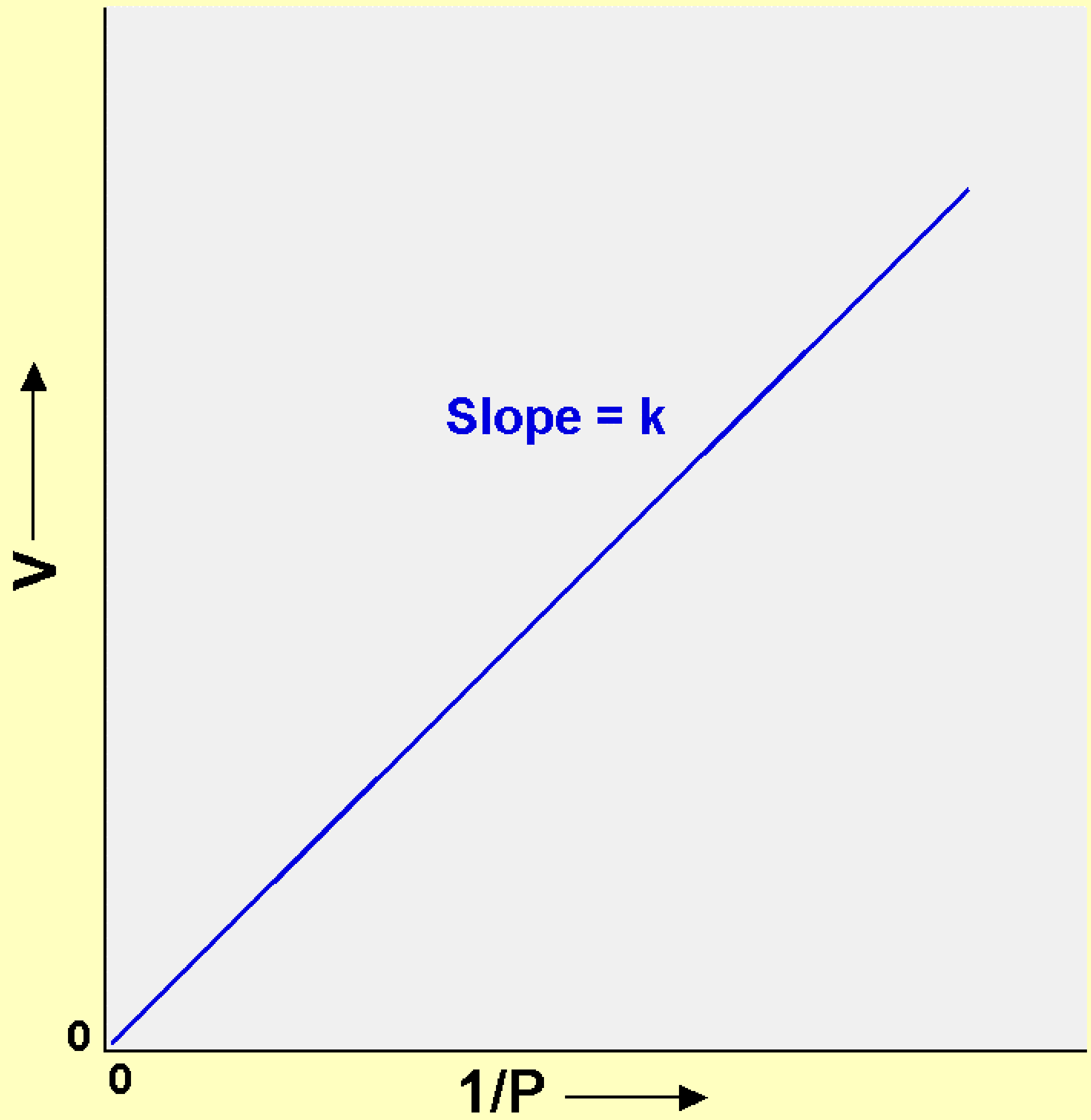


Figure 1-6. A plot of *V* versus *1/P* for an ideal gas gives a straight line, and the slope of the line is the Boyle's law constant *k*.

Table 1-5. Molar volumes for various gases at STP

Gas	Molar volume (L)
Oxygen (O_2)	22.397
Nitrogen (N_2)	22.402
Hydrogen (H_2)	22.433
Helium (He)	22.434
Argon (Ar)	22.397
Carbon dioxide (CO_2)	22.260
Ammonia (NH_3)	22.079

Table 1-6. van der Waals constants for some common gases

Gas	a (atm L^2 mol^{-2})	b (L mol^{-1})
He	0.0346	0.0238
Ne	0.208	0.0167
Ar	1.355	0.0320
Xe	4.192	0.0516
Kr	5.193	0.0106
H_2	0.245	0.0265
N_2	1.370	0.0387
O_2	1.382	0.0319
Cl_2	6.343	0.0542
CO_2	3.658	0.0429
CH_4	2.303	0.0431
NH_3	4.225	0.0371
H_2O	5.537	0.0305

Table 1-7. Properties of water

Property	Comparison to other substances
Heat capacity	Highest of all common liquids (except ammonia) and solids
Latent heat of fusion	Highest of all common liquids (except ammonia) and most solids
Latent heat of vaporization	Highest of all common substances
Dissolving ability	Dissolves more substances (particularly ionic compounds), and in greater quantity than any other common liquid.
Transparency	Relatively high for visible light
Physical state	Water is the only substance that occurs naturally in all three states at the earth's surface
Surface tension	Highest of all common liquids
Conduction of heat	Highest of all common liquids (Hg is higher)
Viscosity	Relatively low viscosity for a liquid

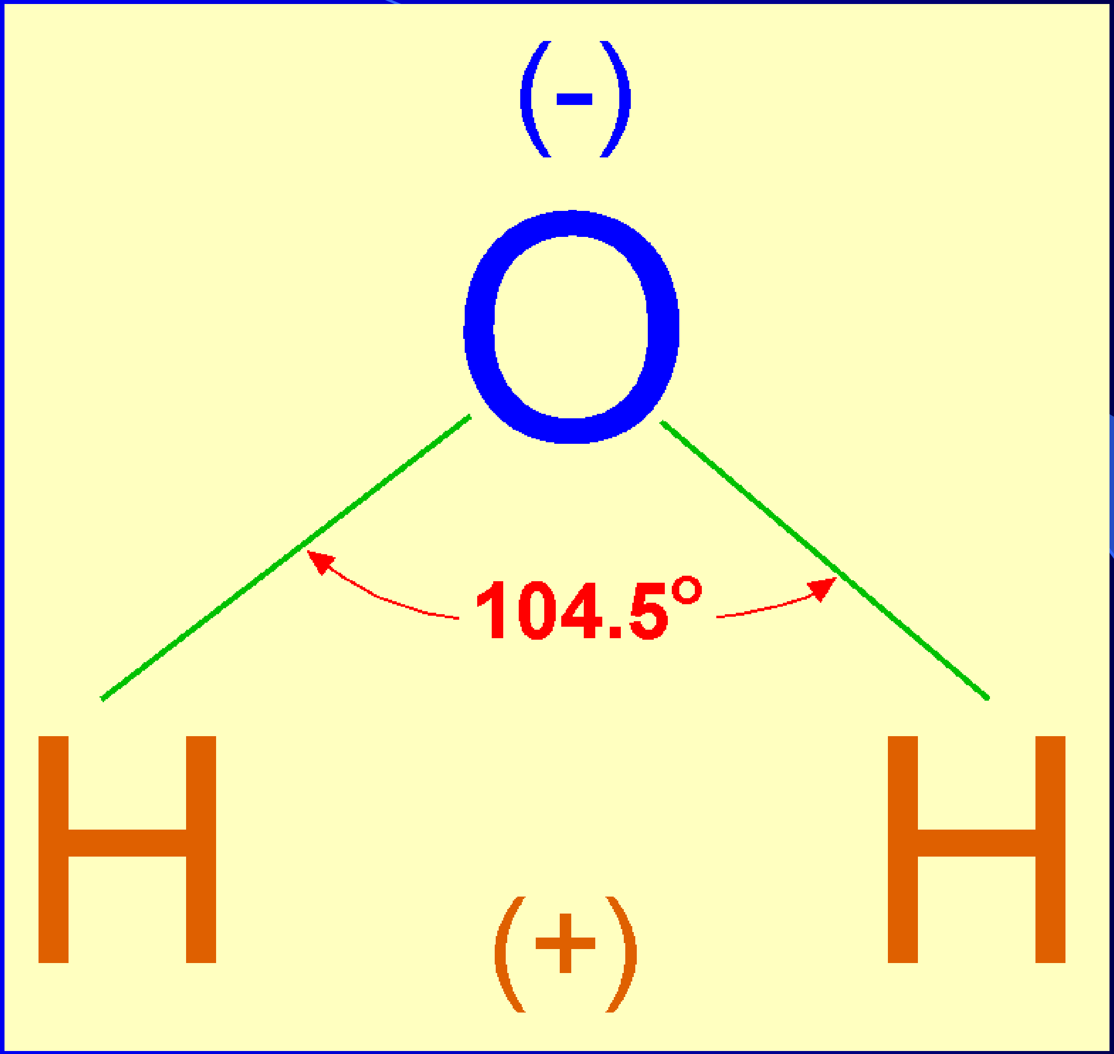
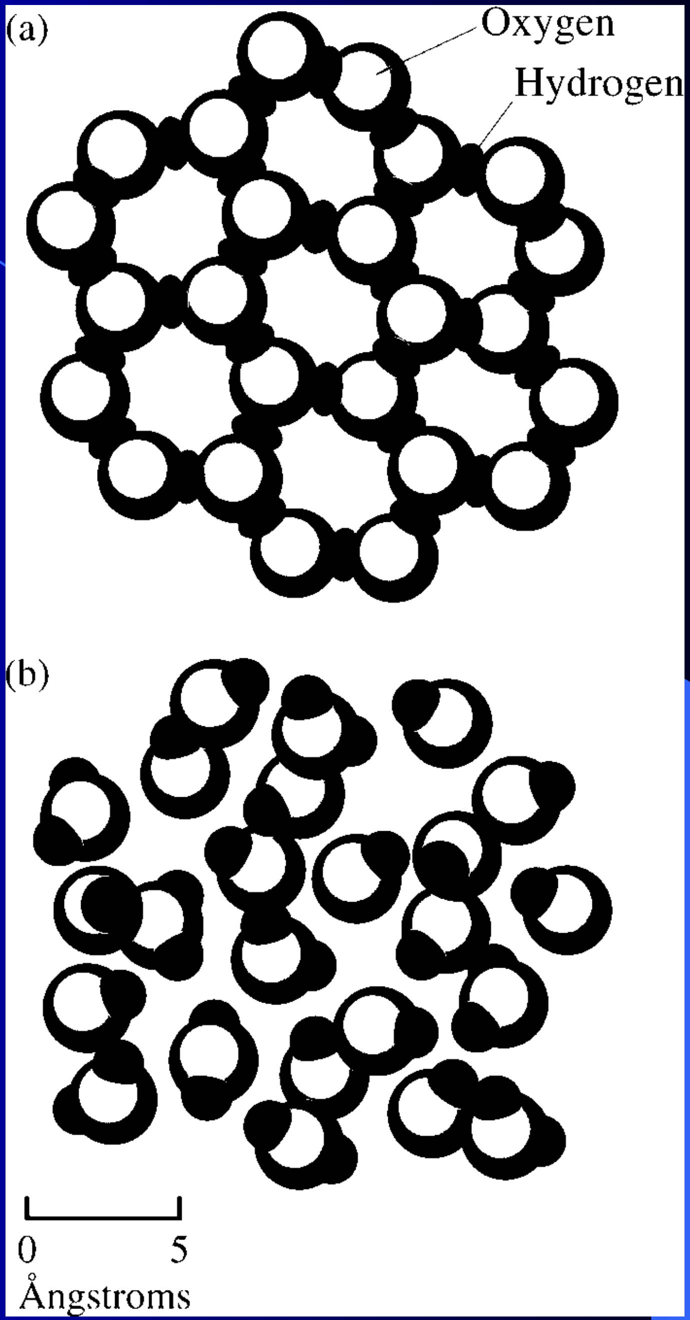


Figure 1-7. Structure of the water molecule. Water behaves as a polar molecule.

Figure 1-8. (a) The crystal structure of ice showing the six-sided rings formed by 24 water molecules. (b) The structure of liquid water. In the same volume of liquid water, there are 27 water molecules; hence, liquid water has a greater density than ice. From Gross and Gross (1996).



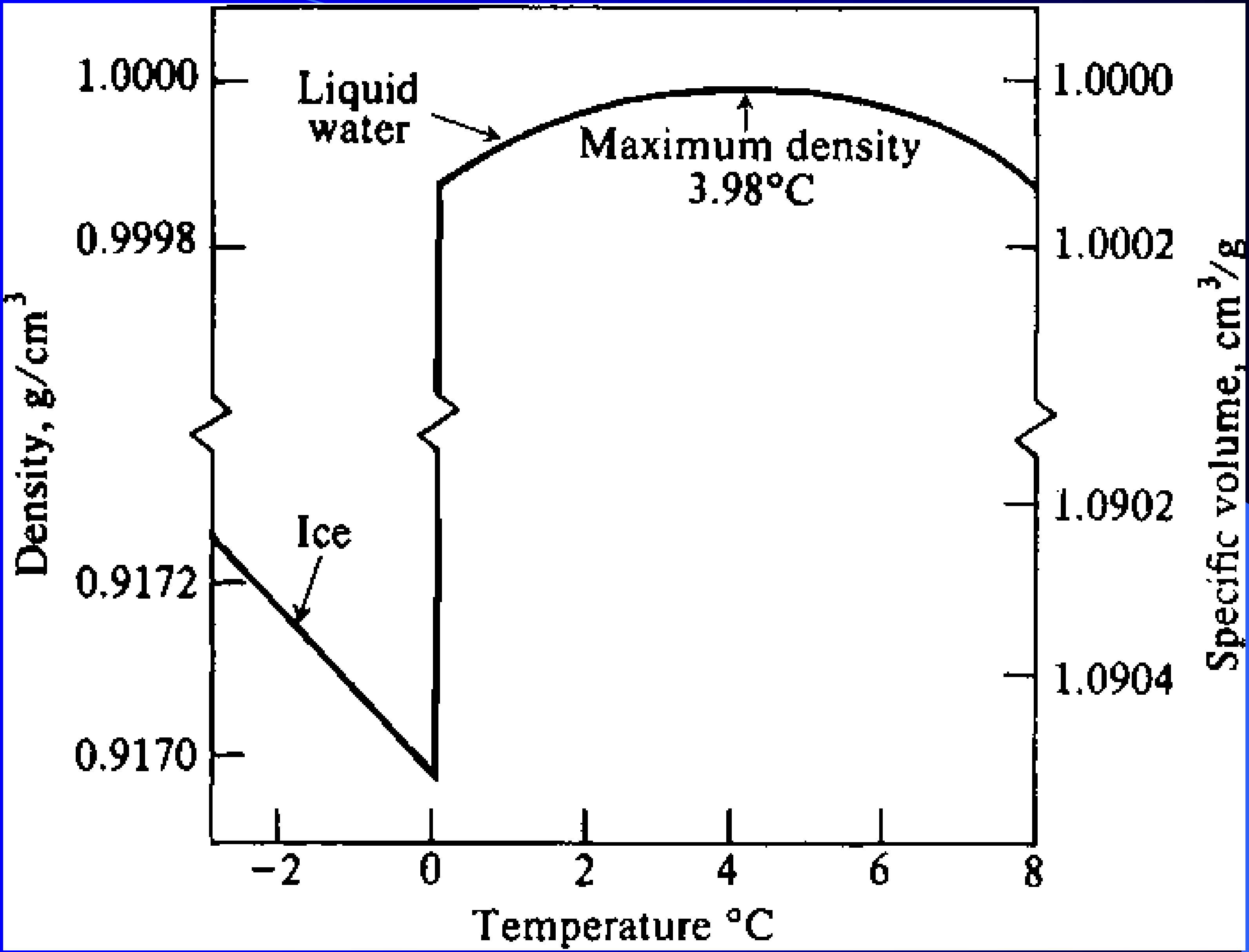


Figure 1-9. Density of pure water near the freezing point. From Duxbury (1971).

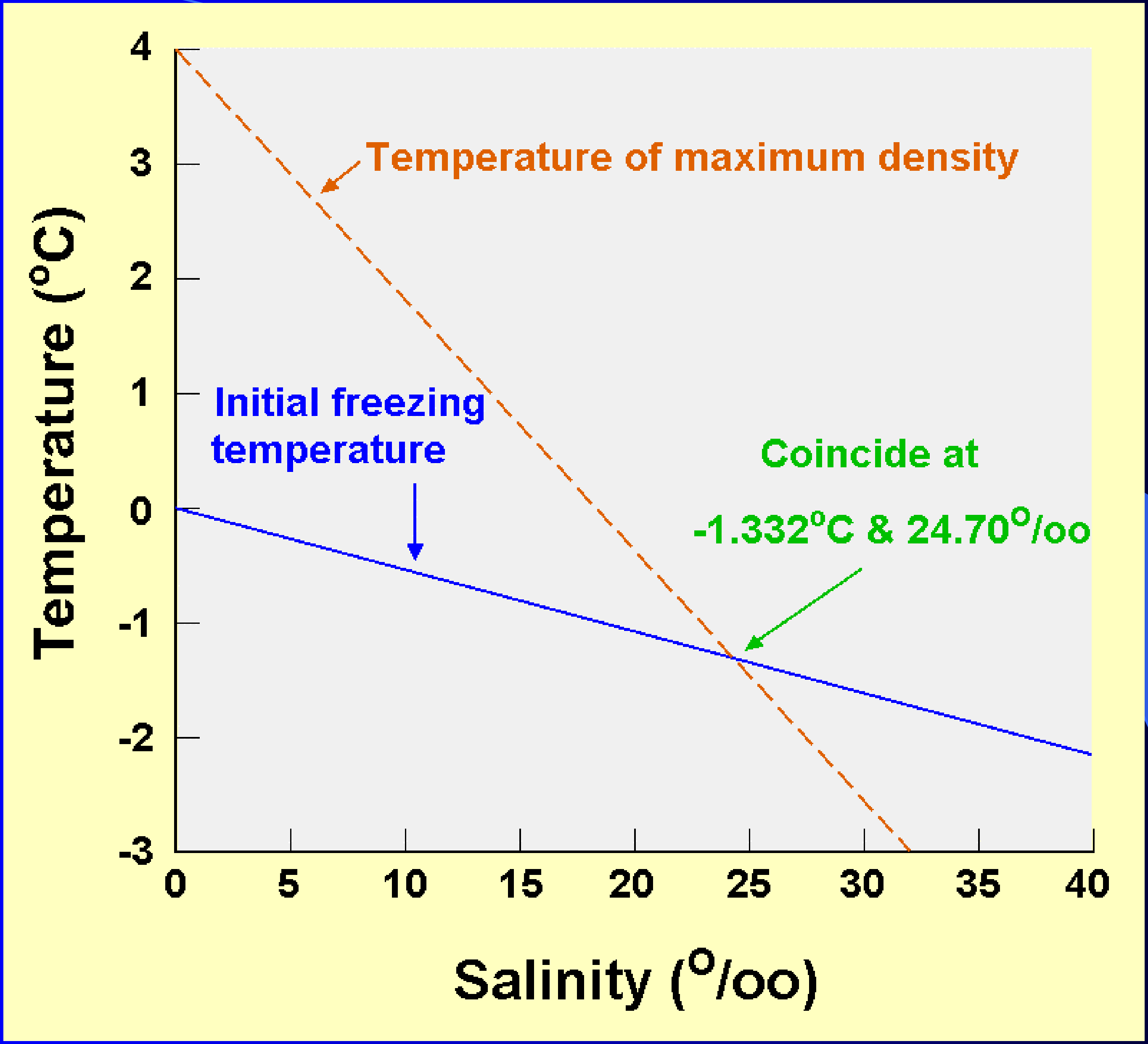


Figure 1-10. Relationship between salinity, decrease in freezing-point temperature, and temperature of maximum density. After Duxbury (1971).

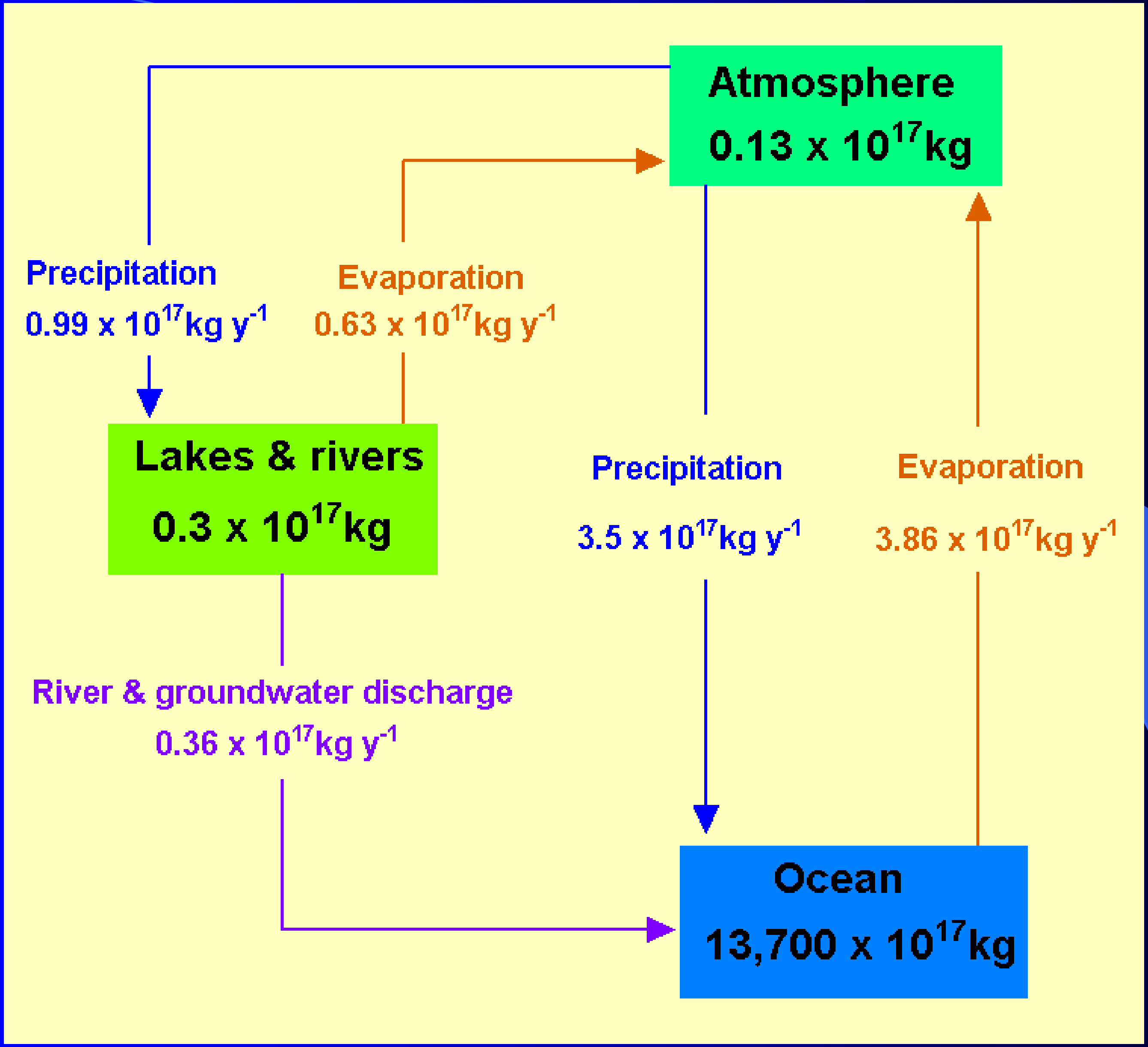


Figure 1-11. Simplified box model of the hydrologic cycle. Modified from Drever (1997).

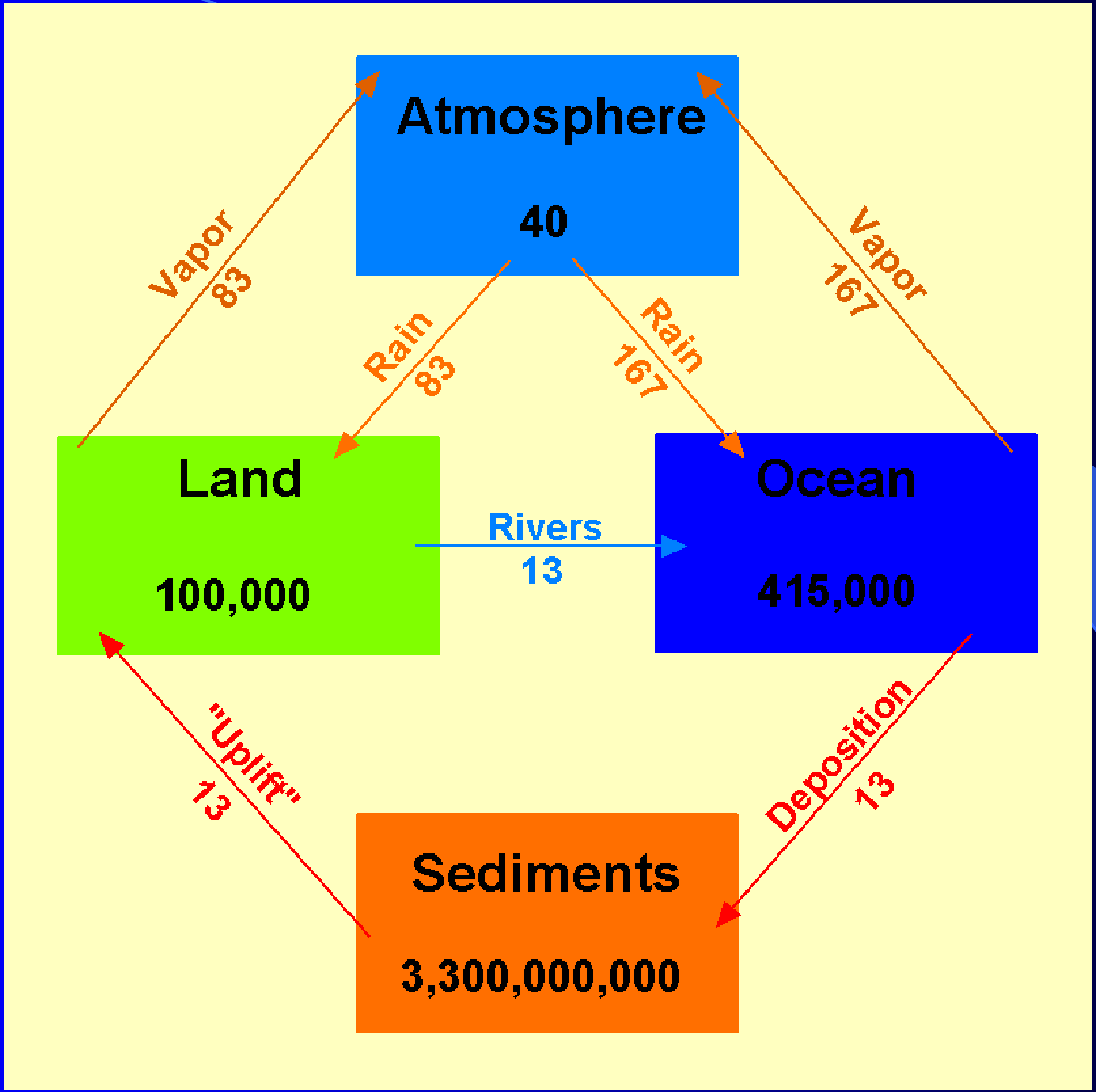


Figure 1-12. Prehuman cycle for mercury. Reservoir masses in units of 10^8 g. Fluxes in units of 10^8 g y^{-1}. From Garrels et al. (1975).

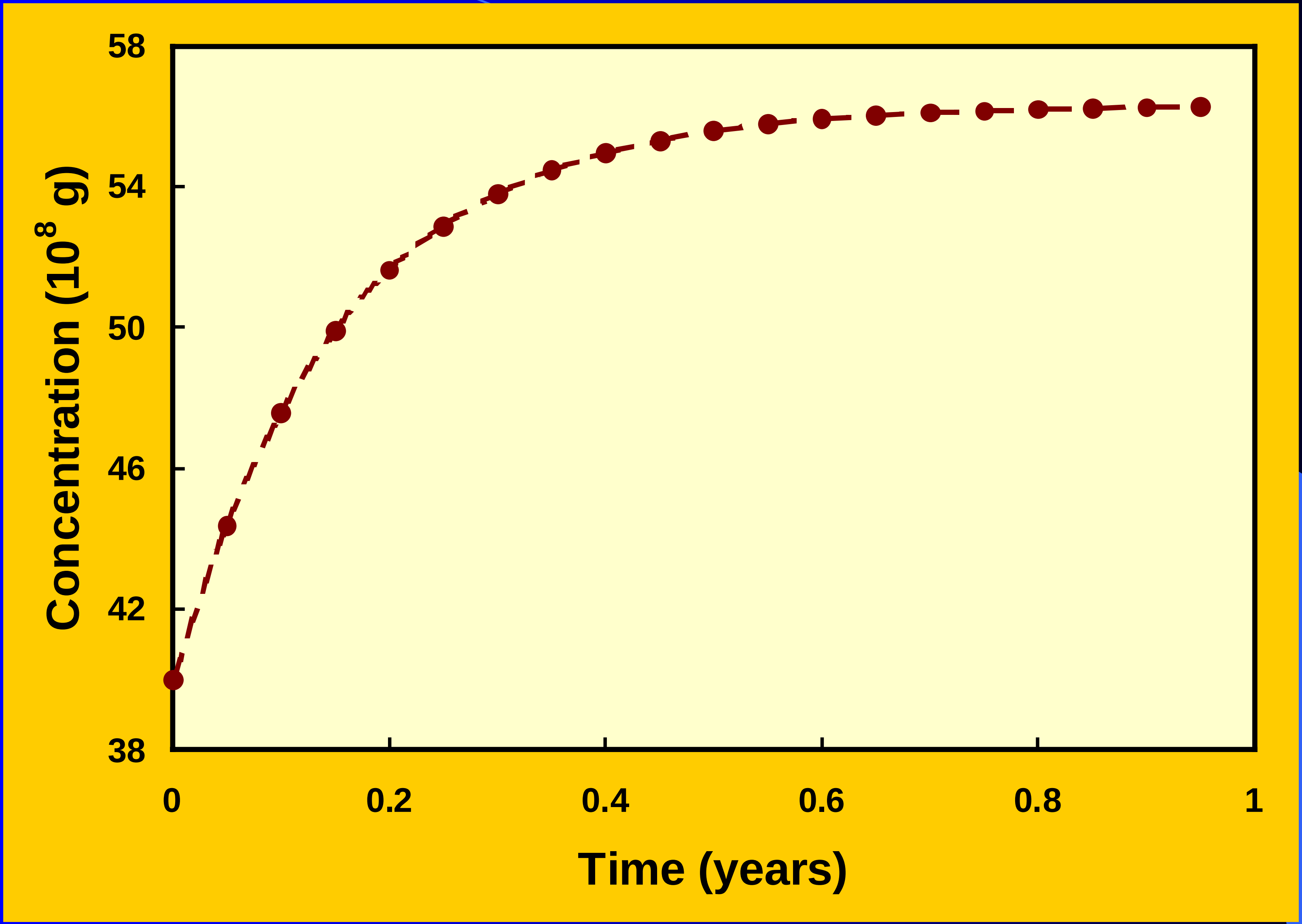


Figure 1-13. Variation in mercury content of the atmosphere as a function of time.

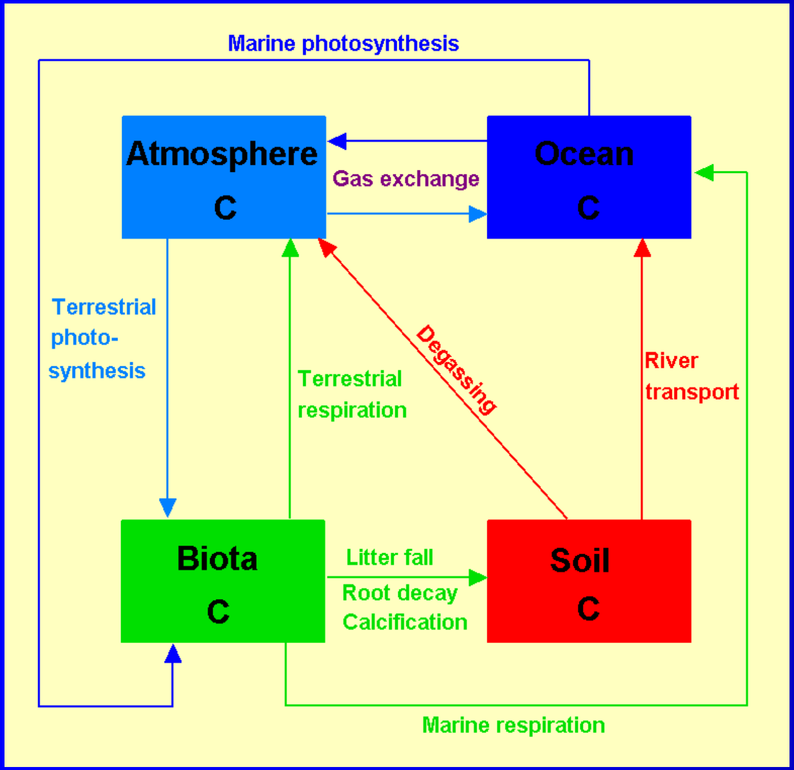


Figure 1-14a. The short-term carbon cycle, excluding anthropogenic inputs. After Berner (1999).

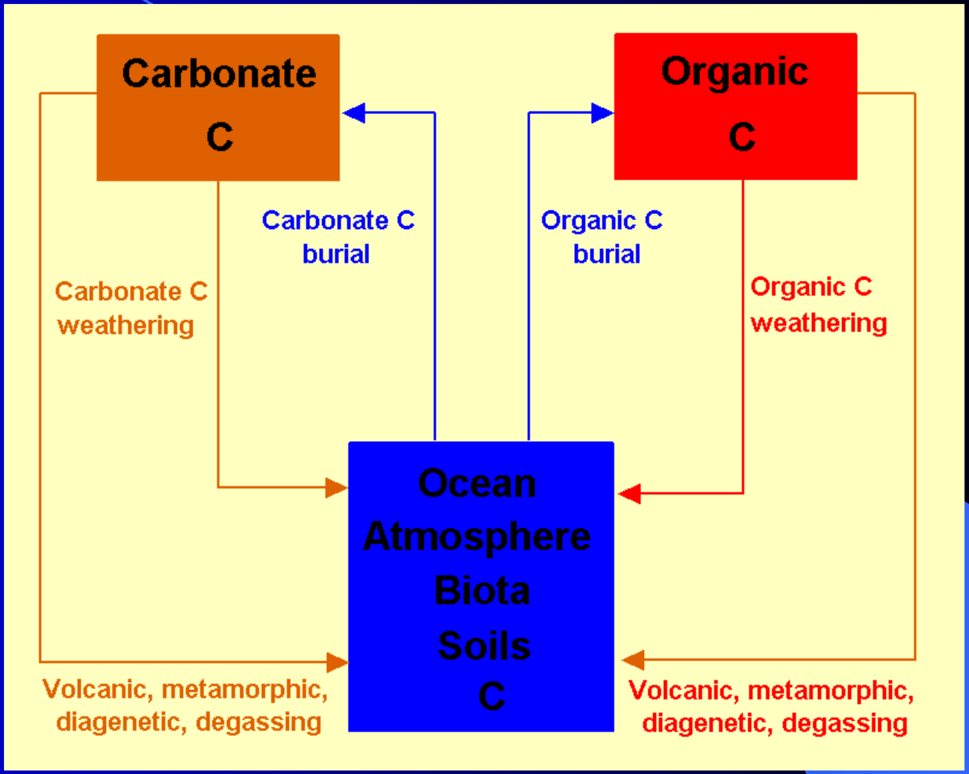


Figure 1-14b. The long term carbon cycle. After Berner (1999).

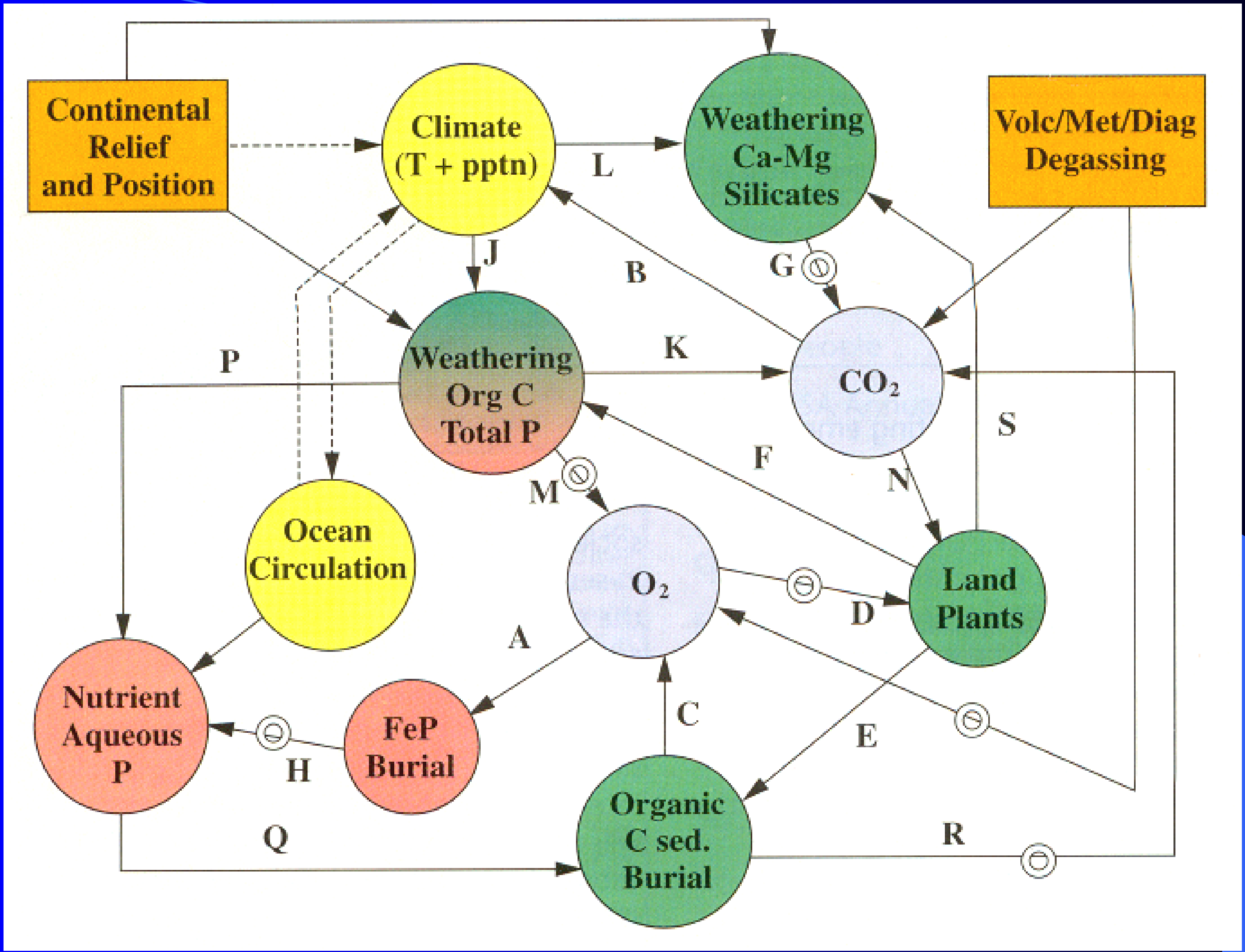


Figure 1-15. Cause-and-effect feedback diagram for the long-term carbon cycle. Arrows originate at causes and end at effects. Arrows with small concentric circles represent inverse responses; arrows without concentric circles represent direct responses. From Berner (1999).