ENERGY CONTENT AND PROCESSES

Energetic Processes

Entity	Process 1	Process 2	Process 3	Notes
ATP hydrolysis	$\Delta G^{0'}$ (standard) $-12.4 k_B T$ –30.5 kJ/mole	ΔG (in cell) ~ $-20 k_B T$[a] ~ –48 kJ/mole		$\Delta G = \Delta G^{0'} + RT \ln\left(\frac{[ADP][P_i]}{[ATP]}\right)$
Glucose	Complete oxidation $-1150 k_B T$ –2823 kJ/mole	Food energy 15.7 kJ/g		$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$
Gasoline (petrol)	Combustion energy 4800 kJ/mole[b]	Combustion energy 44.4 kJ/g		
Human body	Resting power ~100 W	Working power ~200 W	Brain power ~25 W	
Sun	Solar power (emitted) 3.85×10^{26} W	Solar power[c] 1370 W/m^2 (~1000 W/m^2)	Surface temperature 5780 K	See Chapter 9 (Figure 9.1)
Water	Specific heat 4180 J kg^{-1} K^{-1}	H bond energy $1–2 k_B T$	Heat of vapor[d] 2.26×10^6 J/kg (2.46×10^6)	See Chapter 4

[a] Value under cellular conditions: [ADP] = 8 × 10-4 M, [Pi] = 4 × 10-3 M, and [ATP] = 3 × 10-3 M (see Chapter 14). The relevance of this free energy in describing *in vivo* processes is debated.
[b] Assuming average molecular mass 108 D. http://www.atsdr.cdc.gov/MHMI/mmg72.html.
[c] Top of atmosphere (Earth surface).
[d] At 100°C (at 20°C).

CONVERSION FACTORS AND SYSTEMS OF UNITS

Energy

	eV	kJ/mole	kcal/mole	J[a]	pN·nm	K[b]	$k_B T_R$
1 eV =	1	96.49	23.05	1.602×10^{-19}	160.2	1.160×10^4	39.1
1 kJ/mole =	0.01036	1	0.2389	1.661×10^{-21}	1.661	120.3	0.405
1 kcal/mole =	0.04338	4.186	1	6.953×10^{-21}	6.953	503.5	1.70
1 J =	6.242×10^{18}	6.022×10^{20}	1.439×10^{20}	1	10^{21}	7.243×10^{22}	2.44×10^{20}
1 pN·nm =	6.242×10^{-3}	0.6020	0.1439	10^{-21}	1	72.43	0.244
1 K = [b]	8.619×10^{-5}	8.314×10^{-3}	1.986×10^{-3}	1.381×10^{-23}	0.01381	1	3.37×10^{-3}
$1 k_B T_R$ (at 297 K)	0.0256	2.47	0.590	4.10×10^{-21}	4.10	297	1

[a] 1 J = 10^7 ergs.
[b] $E = k_B T$, temperature in Kelvin.

Mass

	kg	g	mg	Dalton (u, amu)
1 kilogram	1	10^{3}	10^{6}	6.022×10^{26}
1 gram	10^{-3}	1	10^{3}	6.022×10^{23}
1 milligram	10^{-6}	10^{-3}	1	6.022×10^{20}
1 Dalton	1.661×10^{-27}	1.661×10^{-24}	1.661×10^{-21}	1

Length

	m	cm	mm	μm	nm	Å	inch
1 meter =	1	10^{2}	10^{3}	10^{6}	10^{9}	10^{10}	39.37
1 centimeter =	10^{-2}	1	10	10^{4}	10^{7}	10^{8}	0.3937
1 millimeter =	10^{-3}	10^{-1}	1	10^{3}	10^{6}	10^{7}	3.937×10^{-2}
1 micron =	10^{-6}	10^{-4}	10^{-3}	1	10^{3}	10^{4}	3.937×10^{-5}
1 nanometer =	10^{-9}	10^{-7}	10^{-6}	10^{-3}	1	10	3.937×10^{-8}
1 Ångström (Å) =	10^{-10}	10^{-8}	10^{-7}	10^{-4}	10^{-1}	1	3.937×10^{-9}
1 inch =	0.02540	2.540	25.40	2.540×10^{4}	2.540×10^{7}	2.540×10^{8}	1

Time

	ns	s	min	h	d	yr
1 nanosecond =	1	10^{-9}	1.667×10^{-11}	2.778×10^{-13}	1.157×10^{-14}	3.169×10^{-17}
1 second =	10^{9}	1	0.1667	2.778×10^{-4}	1.157×10^{-5}	3.169×10^{-8}
1 minute =	60×10^{9}	60	1	0.01667	6.944×10^{-4}	1.902×10^{-6}
1 hour =	3.600×10^{12}	3600	60	1	0.04167	1.141×10^{-4}
1 day =	8.640×10^{13}	86,400	1440	24	1	2.738×10^{-3}
1 year =	3.156×10^{16}	3.156×10^{7}	5.259×10^{5}	8766	365.24	1

FUNDAMENTAL CONSTANTS AND NUMBERS TO REMEMBER

Sizes and masses: See Table 1.1
Physical constants: See Table 1.2