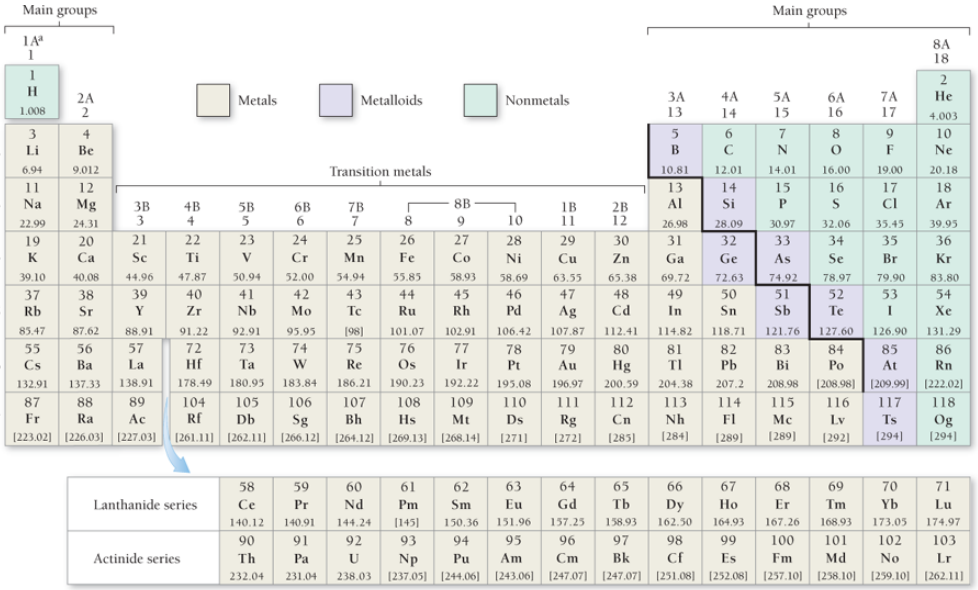
Pearson



[a] The labels on top (1A, 2A, etc.) are common American usage. The labels below these (1, 2, etc.) are those recommended by the International Union of Pure and Applied Chemistry.
Atomic masses in brackets are the masses of the longest-lived or most important isotope of radioactive elements.

List of Elements with Their Symbols and Atomic Masses

Element	Symbol	Atomic Number	Atomic Mass
Actinium	Ac	89	227.03[a]
Aluminum	Al	13	26.98
Americium	Am	95	243.06[a]
Antimony	Sb	51	121.76
Argon	Ar	18	39.95
Arsenic	As	33	74.92
Astatine	At	85	209.99[a]
Barium	Ba	56	137.33
Berkelium	Bk	97	247.07[a]
Beryllium	Be	4	9.012
Bismuth	Bi	83	208.98
Bohrium	Bh	107	264.12[a]
Boron	B	5	10.81
Bromine	Br	35	79.90
Cadmium	Cd	48	112.41
Calcium	Ca	20	40.08
Californium	Cf	98	251.08[a]
Carbon	C	6	12.01
Cerium	Ce	58	140.12
Cesium	Cs	55	132.91
Chlorine	Cl	17	35.45
Chromium	Cr	24	52.00
Cobalt	Co	27	58.93
Copernicium	Cn	112	285[a]
Copper	Cu	29	63.55
Curium	Cm	96	247.07[a]
Darmstadtium	Ds	110	271[a]
Dubnium	Db	105	262.11[a]
Dysprosium	Dy	66	162.50
Einsteinium	Es	99	252.08[a]
Erbium	Er	68	167.26
Europium	Eu	63	151.96
Fermium	Fm	100	257.10[a]
Flerovium	Fl	114	289[a]
Fluorine	F	9	19.00
Francium	Fr	87	223.02[a]
Gadolinium	Gd	64	157.25
Gallium	Ga	31	69.72
Germanium	Ge	32	72.63
Gold	Au	79	196.97
Hafnium	Hf	72	178.49
Hassium	Hs	108	269.13[a]
Helium	He	2	4.003
Holmium	Ho	67	164.93
Hydrogen	H	1	1.008
Indium	In	49	114.82
Iodine	I	53	126.90
Iridium	Ir	77	192.22
Iron	Fe	26	55.85
Krypton	Kr	36	83.80
Lanthanum	La	57	138.91

Element	Symbol	Atomic Number	Atomic Mass
Mendelevium	Md	101	258.10[a]
Mercury	Hg	80	200.59
Molybdenum	Mo	42	95.95
Moscovium	Mc	115	289[a]
Neodymium	Nd	60	144.24
Neon	Ne	10	20.18
Neptunium	Np	93	237.05[a]
Nickel	Ni	28	58.69
Nihonium	Nh	113	284[a]
Niobium	Nb	41	92.91
Nitrogen	N	7	14.01
Nobelium	No	102	259.10[a]
Oganesson	Og	118	294[a]
Osmium	Os	76	190.23
Oxygen	O	8	16.00
Palladium	Pd	46	106.42
Phosphorus	P	15	30.97
Platinum	Pt	78	195.08
Plutonium	Pu	94	244.06[a]
Polonium	Po	84	208.98[a]
Potassium	K	19	39.10
Praseodymium	Pr	59	140.91
Promethium	Pm	61	145[a]
Protactinium	Pa	91	231.04
Radium	Ra	88	226.03[a]
Radon	Rn	86	222.02[a]
Rhenium	Re	75	186.21
Rhodium	Rh	45	102.91
Roentgenium	Rg	111	272[a]
Rubidium	Rb	37	85.47
Ruthenium	Ru	44	101.07
Rutherfordium	Rf	104	261.11[a]
Samarium	Sm	62	150.36
Scandium	Sc	21	44.96
Seaborgium	Sg	106	266.12[a]
Selenium	Se	34	78.97
Silicon	Si	14	28.09
Silver	Ag	47	107.87
Sodium	Na	11	22.99
Strontium	Sr	38	87.62
Sulfur	S	16	32.06
Tantalum	Ta	73	180.95
Technetium	Tc	43	98[a]
Tellurium	Te	52	127.60
Tennessine	Ts	117	294[a]
Terbium	Tb	65	158.93
Thallium	Tl	81	204.38
Thorium	Th	90	232.04
Thulium	Tm	69	168.93
Tin	Sn	50	118.71
Titanium	Ti	22	47.87

Lawrencium	Lr	103	262.11[a]
Lead	Pb	82	207.2
Lithium	Li	3	6.94
Livermorium	Lv	116	292[a]
Lutetium	Lu	71	174.97
Magnesium	Mg	12	24.31
Manganese	Mn	25	54.94
Meitnerium	Mt	109	268.14[a]

Tungsten	W	74	183.84
Uranium	U	92	238.03
Vanadium	V	23	50.94
Xenon	Xe	54	131.293
Ytterbium	Yb	70	173.05
Yttrium	Y	39	88.91
Zinc	Zn	30	65.38
Zirconium	Zr	40	91.22

[a]Mass of longest-lived or most important isotope.

Selected Key Equations

Density (2.3)
$$d = \frac{m}{V}$$

Kinetic Energy (2.4)
$$\text{KE} = \frac{1}{2}mv^2$$

Frequency and Wavelength (3.2)
$$\nu = \frac{c}{\lambda}$$

Energy of a Photon (3.2)
$$E = h\nu$$
$$E = \frac{hc}{\lambda}$$

De Broglie Relation (3.4)
$$\lambda = \frac{h}{mv}$$

Heisenberg's Uncertainty Principle (3.4)
$$\Delta x \times m\,\Delta v \geq \frac{h}{4\pi}$$

Energy of Hydrogen Atom Levels (3.5)
$$E_n = -2.18 \times 10^{-18}\,\text{J}\left(\frac{1}{n^2}\right) \quad (n = 1, 2, 3\ldots)$$

Coulomb's Law (4.3)
$$E = \frac{1}{4\pi\varepsilon_o}\frac{q_1 q_2}{r}$$

Dipole Moment (6.2)
$$\mu = qr$$

Solution Dilution (9.2)
$$M_1 V_1 = M_2 V_2$$

Internal Energy (10.3)
$$\Delta E = q + w$$

Heat Capacity (10.4)
$$q = m \times C_s \times \Delta T$$

Pressure-Volume Work (10.4)
$$w = -P\,\Delta V$$

Change in Enthalpy (10.6)
$$\Delta H = \Delta E + P\,\Delta V$$

Standard Enthalpy of Reaction (10.10)
$$\Delta H^\circ_{\text{rxn}} = \sum \text{n}_\text{p}\,\Delta H^\circ_\text{f}(\text{products}) - \sum n_\text{r}\,\Delta H^\circ_\text{f}(\text{reactants})$$

Ideal Gas Law (11.4)
$$PV = nRT$$

Dalton's Law (11.6)
$$P_{\text{total}} = P_\text{a} + P_\text{b} + P_\text{c} + \ldots$$

Mole Fraction (11.6)
$$\chi_\text{a} = \frac{n_\text{a}}{n_{\text{total}}}$$

Average Kinetic Energy (11.8)
$$KE_{\text{avg}} = \frac{3}{2}RT$$

Root Mean Square Velocity (11.8)
$$u_{\text{rms}} = \sqrt{\frac{3\,RT}{\mathcal{M}}}$$

Effusion (11.9)
$$\frac{\text{rate A}}{\text{rate B}} = \sqrt{\frac{\mathcal{M}_\text{B}}{\mathcal{M}_\text{A}}}$$

Van der Waals Equation (11.11)
$$\left[P + \text{a}\left(\frac{n}{V}\right)^2\right] \times [V - n\text{b}] = nRT$$

Clausius–Clapeyron Equation (12.5)
$$\ln P_{\text{vap}} = \frac{-\Delta H_{\text{vap}}}{RT} + \ln\beta$$
$$\ln\frac{P_2}{P_1} = \frac{-\Delta H_{\text{vap}}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

Henry's Law (14.4)
$$S_{\text{gas}} = k_\text{H} P_{\text{gas}}$$

Raoult's Law (14.6)
$$P_{\text{solution}} = \chi_{\text{solvent}} P^\circ_{\text{solvent}}$$

Freezing Point Depression (14.6)
$$\Delta T_\text{f} = m \times K_\text{f}$$

Boiling Point Elevation Constant (14.6)
$$\Delta T_\text{b} = m \times K_\text{b}$$

Osmotic Pressure (14.6)
$$\Pi = MRT$$

The Rate Law (15.4)
$$\text{Rate} = k[\text{A}]^n \quad \text{(single reactant)}$$
$$\text{Rate} = k[\text{A}]^m[\text{B}]^n \quad \text{(multiple reactants)}$$

Integrated Rate Laws and Half-Life (15.5)

Order	Integrated Rate Law	Half-Life Expression
0	$[\text{A}]_t = -kt + [\text{A}]_0$	$t_{1/2} = \frac{[\text{A}]_0}{2k}$
1	$\ln[\text{A}]_t = -kt + \ln[\text{A}]_0$	$t_{1/2} = \frac{0.693}{k}$
2	$\frac{1}{[\text{A}]_t} = kt + \frac{1}{[\text{A}]_0}$	$t_{1/2} = \frac{1}{k[\text{A}]_0}$

Arrhenius Equation (15.6)
$$k = Ae^{\frac{-E_\text{a}}{RT}}$$
$$\ln k = -\frac{E_\text{a}}{R}\left(\frac{1}{T}\right) + \ln A \quad \text{(linearized form)}$$
$$k = pz\,e^{\frac{-E_\text{a}}{RT}} \quad \text{(collision theory)}$$

K_c and K_p (16.4)
$$K_\text{p} = K_\text{c}(RT)^{\Delta n}$$

pH Scale (17.6)
$$\text{pH} = -\log[\text{H}_3\text{O}^+]$$

Henderson–Hasselbalch Equation (18.2)
$$\text{pH} = \text{p}K_\text{a} + \log\frac{[\text{base}]}{[\text{acid}]}$$

Entropy (19.3)
$$S = k\ln W$$

Change in the Entropy of the Surroundings (19.5)
$$\Delta S_{\text{surr}} = \frac{-\Delta H_{\text{sys}}}{T}$$

Change in Gibbs Free Energy (19.6)
$$\Delta G = \Delta H - T\,\Delta S$$

The Change in Free Energy: Nonstandard Conditions (19.8)
$$\Delta G_{\text{rxn}} = \Delta G^\circ_{\text{rxn}} + RT\ln Q$$

$\Delta G^\circ_{\text{rxn}}$ and K (19.9)
$$\Delta G^\circ_{\text{rxn}} = -RT\ln K$$

Temperature Dependence of the Equilibrium Constant (19.9)
$$\ln K = -\frac{\Delta H^\circ_{\text{rxn}}}{R}\left(\frac{1}{T}\right) + \frac{\Delta S^\circ_{\text{rxn}}}{R}$$

ΔG° and E°_{cell} (20.5)
$$\Delta G^\circ = -nFE^\circ_{\text{cell}}$$

E°_{cell} and K (20.5)
$$E^\circ_{\text{cell}} = \frac{0.0592\,\text{V}}{n}\log K$$

Nernst Equation (20.6)
$$E_{\text{cell}} = E^\circ_{\text{cell}} - \frac{0.0592\,\text{V}}{n}\log Q$$

Einstein's Energy-Mass Equation (21.8)
$$E = mc^2$$

Conversion Factors and Relationships

Length
SI unit: meter (m)

1 m = 1.0936 yd
1 cm = 0.39370 in
1 in = 2.54 cm (exactly)
1 km = 0.62137 mi
1 mi = 5280 ft
= 1.6093 km
1 Å = 10^{-10} m

Temperature
SI unit: kelvin (K)

0 K = −273.15 °C
= −459.67 °F
K = °C + 273.15
$°\text{C} = \frac{(°\text{F} - 32)}{1.8}$
°F = 1.8 (°C) + 32

Energy (derived)
SI unit: joule (J)

1 J = 1 kg · m^2/s^2
= 0.23901 cal
= 1 C · V
= 9.4781 × 10^{-4} Btu
1 cal = 4.184 J
1 eV = 1.6022 × 10^{-19} J

Pressure (derived)
SI unit: pascal (Pa)

1 Pa = $1\,\text{N/m}^2$
= $1\,\text{kg}/(\text{m} \cdot \text{s}^2)$
1 atm = 101,325 Pa
= 760 torr
= 14.70 lb/in^2
1 bar = 10^5 Pa
1 torr = 1 mmHg

Volume (derived)
SI unit: cubic meter (m^3)

1 L = $10^{-3}\,\text{m}^3$
= $1\,\text{dm}^3$
= $10^3\,\text{cm}^3$
= 1.0567 qt
1 gal = 4 qt
= 3.7854 L
$1\,\text{cm}^3$ = 1 mL
$1\,\text{in}^3$ = 16.39 cm^3

Mass
SI unit: kilogram (kg)

1 kg = 2.2046 lb
1 lb = 453.59 g
= 16 oz
1 amu = 1.66053873 × 10^{-27} kg
1 ton = 2000 lb
= 907.185 kg
1 metric ton = 1000 kg
= 2204.6 lb

Geometric Relationships

π	= 3.14159 . . .
Circumference of a circle	$= 2\pi r$
Area of a circle	$= \pi r^2$
Surface area of a sphere	$= 4\pi r^2$
Volume of a sphere	$= \frac{4}{3}\pi r^3$
Volume of a cylinder	$= \pi r^2 h$

1 qt	= 32 fluid oz	

Fundamental Constants

Atomic mass unit	1 amu 1 g	$= 1.66053873 \times 10^{-27}$ kg $= 6.02214199 \times 10^{23}$ amu
Avogadro's number	N_A	$= 6.02214179 \times 10^{23}$/mol
Bohr radius	a_0	$= 5.29177211 \times 10^{-11}$ m
Boltzmann's constant	k	$= 1.38065052 \times 10^{-23}$ J/K
Electron charge	e	$= 1.60217653 \times 10^{-19}$ C
Faraday's constant	F	$= 9.64853383 \times 10^{4}$ C/mol
Gas constant	R	$= 0.08205821$ (L · atm/(mol · K) $= 8.31447215$ J/(mol · K)
Mass of an electron	m_e	$= 5.48579909 \times 10^{-4}$ amu $= 9.10938262 \times 10^{-31}$ kg
Mass of a neutron	m_n	$= 1.00866492$ amu $= 1.67492728 \times 10^{-27}$ kg
Mass of a proton	m_p	$= 1.00727647$ amu $= 1.67262171 \times 10^{-27}$ kg
Planck's constant	h	$= 6.62606931 \times 10^{-34}$ J · s
Speed of light in vacuum	c	$= 2.99792458 \times 10^{8}$ m/s (exactly)

SI Unit Prefixes

a	f	p	n	μ	m	c	d	k	M	G	T	P	E
atto	femto	pico	nano	micro	milli	centi	deci	kilo	mega	giga	tera	peta	exa
10^{-18}	10^{-15}	10^{-12}	10^{-9}	10^{-6}	10^{-3}	10^{-2}	10^{-1}	10^{3}	10^{6}	10^{9}	10^{12}	10^{15}	10^{18}