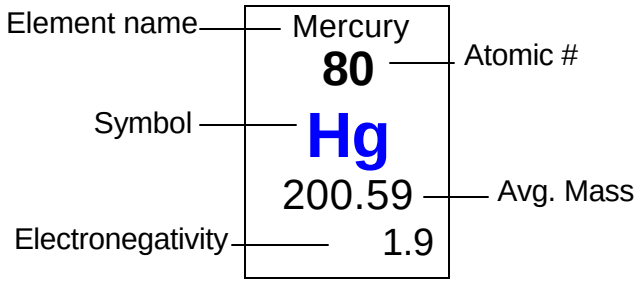
The Modern Periodic Table of the Elements

Average relative masses are 2001 values, rounded to two decimal places.

All average masses are to be treated as measured quantities, and subject to significant figure rules. Do not round them further when performing calculations.



1												13	14	15	16	17	18
Hydrogen 1 H 1.01 2.1	2																Helium 2 He 4.00 ---
Lithium 3 Li 6.94 1.0	Beryllium 4 Be 9.01 1.5											Boron 5 B 10.81 2.0	Carbon 6 C 12.01 2.5	Nitrogen 7 N 14.01 3.0	Oxygen 8 O 16.00 3.5	Fluorine 9 F 19.00 4.0	Neon 10 Ne 20.18 ---
Sodium 11 Na 22.99 0.9	Magnesium 12 Mg 24.31 1.2		3	4	5	6	7	8	9	10	11	12	Aluminum 13 Al 26.98 1.5	Silicon 14 Si 28.09 1.8	Phosphorus 15 P 30.97 2.1	Sulfur 16 S 32.07 2.5	Chlorine 17 Cl 35.45 3.0	Argon 18 Ar 39.95 ---
Potassium 19 K 39.10 0.8	Calcium 20 Ca 40.08 1.0		Scandium 21 Sc 44.96 1.3	Titanium 22 Ti 47.88 1.5	Vanadium 23 V 50.94 1.6	Chromium 24 Cr 52.00 1.6	Manganese 25 Mn 54.94 1.5	Iron 26 Fe 55.85 1.8	Cobalt 27 Co 58.93 1.8	Nickel 28 Ni 58.69 1.8	Copper 29 Cu 63.55 1.9	Zinc 30 Zn 65.39 1.6	Gallium 31 Ga 69.72 1.6	Germanium 32 Ge 72.61 1.8	Arsenic 33 As 74.92 2.0	Selenium 34 Se 78.96 2.4	Bromine 35 Br 79.90 2.8	Krypton 36 Kr 83.80 3.0
Rubidium 37 Rb 85.47 0.8	Strontium 38 Sr 87.62 1.0		Yttrium 39 Y 88.91 1.2	Zirconium 40 Zr 91.22 1.4	Niobium 41 Nb 92.91 1.6	Molybdenum 42 Mo 95.94 1.8	Technetium 43 Tc (98) 1.9	Ruthenium 44 Ru 101.07 2.2	Rhodium 45 Rh 102.91 2.2	Palladium 46 Pd 106.42 2.2	Silver 47 Ag 107.87 1.9	Cadmium 48 Cd 112.41 1.7	Indium 49 In 114.82 1.7	Tin 50 Sn 118.71 1.8	Antimony 51 Sb 121.76 1.9	Tellurium 52 Te 127.60 2.1	Iodine 53 I 126.90 2.5	Xenon 54 Xe 131.29 2.6
Cesium 55 Cs 132.91 0.7	Barium 56 Ba 137.33 0.9	57-70 *	Lutetium 71 Lu 174.97 1.1	Hafnium 72 Hf 178.49 1.3	Tantalum 73 Ta 180.95 1.5	Tungsten 74 W 183.84 1.7	Rhenium 75 Re 186.21 1.9	Osmium 76 Os 190.23 2.2	Iridium 77 Ir 192.22 2.2	Platinum 78 Pt 195.08 2.2	Gold 79 Au 196.97 2.4	Mercury 80 Hg 200.59 1.9	Thallium 81 Tl 204.38 1.8	Lead 82 Pb 207.20 1.8	Bismuth 83 Bi 208.98 1.9	Polonium 84 Po (209) 2.0	Astatine 85 At (210) 2.2	Radon 86 Rn (222) 2.4
Francium 87 Fr (223) 0.7	Radium 88 Ra (226) 0.9	89-102 **	Lawrencium 103 Lr (262) ---	Rutherfordium 104 Rf (261) ---	Dubnium 105 Db (262) ---	Seaborgium 106 Sg (263) ---	Bohrium 107 Bh (262) ---	Hassium 108 Hs (265) ---	Meitnerium 109 Mt (266) ---	Ununnilum 110 Uun (271) ---	Unununium 111 Uuu (272) ---	Ununbium 112 Uub (277) ---		Ununquadium 114 Uuq (289) ---				

*lanthanides	Lanthanum 57 La 138.91 1.1	Cerium 58 Ce 140.12 1.1	Praseodymium 59 Pr 140.91 1.1	Neodymium 60 Nd 144.24 1.1	Promethium 61 Pm (145) 1.1	Samarium 62 Sm 150.36 1.2	Europium 63 Eu 151.97 1.1	Gadolinium 64 Gd 157.25 1.2	Terbium 65 Tb 158.93 1.1	Dysprosium 66 Dy 162.50 1.2	Holmium 67 Ho 164.93 1.2	Erbium 68 Er 167.26 1.2	Thulium 69 Tm 168.93 1.3	Ytterbium 70 Yb 173.04 1.1
**actinides	Actinium 89 Ac (227) 1.1	Thorium 90 Th 232.04 1.3	Protactinium 91 Pa 231.04 1.5	Uranium 92 U 238.03 1.4	Neptunium 93 Np (237) 1.4	Plutonium 94 Pu (244) 1.3	Americium 95 Am (243) 1.3	Curium 96 Cm (247) 1.3	Berkelium 97 Bk (247) 1.3	Californium 98 Cf (251) 1.3	Einsteinium 99 Es (252) 1.3	Fermium 100 Fm (257) 1.3	Mendelevium 101 Md (258) 1.3	Nobelium 102 No (259) 1.3

Atomic structure and energy

$$\Delta E = h\nu$$

$$c = \lambda\nu$$

Gases, liquids and solutions

$$PV = nRT$$

$$n = \frac{m}{M}$$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$P_{TOTAL} = P_A + P_B + P_C + \ldots$$

$$K = °C + 273$$

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

Kinetic Energy (KE) = $\frac{1}{2}m\upsilon^2$

Density = $\frac{m}{V}$

$$\Delta T_f = iK_f \cdot molality$$

$$\Delta T_b = iK_b \cdot molality$$

Acids, Bases, and pH

$K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$ (at 25°C)

$pH = -\log [H^+]$ $\quad pOH = -\log [OH^-]$

$[H^+] = 10^{-pH}$ $\quad [OH^-] = 10^{-pOH}$

Equilibrium

$Q = \frac{[C]^c[D]^d}{[A]^a[B]^b}$ where aA + bB ¾ cC + dD

Thermochemistry

$$\Delta H^0 = \sum \Delta H_f^0 products - \sum \Delta H_f^0 reac\tan ts$$

$$\Delta G^0 = \Delta H^0 - T\Delta S^0$$

$$q = mc\Delta T \qquad C_p = \frac{\Delta H}{\Delta T}$$

Constants

Speed of light, $c = 3.00 \times 10^8$ meters/s

Planck's Constant, $h = 6.63 \times 10^{-34}$ joule·s

Avogadro's Number = 6.022×10^{23}

Gas Constant, $R = 0.0821 \frac{L \cdot atm}{mol \cdot K}$

STP = 0.000°C and 1.000 atmosphere

Standard molar volume = 22.4 L

Freezing point depression constant for water,

$$K_f = \frac{1.86°C}{molal}$$

Boiling point elevation constant for water,

$$K_b = \frac{0.51°C}{molal}$$

Symbols

E = energy

λ = wavelength

ν = frequency

m = mass

M = molar mass in grams per mole

q = heat

P = pressure

V = volume

n = moles

T = temperature

D = density

υ = velocity

r = rate of effusion

t = time (seconds = s)

c = specific heat capacity

C_p = molar heat capacity at constant P

i = van't Hoff factor

Q = reaction quotient

S^0 = standard entropy

H^0 = standard enthalpy

G^0 = standard free energy