PERIODIC TABLE

Atomic Properties of the Elements

NIST NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY
U.S. DEPARTMENT OF COMMERCE

Physical Measurement Laboratory www.nist.gov/pml
Standard Reference Data www.nist.gov/srd

FREQUENTLY USED FUNDAMENTAL PHYSICAL CONSTANTS[§]

1 second = 9 192 631 770 periods of radiation corresponding to the transition between the two hyperfine levels of the ground state of ^{133}Cs

speed of light in vacuum	c	299 792 458 m s^{-1}	(exact)
Planck constant	h	6.626 070 15 x 10^{-34} J Hz^{-1}	(exact)
elementary charge	e	1.602 176 634 x 10^{-19} C	(exact)
Avogadro constant	N_A	6.022 140 76 x 10^{23} mol^{-1}	(exact)
Boltzmann constant	k	1.380 649 x 10^{-23} J K^{-1}	(exact)
electron volt	eV	1.602 176 634 x 10^{-19} J	(exact)
electron mass	m_e	9.109 383 71 x 10^{-31} kg	
energy equivalent	$m_e c^2$	0.510 998 951 MeV	
proton mass	m_p	1.672 621 926 x 10^{-27} kg	
energy equivalent	$m_p c^2$	938.272 089 MeV	
fine-structure constant	α	1/137.035 999	
Rydberg energy	$R_\infty hc$	13.605 693 1230 eV	
Newtonian constant of gravitation	G	6.674 x 10^{-11} m^3 kg^{-1} s^{-2}	

[§]For the most accurate values of these and other constants, visit pml.nist.gov/constants.

Solids
Liquids
Gases
Artificially Prepared

Group	1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIII	10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
Period 1	1 $^2S_{1/2}$ **H** Hydrogen 1.008 $1s$ 13.5984																	2 $^1S_0$ **He** Helium 4.0026 $1s^2$ 24.5874
2	3 $^2S_{1/2}$ **Li** Lithium 6.94 $1s^2 2s$ 5.3917	4 $^1S_0$ **Be** Beryllium 9.0122 $1s^2 2s^2$ 9.3227											5 $^2P^o_{1/2}$ **B** Boron 10.81 $1s^2 2s^2 2p$ 8.2980	6 $^3P_0$ **C** Carbon 12.011 $1s^2 2s^2 2p^2$ 11.2603	7 $^4S^o_{3/2}$ **N** Nitrogen 14.007 $1s^2 2s^2 2p^3$ 14.5341	8 $^3P_2$ **O** Oxygen 15.999 $1s^2 2s^2 2p^4$ 13.6181	9 $^2P^o_{3/2}$ **F** Fluorine 18.998 $1s^2 2s^2 2p^5$ 17.4228	10 $^1S_0$ **Ne** Neon 20.180 $1s^2 2s^2 2p^6$ 21.5645
3	11 $^2S_{1/2}$ **Na** Sodium 22.990 $[Ne]3s$ 5.1391	12 $^1S_0$ **Mg** Magnesium 24.305 $[Ne]3s^2$ 7.6462											13 $^2P^o_{1/2}$ **Al** Aluminum 26.982 $[Ne]3s^2 3p$ 5.9858	14 $^3P_0$ **Si** Silicon 28.085 $[Ne]3s^2 3p^2$ 8.1517	15 $^4S^o_{3/2}$ **P** Phosphorus 30.974 $[Ne]3s^2 3p^3$ 10.4867	16 $^3P_2$ **S** Sulfur 32.06 $[Ne]3s^2 3p^4$ 10.3600	17 $^2P^o_{3/2}$ **Cl** Chlorine 35.45 $[Ne]3s^2 3p^5$ 12.9676	18 $^1S_0$ **Ar** Argon 39.95 $[Ne]3s^2 3p^6$ 15.7596
4	19 $^2S_{1/2}$ **K** Potassium 39.098 $[Ar]4s$ 4.3407	20 $^1S_0$ **Ca** Calcium 40.078 $[Ar]4s^2$ 6.1132	21 $^2D_{3/2}$ **Sc** Scandium 44.956 $[Ar]3d4s^2$ 6.5615	22 $^3F_2$ **Ti** Titanium 47.867 $[Ar]3d^2 4s^2$ 6.8281	23 $^4F_{3/2}$ **V** Vanadium 50.942 $[Ar]3d^3 4s^2$ 6.7462	24 $^7S_3$ **Cr** Chromium 51.996 $[Ar]3d^5 4s$ 6.7665	25 $^6S_{5/2}$ **Mn** Manganese 54.938 $[Ar]3d^5 4s^2$ 7.4340	26 $^5D_4$ **Fe** Iron 55.845 $[Ar]3d^6 4s^2$ 7.9025	27 $^4F_{9/2}$ **Co** Cobalt 58.933 $[Ar]3d^7 4s^2$ 7.8810	28 $^3F_4$ **Ni** Nickel 58.693 $[Ar]3d^8 4s^2$ 7.6399	29 $^2S_{1/2}$ **Cu** Copper 63.546 $[Ar]3d^{10} 4s$ 7.7264	30 $^1S_0$ **Zn** Zinc 65.38 $[Ar]3d^{10} 4s^2$ 9.3942	31 $^2P^o_{1/2}$ **Ga** Gallium 69.723 $[Ar]3d^{10} 4s^2 4p$ 5.9993	32 $^3P_0$ **Ge** Germanium 72.630 $[Ar]3d^{10} 4s^2 4p^2$ 7.8994	33 $^4S^o_{3/2}$ **As** Arsenic 74.922 $[Ar]3d^{10} 4s^2 4p^3$ 9.7886	34 $^3P_2$ **Se** Selenium 78.971 $[Ar]3d^{10} 4s^2 4p^4$ 9.7524	35 $^2P^o_{3/2}$ **Br** Bromine 79.904 $[Ar]3d^{10} 4s^2 4p^5$ 11.8138	36 $^1S_0$ **Kr** Krypton 83.798 $[Ar]3d^{10} 4s^2 4p^6$ 13.9996
5	37 $^2S_{1/2}$ **Rb** Rubidium 85.468 $[Kr]5s$ 4.1771	38 $^1S_0$ **Sr** Strontium 87.62 $[Kr]5s^2$ 5.6949	39 $^2D_{3/2}$ **Y** Yttrium 88.906 $[Kr]4d5s^2$ 6.2173	40 $^3F_2$ **Zr** Zirconium 91.224 $[Kr]4d^2 5s^2$ 6.6341	41 $^6D_{1/2}$ **Nb** Niobium 92.906 $[Kr]4d^4 5s$ 6.7589	42 $^7S_3$ **Mo** Molybdenum 95.95 $[Kr]4d^5 5s$ 7.0924	43 $^6S_{5/2}$ **Tc** Technetium (97) $[Kr]4d^5 5s^2$ 7.1194	44 $^5F_5$ **Ru** Ruthenium 101.07 $[Kr]4d^7 5s$ 7.3605	45 $^4F_{9/2}$ **Rh** Rhodium 102.91 $[Kr]4d^8 5s$ 7.4589	46 $^1S_0$ **Pd** Palladium 106.42 $[Kr]4d^{10}$ 8.3368	47 $^2S_{1/2}$ **Ag** Silver 107.87 $[Kr]4d^{10} 5s$ 7.5762	48 $^1S_0$ **Cd** Cadmium 112.41 $[Kr]4d^{10} 5s^2$ 8.9938	49 $^2P^o_{1/2}$ **In** Indium 114.82 $[Kr]4d^{10} 5s^2 5p$ 5.7864	50 $^3P_0$ **Sn** Tin 118.71 $[Kr]4d^{10} 5s^2 5p^2$ 7.3439	51 $^4S^o_{3/2}$ **Sb** Antimony 121.76 $[Kr]4d^{10} 5s^2 5p^3$ 8.6084	52 $^3P_2$ **Te** Tellurium 127.60 $[Kr]4d^{10} 5s^2 5p^4$ 9.0098	53 $^2P^o_{3/2}$ **I** Iodine 126.90 $[Kr]4d^{10} 5s^2 5p^5$ 10.4512	54 $^1S_0$ **Xe** Xenon 131.29 $[Kr]4d^{10} 5s^2 5p^6$ 12.1298
6	55 $^2S_{1/2}$ **Cs** Cesium 132.91 $[Xe]6s$ 3.8939	56 $^1S_0$ **Ba** Barium 137.33 $[Xe]6s^2$ 5.2117		72 $^3F_2$ **Hf** Hafnium 178.49 $[Xe]4f^{14} 5d^2 6s^2$ 6.8251	73 $^4F_{3/2}$ **Ta** Tantalum 180.95 $[Xe]4f^{14} 5d^3 6s^2$ 7.5496	74 $^5D_0$ **W** Tungsten 183.84 $[Xe]4f^{14} 5d^4 6s^2$ 7.8640	75 $^6S_{5/2}$ **Re** Rhenium 186.21 $[Xe]4f^{14} 5d^5 6s^2$ 7.8335	76 $^5D_4$ **Os** Osmium 190.23 $[Xe]4f^{14} 5d^6 6s^2$ 8.4382	77 $^4F_{9/2}$ **Ir** Iridium 192.22 $[Xe]4f^{14} 5d^7 6s^2$ 8.9670	78 $^3D_3$ **Pt** Platinum 195.08 $[Xe]4f^{14} 5d^9 6s$ 8.9588	79 $^2S_{1/2}$ **Au** Gold 196.97 $[Xe]4f^{14} 5d^{10} 6s$ 9.2256	80 $^1S_0$ **Hg** Mercury 200.59 $[Xe]4f^{14} 5d^{10} 6s^2$ 10.4375	81 $^2P^o_{1/2}$ **Tl** Thallium 204.38 $[Hg]6p$ 6.1083	82 $^3P_0$ **Pb** Lead 207.2 $[Hg]6p^2$ 7.4167	83 $^4S^o_{3/2}$ **Bi** Bismuth 208.98 $[Hg]6p^3$ 7.2855	84 $^3P_2$ **Po** Polonium (209) $[Hg]6p^4$ 8.4181	85 $^2P^o_{3/2}$ **At** Astatine (210) $[Hg]6p^5$ 9.3175	86 $^1S_0$ **Rn** Radon (222) $[Hg]6p^6$ 10.7485
7	87 $^2S_{1/2}$ **Fr** Francium (223) $[Rn]7s$ 4.0727	88 $^1S_0$ **Ra** Radium (226) $[Rn]7s^2$ 5.2784		104 $^3F_2$ **Rf** Rutherfordium (267) $[Rn]5f^{14} 6d^2 7s^2$ 6.02	105 $^4F_{3/2}$ **Db** Dubnium (268) $[Rn]5f^{14} 6d^3 7s^2$ 6.8	106 0 **Sg** Seaborgium (269) $[Rn]5f^{14} 6d^4 7s^2$ 7.8	107 5/2 **Bh** Bohrium (270) $[Rn]5f^{14} 6d^5 7s^2$ 7.7	108 4 **Hs** Hassium (269) $[Rn]5f^{14} 6d^6 7s^2$ 7.6	109 **Mt** Meitnerium (277)	110 **Ds** Darmstadtium (281)	111 **Rg** Roentgenium (282)	112 **Cn** Copernicium (285)	113 **Nh** Nihonium (286)	114 **Fl** Flerovium (290)	115 **Mc** Moscovium (290)	116 **Lv** Livermorium (293)	117 **Ts** Tennessine (294)	118 **Og** Oganesson (294)

Lanthanides	57 $^2D_{3/2}$ **La** Lanthanum 138.91 $[Xe]5d6s^2$ 5.5769	58 $^1G^o_4$ **Ce** Cerium 140.12 $[Xe]4f5d6s^2$ 5.5386	59 $^4I^o_{9/2}$ **Pr** Praseodymium 140.91 $[Xe]4f^3 6s^2$ 5.4702	60 $^5I_4$ **Nd** Neodymium 144.24 $[Xe]4f^4 6s^2$ 5.5250	61 $^6H^o_{5/2}$ **Pm** Promethium (145) $[Xe]4f^5 6s^2$ 5.5819	62 $^7F_0$ **Sm** Samarium 150.36 $[Xe]4f^6 6s^2$ 5.6437	63 $^8S^o_{7/2}$ **Eu** Europium 151.96 $[Xe]4f^7 6s^2$ 5.6704	64 $^9D^o_2$ **Gd** Gadolinium 157.25 $[Xe]4f^7 5d6s^2$ 6.1498	65 $^6H^o_{15/2}$ **Tb** Terbium 158.93 $[Xe]4f^9 6s^2$ 5.8638	66 $^5I_8$ **Dy** Dysprosium 162.50 $[Xe]4f^{10} 6s^2$ 5.9391	67 $^4I^o_{15/2}$ **Ho** Holmium 164.93 $[Xe]4f^{11} 6s^2$ 6.0215	68 $^3H_6$ **Er** Erbium 167.26 $[Xe]4f^{12} 6s^2$ 6.1077	69 $^2F^o_{7/2}$ **Tm** Thulium 168.93 $[Xe]4f^{13} 6s^2$ 6.1844	70 $^1S_0$ **Yb** Ytterbium 173.05 $[Xe]4f^{14} 6s^2$ 6.2542	71 $^2D_{3/2}$ **Lu** Lutetium 174.97 $[Xe]4f^{14} 5d6s^2$ 5.4259
Actinides	89 $^2D_{3/2}$ **Ac** Actinium (227) $[Rn]6d7s^2$ 5.3802	90 $^3F_2$ **Th** Thorium 232.04 $[Rn]6d^2 7s^2$ 6.3067	91 $^4K_{11/2}$ **Pa** Protactinium 231.04 $[Rn]5f^2 6d7s^2$ 5.89	92 $^5L_6$ **U** Uranium 238.03 $[Rn]5f^3 6d7s^2$ 6.1941	93 $^6L_{11/2}$ **Np** Neptunium (237) $[Rn]5f^4 6d7s^2$ 6.2655	94 $^7F_0$ **Pu** Plutonium (244) $[Rn]5f^6 7s^2$ 6.0258	95 $^8S^o_{7/2}$ **Am** Americium (243) $[Rn]5f^7 7s^2$ 5.9738	96 $^9D^o_2$ **Cm** Curium (247) $[Rn]5f^7 6d7s^2$ 5.9922	97 $^6H^o_{15/2}$ **Bk** Berkelium (247) $[Rn]5f^9 7s^2$ 6.1979	98 $^5I_8$ **Cf** Californium (251) $[Rn]5f^{10} 7s^2$ 6.2819	99 $^4I^o_{15/2}$ **Es** Einsteinium (252) $[Rn]5f^{11} 7s^2$ 6.3684	100 $^3H_6$ **Fm** Fermium (257) $[Rn]5f^{12} 7s^2$ 6.50	101 $^2F^o_{7/2}$ **Md** Mendelevium (258) $[Rn]5f^{13} 7s^2$ 6.58	102 $^1S_0$ **No** Nobelium (259) $[Rn]5f^{14} 7s^2$ 6.6262	103 $^2P^o_{1/2}$ **Lr** Lawrencium (262) $[Rn]5f^{14} 7s^2 7p$ 4.96

Atomic Number — Ground State — Symbol — Name — Standard Atomic Weight[†](u) — Ground-state Configuration — Ionization Energy (eV)

58 $^1G^o_4$ **Ce** Cerium 140.12 $[Xe]4f5d6s^2$ 5.5386

[†]Based upon ^{12}C. () indicates the mass number of the longest-lived isotope.

For the most precise values and uncertainties visit ciaaw.org and pml.nist.gov/data.

NIST SP 966 (June 2024)

NIST MASS SPECTROMETRY DATA CENTER

382,180 Total Compounds

33% Increase in Size

New Full Chromato-gram Analysis

NIST26 EI MS Library

The NIST/EPA/NIH GC-MS

Why Upgrade to NIST26?

- 35,000+ New Compounds

Compounds Selected for Analytical Interest in:

- Metabolites
- Drugs
- Flavors & Fragrances
- Environmental
- Food
- PFAS

NIST26 Tandem MS Library

Comprehensive:

- 68,635 Compounds
- 567k Precursor Ions
- 3.2M Total Spectra
- Instruments: Ion Trap, Collision Cell, QTOF

Wide Analyte Coverage:

- Metabolites
- Contaminants
- Extractables & Leachables
- Lipids
- Pharmaceuticals
- Pesticides

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- AMDIS/MS Interpreter

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