

PERIODIC TABLE Atomic Properties of the Elements

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 ¹³³Cs

speed of light in vacuum	<i>c</i>	299 792 458 m s ⁻¹	(exact)
Planck constant	<i>h</i>	6.626 070 15 × 10 ⁻³⁴ J Hz ⁻¹	(exact)
elementary charge	<i>e</i>	1.602 176 634 × 10 ⁻¹⁹ C	(exact)
Avogadro constant	<i>N_A</i>	6.022 140 76 × 10 ²³ mol ⁻¹	(exact)
Boltzmann constant	<i>k</i>	1.380 649 × 10 ⁻²³ J K ⁻¹	(exact)
electron volt	eV	1.602 176 634 × 10 ⁻¹⁹ J	(exact)
electron mass	<i>m_e</i>	9.109 383 70 × 10 ⁻³¹ kg	
energy equivalent	<i>m_ec²</i>	0.510 998 950 MeV	
proton mass	<i>m_p</i>	1.672 621 924 × 10 ⁻²⁷ kg	
energy equivalent	<i>m_pc²</i>	938.272 088 MeV	
fine-structure constant	<i>α</i>	1/137.035 999	
Rydberg energy	<i>R_∞hc</i>	13.605 693 1230 eV	
Newtonian constant of gravitation	<i>G</i>	6.674 × 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	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
IA	IIA	IIIB	IVB	VB	VIB	VII B	VIII	VIII	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA	
1	1 ² S _{1/2} H Hydrogen 1.008 1s 13.5984																	2 ¹ S ₀ He Helium 4.0026 1s ² 24.5874
2	3 ² S _{1/2} Li Lithium 6.94 1s ² 2s 5.3917	4 ¹ S ₀ Be Beryllium 9.0122 1s ² 2s ² 9.3227											5 ² P _{1/2} B Boron 10.81 1s ² 2s ² 2p 8.2980	6 ³ P ₀ C Carbon 12.011 1s ² 2s ² 2p ² 11.2603	7 ⁴ S _{3/2} N Nitrogen 14.007 1s ² 2s ² 2p ³ 14.5341	8 ³ P ₂ O Oxygen 15.999 1s ² 2s ² 2p ⁴ 13.6181	9 ² P _{3/2} F Fluorine 18.998 1s ² 2s ² 2p ⁵ 17.4228	10 ¹ S ₀ Ne Neon 20.180 1s ² 2s ² 2p ⁶ 21.5645
3	11 ² S _{1/2} Na Sodium 22.990 [Ne]3s	12 ¹ S ₀ Mg Magnesium 24.305 [Ne]3s ² 7.6462											13 ² P _{1/2} Al Aluminum 26.982 [Ne]3s ² 3p 9.5858	14 ³ P ₀ Si Silicon 28.085 [Ne]3s ² 3p ² 8.1517	15 ⁴ S _{3/2} P Phosphorus 30.974 [Ne]3s ² 3p ³ 10.4867	16 ³ P ₂ S Sulfur 32.06 [Ne]3s ² 3p ⁴ 10.3600	17 ² P _{3/2} Cl Chlorine 35.45 [Ne]3s ² 3p ⁵ 12.9676	18 ¹ S ₀ Ar Argon 39.948 [Ne]3s ² 3p ⁶ 15.7596
4	19 ² S _{1/2} K Potassium 39.098 [Ar]4s 4.3407	20 ¹ S ₀ Ca Calcium 40.078 [Ar]4s ² 6.1132	21 ² D _{3/2} Sc Scandium 44.956 [Ar]3d4s ² 6.5615	22 ³ F ₂ Ti Titanium 47.867 [Ar]3d ² 4s ² 6.8281	23 ⁴ F _{3/2} V Vanadium 50.942 [Ar]3d ³ 4s ² 6.7462	24 ⁷ S ₃ Cr Chromium 51.996 [Ar]3d ⁵ 4s 6.7665	25 ⁶ S _{5/2} Mn Manganese 54.938 [Ar]3d ⁵ 4s ² 7.4340	26 ⁵ D ₄ Fe Iron 55.845 [Ar]3d ⁶ 4s ² 7.9025	27 ⁴ F _{9/2} Co Cobalt 58.933 [Ar]3d ⁷ 4s ² 7.8810	28 ³ F ₄ Ni Nickel 58.693 [Ar]3d ⁸ 4s ² 7.6399	29 ² S _{1/2} Cu Copper 63.546 [Ar]3d ¹⁰ 4s 7.7264	30 ¹ S ₀ Zn Zinc 65.38 [Ar]3d ¹⁰ 4s ² 9.3942	31 ² P _{1/2} Ga Gallium 69.723 [Ar]3d ¹⁰ 4s ² 4p 5.9993	32 ³ P ₀ Ge Germanium 72.630 [Ar]3d ¹⁰ 4s ² 4p ² 7.8994	33 ⁴ S _{3/2} As Arsenic 74.922 [Ar]3d ¹⁰ 4s ² 4p ³ 9.7886	34 ³ P ₂ Se Selenium 78.971 [Ar]3d ¹⁰ 4s ² 4p ⁴ 9.7524	35 ² P _{3/2} Br Bromine 79.904 [Ar]3d ¹⁰ 4s ² 4p ⁵ 11.8138	36 ¹ S ₀ Kr Krypton 83.798 [Ar]3d ¹⁰ 4s ² 4p ⁶ 13.9996
5	37 ² S _{1/2} Rb Rubidium 85.468 [Kr]5s 4.1771	38 ¹ S ₀ Sr Strontium 87.62 [Kr]5s ² 5.6949	39 ² D _{3/2} Y Yttrium 88.906 [Kr]4d5s ² 6.2173	40 ³ F ₂ Zr Zirconium 91.224 [Kr]4d ² 5s ² 6.6341	41 ⁶ D _{1/2} Nb Niobium 92.906 [Kr]4d ⁴ 5s 6.7589	42 ⁷ S ₃ Mo Molybdenum 95.95 [Kr]4d ⁵ 5s 7.0924	43 ⁶ S _{5/2} Tc Technetium (97) [Kr]4d ⁵ 5s ² 7.1194	44 ⁵ F ₅ Ru Ruthenium 101.07 [Kr]4d ⁷ 5s 7.3605	45 ⁴ F _{9/2} Rh Rhodium 102.91 [Kr]4d ⁸ 5s 7.4589	46 ¹ S ₀ Pd Palladium 106.42 [Kr]4d ¹⁰ 8.3368	47 ² S _{1/2} Ag Silver 107.87 [Kr]4d ¹⁰ 5s 7.5762	48 ¹ S ₀ Cd Cadmium 112.41 [Kr]4d ¹⁰ 5s ² 8.9938	49 ² P _{1/2} In Indium 114.82 [Kr]4d ¹⁰ 5s ² 5p 7.5864	50 ³ P ₀ Sn Tin 118.71 [Kr]4d ¹⁰ 5s ² 5p ² 7.3439	51 ⁴ S _{3/2} Sb Antimony 121.76 [Kr]4d ¹⁰ 5s ² 5p ³ 8.6084	52 ³ P ₂ Te Tellurium 127.60 [Kr]4d ¹⁰ 5s ² 5p ⁴ 9.0098	53 ² P _{3/2} I Iodine 126.90 [Kr]4d ¹⁰ 5s ² 5p ⁵ 10.4513	54 ¹ S ₀ Xe Xenon 131.29 [Kr]4d ¹⁰ 5s ² 5p ⁶ 12.1298
6	55 ² S _{1/2} Cs Cesium 132.91 [Xe]6s 3.8939	56 ¹ S ₀ Ba Barium 137.33 [Xe]6s ² 5.2117		72 ³ F ₂ Hf Hafnium 178.49 [Xe]4f ¹⁴ 5d ² 6s ² 6.8251	73 ⁴ F _{3/2} Ta Tantalum 180.95 [Xe]4f ¹⁴ 5d ³ 6s ² 7.5496	74 ⁵ D ₀ W Tungsten 183.84 [Xe]4f ¹⁴ 5d ⁴ 6s ² 8.3640	75 ⁶ S _{5/2} Re Rhenium 186.21 [Xe]4f ¹⁴ 5d ⁵ 6s ² 7.8335	76 ⁵ D ₄ Os Osmium 190.23 [Xe]4f ¹⁴ 5d ⁶ 6s ² 8.4382	77 ⁴ F _{9/2} Ir Iridium 192.22 [Xe]4f ¹⁴ 5d ⁷ 6s ² 8.9670	78 ³ D ₃ Pt Platinum 195.08 [Xe]4f ¹⁴ 5d ⁹ 6s 8.9588	79 ² S _{1/2} Au Gold 196.97 [Xe]4f ¹⁴ 5d ¹⁰ 6s 9.2256	80 ¹ S ₀ Hg Mercury 200.59 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 10.4375	81 ² P _{1/2} Tl Thallium 204.38 [Hg]6p 6.1083	82 ³ P ₀ Pb Lead 207.2 [Hg]6p ² 7.4167	83 ⁴ S _{3/2} Bi Bismuth 208.98 [Hg]6p ³ 7.2855	84 ³ P ₂ Po Polonium (209) [Hg]6p ⁴ 8.4181	85 ² P _{3/2} At Astatine (210) [Hg]6p ⁵ 9.3175	86 ¹ S ₀ Rn Radon (222) [Hg]6p ⁶ 10.7485
7	87 ² S _{1/2} Fr Francium (223) [Rn]7s 4.0727	88 ¹ S ₀ Ra Radium (226) [Rn]7s ² 5.2784		104 ³ F ₂ Rf Rutherfordium (261) [Rn]5f ¹⁴ 6d ² 7s ² 6.02	105 ⁴ F _{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 (277) [Rn]5f ¹⁴ 6d ⁶ 7s ² 7.6	109 Mt Meitnerium (278)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (282)	112 Cn Copernicium (285)	113 Nh Nihonium (286)	114 Fl Flerovium (289)	115 Mc Moscovium (289)	116 Lv Livermorium (293)	117 Ts Tennessine (294)	118 Og Oganesson (294)
			57 ² D _{3/2} La Lanthanum 138.91 [Xe]5d6s ² 5.5769	58 ¹ G ₄ Ce Cerium 140.12 [Xe]4f5d6s ² 5.5386	59 ⁴ I _{9/2} Pr Praseodymium 140.91 [Xe]4f ³ 6s ² 5.4702	60 ⁵ I ₄ Nd Neodymium 144.24 [Xe]4f ⁴ 6s ² 5.5250	61 ⁶ H _{9/2} Pm Promethium (145) [Xe]4f ⁵ 6s ² 5.5819	62 ⁷ F ₀ Sm Samarium 150.36 [Xe]4f ⁶ 6s ² 5.6437	63 ⁸ S _{7/2} Eu Europium 151.96 [Xe]4f ⁷ 6s ² 5.6704	64 ⁹ D ₂ Gd Gadolinium 157.25 [Xe]4f ⁷ 5d6s ² 6.1498	65 ⁶ H _{15/2} Tb Terbium 158.93 [Xe]4f ⁹ 6s ² 5.9391	66 ⁵ I ₈ Dy Dysprosium 162.50 [Xe]4f ¹⁰ 6s ² 6.0215	67 ⁴ I _{15/2} Ho Holmium 164.93 [Xe]4f ¹¹ 6s ² 6.0215	68 ³ H ₆ Er Erbium 167.26 [Xe]4f ¹² 6s ² 6.1077	69 ² F _{7/2} Tm Thulium 168.93 [Xe]4f ¹³ 6s ² 6.1844	70 ¹ S ₀ Yb Ytterbium 173.05 [Xe]4f ¹⁴ 6s ² 6.2542	71 ² D _{3/2} Lu Lutetium 174.97 [Xe]4f ¹⁴ 5d6s ² 5.4259	
			89 ² D _{3/2} Ac Actinium (227) [Rn]6d7s ² 5.3802	90 ³ F ₂ Th Thorium 232.04 [Rn]6d7s ² 6.3067	91 ⁴ K _{11/2} Pa Protactinium 231.04 [Rn]5f ² 6d7s ² 5.89	92 ⁵ L ₆ U Uranium 238.03 [Rn]5f ³ 6d7s ² 6.1941	93 ⁶ L _{11/2} Np Neptunium (237) [Rn]5f ⁴ 6d7s ² 6.2655	94 ⁷ F ₀ Pu Plutonium (244) [Rn]5f ⁶ 7s ² 6.0258	95 ⁸ S _{7/2} Am Americium (243) [Rn]5f ⁷ 7s ² 5.9738	96 ⁹ D ₂ Cm Curium (247) [Rn]5f ⁸ 6d7s ² 5.9914	97 ⁶ H _{15/2} Bk Berkelium (247) [Rn]5f ⁹ 7s ² 6.2819	98 ⁵ I ₈ Cf Californium (251) [Rn]5f ¹⁰ 7s ² 6.2819	99 ⁴ I _{15/2} Es Einsteinium (252) [Rn]5f ¹¹ 7s ² 6.3676	100 ³ H ₆ Fm Fermium (258) [Rn]5f ¹² 7s ² 6.50	101 ² F _{7/2} Md Mendelevium (258) [Rn]5f ¹³ 7s ² 6.58	102 ¹ S ₀ No Nobelium (259) [Rn]5f ¹⁴ 7s ² 6.6262	103 ² P _{1/2} Lr Lawrencium (266) [Rn]5f ¹⁴ 7s ² 7p 4.96	

Atomic Number: 58
Ground State: ¹G₄
Symbol: Ce
Name: Cerium
Standard Atomic Weight (u): 140.12
Ground-state Configuration: [Xe]4f5d6s²
Ionization Energy (eV): 5.5386

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

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

347,100
Total
Compounds

60%
Increase
in Size

New
Quality
Assurance
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