

PERIODIC TABLE

Atomic Properties of the Elements

NIST National Institute of Standards and Technology
U.S. Department of Commerce

18
VIII A

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 x 10 ⁻³⁴ J s	
elementary charge	<i>e</i>	1.602 177 x 10 ⁻¹⁹ C	
electron mass	<i>m_e</i>	9.109 384 x 10 ⁻³¹ kg	
	<i>m_ec²</i>	0.510 999 MeV	
proton mass	<i>m_p</i>	1.672 622 x 10 ⁻²⁷ kg	
fine-structure constant	<i>α</i>	1/137.035 999	
Rydberg constant	<i>R_∞</i>	10 973 731.569 m ⁻¹	
	<i>R_∞c</i>	3.289 841 960 x 10 ¹⁵ Hz	
	<i>R_∞hc</i>	13.605 693 eV	
electron volt	eV	1.602 177 x 10 ⁻¹⁹ J	
Boltzmann constant	<i>k</i>	1.380 65 x 10 ⁻²³ J K ⁻¹	
molar gas constant	<i>R</i>	8.314 5 J mol ⁻¹ K ⁻¹	

[§] 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											IIIA	IVA	VA	VIA	VIIA	
Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H Hydrogen 1.008 1s 13.5984																	2 He Helium 4.0026 1s ² 24.5874
2	3 Li Lithium 6.94 1s ² 2s 5.3917	4 Be Beryllium 9.0122 1s ² 2s ² 9.3227																
3	11 Na Sodium 22.990 [Ne]3s 5.1391	12 Mg Magnesium 24.305 [Ne]3s ² 7.6462																
4	19 K Potassium 39.098 [Ar]4s 4.3407	20 Ca Calcium 40.078 [Ar]3d ⁴ 4s ² 6.1132	21 Sc Scandium 44.956 [Ar]3d ⁴ 4s ² 6.5615	22 Ti Titanium 47.867 [Ar]3d ² 4s ² 6.8281	23 V Vanadium 50.942 [Ar]3d ³ 4s ² 6.7462	24 Cr Chromium 51.996 [Ar]3d ⁵ 4s 6.7665	25 Mn Manganese 54.938 [Ar]3d ⁵ 4s ² 7.4340	26 Fe Iron 55.845 [Ar]3d ⁶ 4s ² 7.9025	27 Co Cobalt 58.933 [Ar]3d ⁷ 4s ² 7.8810	28 Ni Nickel 58.693 [Ar]3d ⁸ 4s ² 7.6399	29 Cu Copper 63.546 [Ar]3d ¹⁰ 4s 7.7264	30 Zn Zinc 65.38 [Ar]3d ¹⁰ 4s ² 9.3942	31 Ga Gallium 69.723 [Ar]3d ¹⁰ 4s ² 4p 5.9993	32 Ge Germanium 72.630 [Ar]3d ¹⁰ 4s ² 4p ² 7.8994	33 As Arsenic 74.922 [Ar]3d ¹⁰ 4s ² 4p ³ 9.7886	34 Se Selenium 78.971 [Ar]3d ¹⁰ 4s ² 4p ⁴ 9.7524	35 Br Bromine 79.904 [Ar]3d ¹⁰ 4s ² 4p ⁵ 11.8138	36 Kr Krypton 83.798 [Ar]3d ¹⁰ 4s ² 4p ⁶ 13.9996
5	37 Rb Rubidium 85.468 [Kr]5s 4.1771	38 Sr Strontium 87.62 [Kr]5s ² 5.6949	39 Y Yttrium 88.906 [Kr]4d ⁵ 5s ² 6.2173	40 Zr Zirconium 91.224 [Kr]4d ⁵ 5s ² 6.8341	41 Nb Niobium 92.906 [Kr]4d ⁴ 5s 6.7589	42 Mo Molybdenum 95.95 [Kr]4d ⁵ 5s 7.0924	43 Tc Technetium (98) [Kr]4d ⁵ 5s ² 7.1194	44 Ru Ruthenium 101.07 [Kr]4d ⁷ 5s 7.3605	45 Rh Rhodium 102.91 [Kr]4d ⁸ 5s 7.4589	46 Pd Palladium 106.42 [Kr]4d ¹⁰ 8.3369	47 Ag Silver 107.87 [Kr]4d ¹⁰ 5s 8.9938	48 Cd Cadmium 112.41 [Kr]4d ¹⁰ 5s ² 5.7864	49 In Indium 114.82 [Kr]4d ¹⁰ 5s ² 5p 7.3439	50 Sn Tin 118.71 [Kr]4d ¹⁰ 5s ² 5p ² 7.3439	51 Sb Antimony 121.76 [Kr]4d ¹⁰ 5s ² 5p ³ 8.6084	52 Te Tellurium 127.60 [Kr]4d ¹⁰ 5s ² 5p ⁴ 9.0097	53 I Iodine 126.90 [Kr]4d ¹⁰ 5s ² 5p ⁵ 10.4513	54 Xe Xenon 131.29 [Kr]4d ¹⁰ 5s ² 5p ⁶ 12.1298
6	55 Cs Cesium 132.91 [Xe]6s 3.8939	56 Ba Barium 137.33 [Xe]6s ² 5.2117		72 Hf Hafnium 178.49 [Xe]4f ¹⁴ 5d ² 6s ² 6.8251	73 Ta Tantalum 180.95 [Xe]4f ¹⁴ 5d ³ 6s ² 7.5496	74 W Tungsten 183.84 [Xe]4f ¹⁴ 5d ⁴ 6s ² 7.8640	75 Re Rhenium 186.21 [Xe]4f ¹⁴ 5d ⁵ 6s ² 7.8335	76 Os Osmium 190.23 [Xe]4f ¹⁴ 5d ⁶ 6s ² 8.4382	77 Ir Iridium 192.22 [Xe]4f ¹⁴ 5d ⁷ 6s ² 8.9670	78 Pt Platinum 195.08 [Xe]4f ¹⁴ 5d ⁹ 6s 8.9588	79 Au Gold 196.97 [Xe]4f ¹⁴ 5d ¹⁰ 6s 9.2256	80 Hg Mercury 200.59 [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 10.4375	81 Tl Thallium 204.38 [Hg]6p 6.1083	82 Pb Lead 207.2 [Hg]6p ² 7.4167	83 Bi Bismuth 208.98 [Hg]6p ³ 7.2855	84 Po Polonium (209) [Hg]6p ⁴ 8.414	85 At Astatine (210) [Hg]6p ⁵ 9.3175	86 Rn Radon (222) [Hg]6p ⁶ 10.7485
7	87 Fr Francium (223) [Rn]7s 4.0727	88 Ra Radium (226) [Rn]7s ² 5.2784		104 Rf Rutherfordium (261) [Rn]5f ¹⁴ 6d ² 7s ² 6.02	105 Db Dubnium (268) [Rn]5f ¹⁴ 6d ³ 7s ² 6.8	106 Sg Seaborgium (271) [Rn]5f ¹⁴ 6d ⁴ 7s ² 7.8	107 Bh Bohrium (270) [Rn]5f ¹⁴ 6d ⁵ 7s ² 7.7	108 Hs Hassium (289) [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 La Lanthanum 138.91 [Xe]5d ¹ 6s ² 5.5769	58 Ce Cerium 140.116 [Xe]4f ¹ 5d ¹ 6s ² 5.5386	59 Pr Praseodymium 140.91 [Xe]4f ² 6s ² 5.4702	60 Nd Neodymium 144.24 [Xe]4f ³ 6s ² 5.5250	61 Pm Promethium (145) [Xe]4f ⁴ 6s ² 5.577	62 Sm Samarium 150.36 [Xe]4f ⁵ 6s ² 5.6437	63 Eu Europium 151.96 [Xe]4f ⁶ 6s ² 5.6704	64 Gd Gadolinium 157.25 [Xe]4f ⁷ 6s ² 6.1498	65 Tb Terbium 158.93 [Xe]4f ⁸ 6s ² 5.8638	66 Dy Dysprosium 162.50 [Xe]4f ⁹ 6s ² 5.9391	67 Ho Holmium 164.93 [Xe]4f ¹⁰ 6s ² 6.0215	68 Er Erbium 167.26 [Xe]4f ¹¹ 6s ² 6.1077	69 Tm Thulium 168.93 [Xe]4f ¹² 6s ² 6.1843	70 Yb Ytterbium 173.05 [Xe]4f ¹³ 6s ² 6.2542	71 Lu Lutetium 174.97 [Xe]4f ¹⁴ 6s ² 5.4259
				89 Ac Actinium (227) [Rn]6d ¹ 7s ² 5.3802	90 Th Thorium 232.04 [Rn]6d ² 7s ² 6.3067	91 Pa Protactinium 231.04 [Rn]5f ¹ 6d ² 7s ² 5.89	92 U Uranium 238.03 [Rn]5f ³ 6d ¹ 7s ² 6.1941	93 Np Neptunium (237) [Rn]5f ⁴ 6d ¹ 7s ² 6.2655	94 Pu Plutonium (244) [Rn]5f ⁶ 7s ² 6.0258	95 Am Americium (243) [Rn]5f ⁷ 7s ² 5.9738	96 Cm Curium (247) [Rn]5f ⁷ 6d ¹ 7s ² 5.9914	97 Bk Berkelium (247) [Rn]5f ⁹ 7s ² 6.1978	98 Cf Californium (251) [Rn]5f ¹⁰ 7s ² 6.2817	99 Es Einsteinium (252) [Rn]5f ¹¹ 7s ² 6.3676	100 Fm Fermium (257) [Rn]5f ¹² 7s ² 6.50	101 Md Mendelevium (258) [Rn]5f ¹³ 7s ² 6.58	102 No Nobelium (259) [Rn]5f ¹⁴ 7s ² 6.66	103 Lr Lawrencium (262) [Rn]5f ¹⁴ 7s ² 7p 4.96

Atomic Number	Ground State
58	¹ G ₄
Symbol	Ce
Name	Cerium
Standard Atomic Weight (M _a)	140.12 [Xe]4f ¹ 5d ¹ 6s ² 5.5386
Ground-state Configuration	
Ionization Energy (eV)	

[†]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.
NIST SP 966 (July 2018)

NISTory of the Periodic Table

