

Periodic Table of the Elements

1-IA	
1 H Hydrogen 1.00794 1-1 52.9/154 13.99/20.271 g.H ₂ ,H hex 1s ²	2-IIA
3 Li Lithium 6.941 1 167/90 453.65/1603 s,Li _n ,Li ⁺ bcc 1s ² 2s ¹	4 Be Beryllium 9.0121831(5) 2 112/59 1560/2742 s,Be _n ,Be ²⁺ hcp 1s ² 2s ²
11 Na Sodium 22.98976928(2) 1 190/116 312.49/1156.09 s,Na _n ,Na ⁺ bcc [Ne]3s ¹	12 Mg Magnesium 24.305 2 145/86 923/1363 s,Mg _n ,Mg ²⁺ hcp [Ne]3s ²

group

Xy

Atomname.....If written in black, the atom is usually produced synthetically.

MW.....Molecular weight (g/mol)

ox. no......Most common oxidation states

EN.....Electro negativity (pauling scale)

r_a.....atomic radius (pm)

r_i.....ionic radius (pm)

m.p......melting point (K)*

b.p......boiling point (K)*

p.....phases*: **solid (s)**, **liquid (l)**, **gas (g)**

Xy_n.....Elementar form

ion.....Ion corresponding to r_i

el. conf......electron configuration

abc.....crystal structure

*Values at STP (273.15 K, 1 bar)

key

group

#

Xy

Atomname

MW

ox. no.

EN

r_a

r_i

m.p.

b.p.

p

Xy_n

ion

el. conf.

abc

relative ionic radius (r_i, Xy^{z+})

relative atomic radius (r_a)

Equations:

Concentration: $c = n/V$ [mol/L]

Amount of substance: $n = N/N_A$ [mol]

Volume: V [L]

Particle number: $N = n \cdot N_A$

Pressure: p [Pa]

Ideal gas equation: $pV = nRT = Nk_B T$

bcc: body centered cubic
cub: cubic
dhcp: double hexagonal close-packed
fcc: face-centered cubic
fdcd: face-centered diamond-cubic
fcc: hexagonal closed-packed
hex: hexagonal
mon: monoclinic
ort: orthorhombic
rho: rhombohedral
she: simple hexagonal

Conversion factors:

1 μm = 10⁻⁶ m; 1 nm = 10⁻⁹ m; 1 Å (Angs.) = 10⁻¹⁰ m; 1 pm = 10⁻¹² m; 1 fm = 10⁻¹⁵ m

1 bar = 10⁵ N/m² = 10⁵ Pa; 1 atm = 101325 Pa = 1.01325 bar

1 Torr = 1/760 atm = 1.333 mbar = 1 mmHg

1 L = 10⁻³ m³ = 1 dm³ = 10³ cm³ = 10⁶ mm³

Constants:

Avogadro number $N_A = 6.02214179(30) \cdot 10^{23}$ mol⁻¹

Mass of proton $m_p = 1.672621777(74) \cdot 10^{-27}$ kg

Mass of electron $m_e = 9.10938291(40) \cdot 10^{-31}$ kg

Mass of neutron $m_n = 1.674927351(74) \cdot 10^{-27}$ kg

Standard temperature $T_s = 273.15$ K = 0 °C

Universal gas constant $R = 8.314472(15)$ J/(mol·K)

Boltzmann-constant $k_B = 1.3806504(24) \cdot 10^{-23}$ J/K

Speed of light $c = 2.99792458(10) \cdot 10^8$ m/s

Elementary charge $e = 1.602176487(40) \cdot 10^{-19}$ C

Planck constant $h = 6.62606896(33) \cdot 10^{-34}$ J·s

$\hbar = h/2\pi = 1.054571628(53) \cdot 10^{-34}$ J·s

Unified atomic mass unit $1 \text{ u} = 1.660538921(73) \cdot 10^{-27}$ kg

The unified atomic mass is equal to 1/12 of the mass of a single isolated C-12 atom.

REFERENCES:

[MW] Commission on Isotopic Abundancies and Atomic Weights, <http://www.iaaw.org/>

[r_a] E. Clementi, D.L. Raimondi, W.P. Reinhardt, *J. Chem. Phys.*, **1967**, *47*, 1300-1307.

[r_i] R. D. Shannon, *Acta Cryst.*, **1976**, *A32*, 751-767 and https://en.wikipedia.org/wiki/ionic_radius.

[m.s., b.p., phases, cryst. struct., ox. no.] <https://www.wikipedia.org>

[EN] A. L. Allred, *J. Inorg. Nucl. Chem.*, **1961**, *17*, 215-221.

[Constants] <http://physics.nist.gov/cuu/Constants/index.html>

18-VIII B	
2 He Helium 4.002602(2) -1 - g.He 1s ²	10 Ne Neon 20.1797(6) -1 - g.Ne 1s ² 2s ² 2p ⁶
13 Al Aluminum 26.9815385(7) 3 118/67.5 933.47/2743 s,Al _n ,Al ³⁺ fcc [Ne]3s ² 3p ¹	14 Si Silicon 28.085 4 116/54 167/3538 s,Si _n ,Si ⁴⁺ fcc [Ne]3s ² 3p ²
15 P Phosphorus 30.973761998 3 98/52 117/553 (white) s,P _n ,P ³⁺ bcc [Ne]3s ² 3p ³	16 S Sulfur 32.06 4 88/170 388.36/717.8 s,S _n ,S ²⁺ orth [Ne]3s ² 3p ⁴
17 Cl Chlorine 35.45 3 79/167 171.6/239.11 g,Cl ₂ ,Cl ⁻ orth [Ne]3s ² 3p ⁵	18 Ar Argon 39.948(1) -1 - g.Ar [Ne]3s ² 3p ⁶

19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
K Potassium 39.0983(1) 1 243/152 336.7/1032 s,K _n ,K ⁺ bcc [Ar]4s ¹	Ca Calcium 40.078(4) 2 194/114 1115/1757 s,Ca _n ,Ca ²⁺ fcc [Ar]3d ⁴ 4s ²	Sc Scandium 44.955908(5) 3 184/88.5 1941/3560 s,Sc _n ,Sc ³⁺ hcp [Ar]3d ¹ 4s ²	Ti Titanium 47.867(1) 4 176/74.5 1941/3560 s,Ti _n ,Ti ⁴⁺ hcp [Ar]3d ² 4s ²	V Vanadium 50.9415(1) 5 171/68 1811/3360 s,V _n ,V ⁵⁺ bcc [Ar]3d ³ 4s ²	Cr Chromium 51.9961(6) 6 166/58 2180/2944 s,Cr _n ,Cr ⁶⁺ bcc [Ar]3d ⁵ 4s ¹	Mn Manganese 54.938044(3) 7 161/60 1519/2334 s,Mn _n ,Mn ²⁺ bcc [Ar]3d ⁵ 4s ²	Fe Iron 55.845(2) 8 156/39 1811/3134 s,Fe _n ,Fe ²⁺ bcc [Ar]3d ⁶ 4s ²	Co Cobalt 58.933194(4) 9 152/68.5 1728/3003 s,Co _n ,Co ³⁺ hcp [Ar]3d ⁷ 4s ²	Ni Nickel 58.6934(4) 10 149/83 1789/3003 s,Ni _n ,Ni ²⁺ fcc [Ar]3d ⁸ 4s ²	Cu Copper 63.546(3) 11 145/87 1357.77/2835 s,Cu _n ,Cu ²⁺ fcc [Ar]3d ¹⁰ 4s ¹	Zn Zinc 65.38(2) 12 142/88 692.68/1180 s,Zn _n ,Zn ²⁺ hcp [Ar]3d ¹⁰ 4s ²	Ga Gallium 69.723(1) 13 136/76 302.91/2673 s,Ga _n ,Ga ³⁺ orth [Ar]3d ¹⁰ 4s ² 4p ¹	Ge Germanium 72.630(8) 14 125/67 1211.40/3106 s,Ge _n ,Ge ⁴⁺ fcc [Ar]3d ¹⁰ 4s ² 4p ²	As Arsenic 74.921595(6) 15 114/72 887 (subl.) s,As _n ,As ³⁺ rho [Ar]3d ¹⁰ 4s ² 4p ³	Se Selenium 78.9718(8) 16 103/184 265.8/332.0 s,Se _n ,Se ²⁺ hex [Ar]3d ¹⁰ 4s ² 4p ⁴	Br Bromine 79.904 17 94/182 318.5/457.4 l,Br ₂ ,Br ⁻ orth [Ar]3d ¹⁰ 4s ² 4p ⁵	Kr Krypton 83.798(2) 18 188/ 115.78/119.93 g,Kr fcc [Ar]3d ¹⁰ 4s ² 4p ⁶
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Rb Rubidium 85.4678(3) 1 265/166 312.45/961 s,Rb _n ,Rb ⁺ bcc [Kr]5s ¹	Sr Strontium 87.62(1) 2 219/132 1050/1650 s,Sr _n ,Sr ²⁺ fcc [Kr]5s ²	Y Yttrium 88.90584(2) 3 212/104 1799/3203 s,Y _n ,Y ³⁺ hcp [Kr]4d ⁵ 5s ²	Zr Zirconium 91.224(2) 4 206/86 2128/4650 s,Zr _n ,Zr ⁴⁺ hcp [Kr]4d ⁵ 5s ²	Nb Niobium 92.90637(2) 5 198/78 2750/5017 s,Nb _n ,Nb ⁵⁺ bcc [Kr]4d ⁴ 5s ¹	Mo Molybdenum 95.95(1) 6 190/73 2896/4912 s,Mo _n ,Mo ⁶⁺ bcc [Kr]4d ⁵ 5s ¹	Tc Technetium (98) 7 183/70 2430/4538 s,Tc _n ,Tc ⁷⁺ hcp [Kr]4d ⁵ 5s ²	Ru Ruthenium 101.07(2) 8 178/76 2237/3968 s,Ru _n ,Ru ³⁺ hcp [Kr]4d ⁷ 5s ¹	Rh Rhodium 102.90550(2) 9 173/80.5 1828.05/3236 s,Rh _n ,Rh ³⁺ fcc [Kr]4d ⁸ 5s ¹	Pd Palladium 106.42(1) 10 169/100 1234.93/2435 s,Pd _n ,Pd ²⁺ fcc [Kr]4d ¹⁰	Ag Silver 107.8682(2) 11 165/129 959.22/1040 s,Ag _n ,Ag ⁺ fcc [Kr]4d ¹⁰ 5s ¹	Cd Cadmium 112.414(4) 12 161/109 594.22/1040 s,Cd _n ,Cd ²⁺ hcp [Kr]4d ¹⁰ 5s ²	In Indium 114.818(1) 13 156/94 429.75/2345 s,In _n ,In ³⁺ tet [Kr]4d ¹⁰ 5s ² 5p ¹	Sn Tin 118.710(7) 14 145/83 505.08/2875 s,Sn _n ,Sn ²⁺ tet,fcc [Kr]4d ¹⁰ 5s ² 5p ²	Sb Antimony 121.760(1) 15 133/74 903.73/1908 s,Sb _n ,Sb ³⁺ rho [Kr]4d ¹⁰ 5s ² 5p ³	Te Tellurium 127.60(3) 16 123/207 1222.66/1261 s,Te _n ,Te ²⁺ hex [Kr]4d ¹⁰ 5s ² 5p ⁴	I Iodine 126.90447(3) 17 158/206 318.5/457.4 s,I ₂ ,I ⁻ orth [Kr]4d ¹⁰ 5s ² 5p ⁵	Xe Xenon 131.293(6) 18 168/ 101.40/165.051 g,Xe fcc [Kr]4d ¹⁰ 5s ² 5p ⁶
55	56	57-71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
Cs Cesium 132.90545196 1 298/181 301.7/944 s,Cs _n ,Cs ⁺ bcc [Xe]6s ¹	Ba Barium 137.327(7) 2 253/149 1000/2118 s,Ba _n ,Ba ²⁺ bcc [Xe]6s ²	Hf Hafnium 178.49(2) 4 208/85 2506/4876 s,Hf _n ,Hf ⁴⁺ hcp [Xe]4f ¹⁴ 5d ² 6s ²	Ta Tantalum 180.94788(2) 5 200/85 3290/5731 s,Ta _n ,Ta ⁵⁺ bcc,tet [Xe]4f ¹⁴ 5d ³ 6s ²	Ta Tantalum 180.94788(2) 5 200/85 3290/5731 s,Ta _n ,Ta ⁵⁺ bcc,tet [Xe]4f ¹⁴ 5d ³ 6s ²	W Tungsten 183.84(1) 6 193/74 3695/6203 s,W _n ,W ⁶⁺ bcc [Xe]4f ¹⁴ 5d ⁴ 6s ²	Re Rhenium 186.207(1) 7 188/67 3459/5869 s,Re _n ,Re ⁷⁺ hcp [Xe]4f ¹⁴ 5d ⁵ 6s ²	Os Osmium 190.23(3) 8 185/53 3306/5285 s,Os _n ,Os ⁸⁺ hcp [Xe]4f ¹⁴ 5d ⁶ 6s ²	Ir Iridium 192.2217(3) 9 180/82 2719/4403 s,Ir _n ,Ir ³⁺ fcc [Xe]4f ¹⁴ 5d ⁷ 6s ²	Pt Platinum 195.084(9) 10 177/94 2041.4/4098 s,Pt _n ,Pt ²⁺ fcc [Xe]4f ¹⁴ 5d ⁹ 6s ¹	Au Gold 196.966569(5) 11 174/99 1337.33/3243 s,Au _n ,Au ⁺ fcc [Xe]4f ¹⁴ 5d ¹⁰ 6s ¹	Hg Mercury 200.592(3) 12 171/116 234.310/629.88 s,Hg _n ,Hg ²⁺ rho [Xe]4f ¹⁴ 5d ¹⁰ 6s ²	Tl Thallium 204.38 13 156/102.5 577.1/746 s,Tl _n ,Tl ³⁺ hcp [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ¹	Pb Lead 207.2(1) 14 154/133 600.6/2022 s,Pb _n ,Pb ²⁺ fcc [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ²	Bi Bismuth 208.98040(1) 15 544.7/1837 527/1235 s,Bi _n ,Bi ³⁺ hcp [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ³	Po Polonium (209) 16 143/90 544.7/1837 s,Po _n ,Po ²⁺ hcp [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁴	At Astatine (210) 17 177/n.a. 575/610 s,At _n ,At ⁻ fcc [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁵	Rn Radon (222) 18 127/n.a. 575/610 s,Rn _n ,Rn ⁺ fcc [Xe]4f ¹⁴ 5d ¹⁰ 6s ² 6p ⁶
87	88	89-103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118
Fr Francium (223) 1 n.a./n.a. n.a./n.a. n.a./n.a. s,Fr _n ,Fr ⁺ [Rn]7s ¹	Ra Radium (226) 2 n.a./162 973/2010 s,Ra _n ,Ra ²⁺ bcc [Rn]7s ²	Rf Rutherfordium (267) 4 n.a./n.a. 2400/5800 s,Rf _n ,Rf ⁴⁺ hcp [Rn]5f ¹⁴ 6d ⁷ 7s ²	Rf Rutherfordium (267) 4 n.a./n.a. 2400/5800 s,Rf _n ,Rf ⁴⁺ hcp [Rn]5f ¹⁴ 6d ⁷ 7s ²	Db Dubnium (268) 5 n.a./n.a. n.a./n.a. s,Db _n ,Db ⁵⁺ bcc [Rn]5f ¹⁴ 6d ⁷ 7s ²	Sg Seaborgium (269) 6 n.a./n.a. n.a./n.a. s,Sg _n ,Sg ⁶⁺ bcc [Rn]5f ¹⁴ 6d ⁷ 7s ²	Bh Bohrium (270) 7 n.a./n.a. n.a./n.a. s,Bh _n ,Bh ⁷⁺ hcp [Rn]5f ¹⁴ 6d ⁷ 7s ²	Hs Hassium (269) 8 n.a./n.a. n.a./n.a. s,Hs _n ,Hs ⁸⁺ hcp [Rn]5f ¹⁴ 6d ⁷ 7s ²	Mt Meitnerium (278) 9 n.a./n.a. n.a./n.a. s,Mt _n ,Mt ⁹⁺ fcc [Rn]5f ¹⁴ 6d ⁷ 7s ²	Ds Darmstadtium (281) 10 n.a./n.a. n.a./n.a. s,Ds _n ,Ds ¹⁰⁺ bcc [Rn]5f ¹⁴ 6d ⁷ 7s ²	Rg Roentgenium (282) 11 n.a./n.a. 1814/3109 s,Rg _n ,Rg ¹¹⁺ bcc [Rn]5f ¹⁴ 6d ⁷ 7s ²	Cn Copernicium (285) 12 n.a./n.a. n.a./n.a. s,Cn _n ,Cn ¹²⁺ hcp [Rn]5f ¹⁴ 6d ⁷ 7s ²	Nh Nihonium (286) 13 n.a./n.a. 700/1430 s,Nh _n ,Nh ¹³⁺ hcp [Rn]5f ¹⁴ 6d ⁷ 7s ²	Fl Flerovium (289) 14 n.a./n.a. 340/420 s,Fl _n ,Fl ¹⁴⁺ hcp [Rn]5f ¹⁴ 6d ⁷ 7s ²	Mc Moscovium (289) 15 n.a./n.a. 670/1400 s,Mc _n ,Mc ¹⁵⁺ hcp [Rn]5f ¹⁴ 6d ⁷ 7s ²	Lv Livermorium (293) 16 n.a./n.a. n.a./n.a. s,Lv _n ,Lv ¹⁶⁺ hcp [Rn]5f ¹⁴ 6d ⁷ 7s ²	Ts Tennessine (294) 17 n.a./n.a. n.a./n.a. s,Ts _n ,Ts ¹⁷⁺ hcp [Rn]5f ¹⁴ 6d ⁷ 7s ²	Og Oganesson (294) 18 n.a./n.a. n.a./n.a. s,Og _n ,Og ¹⁸⁺ hcp [Rn]5f ¹⁴ 6d ⁷ 7s ²



57	58	59	60	61	62	63	64	65	66	67	68	69	70	71
La Lanthanum 138.90547(7) 3 n.a./117.2 1193/3787 s,La _n ,La ³⁺ dhcp [Xe]5d ¹ 6s ²	Ce Cerium 140.116(1) 4 n.a./101 1068/3716 s,Ce _n ,Ce ³⁺ dhcp [Xe]4f ¹ 5d ¹ 6s ²	Pr Praseodymium 140.90766(2) 3 n.a./113 1208/3403 s,Pr _n ,Pr ³⁺ dhcp [Xe]4f ² 6s ²	Nd Neodymium 144.242(3) 3 n.a./112.3 1297/3347 s,Nd _n ,Nd ³⁺ dhcp [Xe]4f ² 6s ²	Pm Promethium (145) 3 n.a./111 1315/3273 s,Pm _n ,Pm ³⁺ dhcp [Xe]4f ² 6s ²	Sm Samarium 150.36(2) 3 n.a./109.8 1345/2173 s,Sm _n ,Sm ²⁺ rho [Xe]4f ⁶ 6s ²	Eu Europium 151.964(1) 3 n.a./108.7 1099/1802 s,Eu _n ,Eu ²⁺ bcc [Xe]4f ⁶ 6s ²	Gd Gadolinium 157.25(3) 3 n.a./107.8 1585/3273 s,Gd _n ,Gd ³⁺ hcp [Xe]4f ⁷ 6s ²	Tb Terbium 158.92535(2) 3 n.a./106.3 1629/3396 s,Tb _n ,Tb ³⁺ hcp [Xe]4f ⁷ 6s ²	Dy Dysprosium 162.500(1) 3 n.a					