

Periodic Table of the Elements

REFERENCES:

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[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>

I-IA

1 H
Hydrogen
1.00794
-1.1
52.9/154
13.99/20.271
g, H₂, H
1s²

3 Li
Lithium
6.941
1
167/90
453.65/1603
s, Li, Li⁺
1s²2s¹

11 Na
Sodium
22.98976928(2)
1
190/116
370.94/1156.09
s, Na, Na⁺
[Ne]3s¹

2-IIA
4 Be
Beryllium
9.0121831(5)
2
112/59
1560/2742
s, Be, Be²⁺
1s²2s²

12 Mg
Magnesium
24.305
2
145/86
923/1363
s, Mg, Mg²⁺
[Ne]3s²

20 Ca
Calcium
40.078(4)
2
194/114
1115/1757
s, Ca, Ca²⁺
[Ar]4s²

Alkali metal **Alkaline earth metal** **Lanthanide** **Actinide** **Transition metal** **Post transition metal** **Metalloid** **Nonmetal** **Noble gas** **Unclassified** **Group 17 = Halogen**

Key
group
Xy
Atomname
MW
ox. no.
EN
r_a/r_i
m.p./b.p.
p, X_n, Y_n, X_n^{+/+}, Y_n^{+/+}
el. conf.
relative ionic radius (r_i, X_n^{+/+})
relative atomic radius (r_a)

Note: values written in gray are predictions
#.....Atomic number
Xy.....Symbol
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)*
pphases*: solid (s), liquid (l), gas (g)
X_n.....Elementar form
X_n^{+/+}.....Ion corresponding to r_i
el. conf.electron configuration
abc.....crystal structure
*Values at STP (273.15 K, 1 bar)

Equations:
Concentration: $c = n/V$ [mol/L]
Amount of substance: n [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
fcd: face-centered diamond-cubic
hcp: 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
Torr = 1/760 atm = 1.333 mbar = 1 mmHg
1 L = 10⁻³ m³ = 1 dm³ = 10³ cm³ = 10⁶ mm³

Constants:
Avogadro number $N_A = 6.022\ 141\ 79(30) \cdot 10^{23}$ mol⁻¹
Mass of proton $m_p = 1.672\ 621\ 777(74) \cdot 10^{-27}$ kg
Mass of electron $m_e = 9.109\ 382\ 91(40) \cdot 10^{-31}$ kg
Mass of neutron $m_n = 1.674\ 927\ 351(74) \cdot 10^{-27}$ kg
Standard temperature $T_s = 273.15$ K = 0 °C
Univaersal gas constant $R = 8.314\ 472(15)$ J/(mol·K)
Boltzmann-constant $k_B = 1.380\ 650\ 4(24) \cdot 10^{-23}$ J/K
Speed of light $c = 2.997\ 924\ 58 \cdot 10^8$ m/s
Elementary charge $e = 1.602\ 176\ 487(40) \cdot 10^{-19}$ C
Planck constant $h = 6.626\ 068\ 96(33) \cdot 10^{-34}$ J·s
 $\hbar = h/2\pi = 1.054\ 571\ 628(53) \cdot 10^{-34}$ J·s
Unified atomic mass unit $1\ u = 1.660\ 538\ 921(73) \cdot 10^{-27}$ kg
The unified atomic mass is equal to 1/12 of the mass of a single isolated C-atom.

18-VIIIB

2 He
Helium
4.002602(2)
-
31/-
0.95/4.222
g, He
1s²

10 Ne
Neon
20.1797(6)
-
38/-
24.56/27.104
g, Ne
1s²2s²2p⁶

18 Ar
Argon
39.948(1)
-
71/-
83.81/87.302
g, Ar
[Ne]3s²3p⁶

13-IIIB 14-IVB 15-VB 16-VIB 17-VIIB

5 B
Boron
10.81
3
87/41
2349/4200
s, B, B³⁺
1s²2s²2p¹

6 C
Carbon
12.011
-4,-3,-2,-1,1,2,3,4
67/30
3915 (subl.)
s, C, C⁴⁺ she, fcd
1s²2s²2p²

7 N
Nitrogen
14.007
-3,3,5
56/132/27
63.15/77.355
g, N₂, N³⁻, N⁵⁺ hex
1s²2s²2p³

8 O
Oxygen
15.999
-2
48/126
53.48/90.188
g, O₂, O²⁻ cub
1s²2s²2p⁴

9 F
Fluorine
18.998403163
-1
42/119
53.48/85.03
g, F₂, F⁻ cub
1s²2s²2p⁵

13 Al
Aluminium
26.9815385(7)
3
118/67.5
933.47/2743
s, Al, Al³⁺ fcc
[Ne]3s²3p¹

14 Si
Silicon
28.085
-4,4
111/54
1687/3538
s, Si, Si⁴⁺ fcd
[Ne]3s²3p²

15 P
Phosphorous
30.973761998
-3,5
98/52
317/553 (white)
s, P, P³⁺ bcc
[Ne]3s²3p³

16 S
Sulfur
32.06
-2,2,4,6
88/170
388.36/717.8
s, S₈, S²⁻ ort
[Ne]3s²3p⁴

17 Cl
Chlorine
35.45
-1,1,3,5,7
79/167
171.6/239.11
g, Cl₂, Cl⁻ ort
[Ne]3s²3p⁵

36 Kr
Krypton
83.798(2)
2
88/-
115.78/119.93
g, Kr
[Ar]3d¹⁰4s²4p⁶

19 K
Potassium
39.0983(1)
1
243/152
336.7/1032
s, K, K⁺ bcc
[Ar]4s¹

21 Sc
Scandium
44.955908(5)
3
184/88.5
1814/3109
s, Sc, Sc³⁺ hcp
[Ar]3d¹4s²

22 Ti
Titanium
47.867(1)
4
176/74.5
1814/3109
s, Ti, Ti⁴⁺ hcp
[Ar]3d²4s²

23 V
Vanadium
50.9415(1)
5
171/68
2180/2944
s, V, V⁵⁺ bcc
[Ar]3d³4s²

24 Cr
Chromium
51.9961(6)
3,6
166/58
1519/2334
s, Cr, Cr⁶⁺ bcc
[Ar]3d⁵4s¹

25 Mn
Manganese
54.938044(3)
2,4,7
161/60
1519/2334
s, Mn, Mn⁷⁺ bcc
[Ar]3d⁵4s²

26 Fe
Iron
55.845(2)
2,3,6
156/39
1811/3134
s, Fe, Fe⁶⁺ bcc, fcc
[Ar]3d⁶4s²

27 Co
Cobalt
58.933194(4)
2,3
152/68.5
1768/3200
s, Co, Co³⁺ hcp
[Ar]3d⁷4s²

28 Ni
Nickel
58.6934(4)
2
149/83
1728/3003
s, Ni, Ni²⁺ fcc
[Ar]3d⁸4s²

29 Cu
Copper
63.546(3)
2
145/87
1357.77/2835
s, Cu, Cu²⁺ fcc
[Ar]3d¹⁰4s¹

30 Zn
Zinc
65.38(2)
2
142/88
692.68/1180
s, Zn, Zn²⁺ hcp
[Ar]3d¹⁰4s²

31 Ga
Gallium
69.723(1)
3
136/76
302.91/2673
s, Ga, Ga³⁺ ort
[Ar]3d¹⁰4s²4p¹

32 Ge
Germanium
72.630(8)
-4,2,4
125/67
1211.40/3106
s, Ge, Ge⁴⁺ fcd
[Ar]3d¹⁰4s²4p²

33 As
Arsenic
74.921595(6)
-3,3,5
114/72
887 (subl.)
s, As, As³⁺ rho
[Ar]3d¹⁰4s²4p³

34 Se
Selenium
78.971(8)
-2,2,4,6
103/184
494/958
s, Se, Se²⁻ hex
[Ar]3d¹⁰4s²4p⁴

35 Br
Bromine
79.904
-1,1,3,5
94/182
265.8/332.0
l, Br₂, Br⁻ ort
[Ar]3d¹⁰4s²4p⁵

37 Rb
Rubidium
85.4678(3)
1
265/166
312.45/961
s, Rb, Rb⁺ bcc
[Kr]5s¹

38 Sr
Strontium
87.62(1)
2
219/132
1050/1650
s, Sr, Sr²⁺ fcc
[Kr]5s²

39 Y
Yttrium
88.90584(2)
3
212/104
1799/3203
s, Y, Y³⁺ hcp
[Kr]4d¹5s²

40 Zr
Zirconium
91.224(2)
4
206/86
2128/4650
s, Zr, Zr⁴⁺ hcp
[Kr]4d²5s²

41 Nb
Niobium
92.90637(2)
5
198/78
2750/5017
s, Nb, Nb⁵⁺ bcc
[Kr]4d⁴5s¹

42 Mo
Molybdenum
95.95(1)
4,6
190/73
2896/4912
s, Mo, Mo⁶⁺ bcc
[Kr]4d⁵5s¹

43 Tc
Technetium
(98)
4,7
183/70
2430/4538
s, Tc, Tc⁷⁺ hcp
[Kr]4d⁵5s²

44 Ru
Ruthenium
101.07(2)
3,4
178/76
2607/4423
s, Ru, Ru⁴⁺ hcp
[Kr]4d⁷5s¹

45 Rh
Rhodium
102.90550(2)
3
173/80.5
2237/3968
s, Rh, Rh³⁺ fcc
[Kr]4d⁸5s¹

46 Pd
Palladium
106.42(1)
2,4
169/100
1828.05/3236
s, Pd, Pd²⁺ fcc
[Kr]4d¹⁰

47 Ag
Silver
107.8682(2)
1
165/129
1234.93/2435
s, Ag, Ag⁺ fcc
[Kr]4d¹⁰5s¹

48 Cd
Cadmium
112.414(4)
2
161/109
594.22/1040
s, Cd, Cd²⁺ hcp
[Kr]4d¹⁰5s²

49 In
Indium
114.818(1)
3
156/94
429.75/2345
s, In, In³⁺ tet
[Kr]4d¹⁰5s²5p¹

50 Sn
Tin
118.710(7)
-4,2,4
145/83
505.08/2875
s, Sn, Sn⁴⁺ tet, fcd
[Kr]4d¹⁰5s²5p²

51 Sb
Antimony
121.760(1)
-3,3,5
133/74
903.73/1908
s, Sb, Sb³⁺ rho
[Kr]4d¹⁰5s²5p³

52 Te
Tellurium
127.60(3)
-2,2,4,6
123/207
722.66/1261
s, Te, Te²⁻ hex
[Kr]4d¹⁰5s²5p⁴

53 I
Iodine
126.90447(3)
-1,1,3,5,7
115/206
386.85/457.4
s, I₂, I⁻ ort
[Kr]4d¹⁰5s²5p⁵

54 Xe
Xenon
131.293(6)
2,4,6
108
161.40/165.051
g, Xe
[Kr]4d¹⁰5s²5p⁶

55 Cs
Cesium
132.90545196
1
298/181
301.7/944
s, Cs, Cs⁺ bcc
[Xe]6s¹

56 Ba
Barium
137.327(7)
2
253/149
1000/2118
s, Ba, Ba²⁺ bcc
[Xe]6s²

72 Hf
Hafnium
178.49(2)
4
208/85
2506/4876
s, Hf, Hf⁴⁺ hcp
[Xe]4f¹⁴5d²6s²

73 Ta
Tantalum
180.94788(2)
5
200/78
3290/5731
s, Ta, Ta⁵⁺ bcc, tet
[Xe]4f¹⁴5d³6s²

74 W
Tungsten
183.84(1)
4,6
193/74
3695/6203
s, W, W⁶⁺ bcc
[Xe]4f¹⁴5d⁴6s²

75 Re
Rhenium
186.207(1)
4
188/67
3459/5869
s, Re, Re⁷⁺ hcp
[Xe]4f¹⁴5d⁵6s²

76 Os
Osmium
190.23(3)
4
185/53
3306/5285
s, Os, Os⁸⁺ hcp
[Xe]4f¹⁴5d⁶6s²

77 Ir
Iridium
192.227(3)
3,4
180/82
2719/4403
s, Ir, Ir³⁺ fcc
[Xe]4f¹⁴5d⁷6s²

78 Pt
Platinum
195.084(9)
2,4
177/94
2041.4/4098
s, Pt, Pt²⁺ fcc
[Xe]4f¹⁴5d⁹6s¹

79 Au
Gold
196.966569(5)
3
174/99
1337.33/3243
s, Au, Au³⁺ fcc
[Xe]4f¹⁴5d¹⁰6s¹

80 Hg
Mercury
200.592(3)
1,2
171/116
234.3210/629.88
l, Hg, Hg²⁺ rho
[Xe]4f¹⁴5d¹⁰6s²

81 Tl
Thallium
204.38
1,3
156/102.5
577/1746
s, Tl, Tl³⁺ hcp
[Xe]4f¹⁴5d¹⁰6s²6p¹

82 Pb
Lead
207.2(1)
2,4
154/133
600.61/2022
s, Pb, Pb²⁺ fcc
[Xe]4f¹⁴5d¹⁰6s²6p²

83 Bi
Bismuth
208.98040(1)
3
143/90
544.7/1837
s, Bi, Bi³⁺ rho
[Xe]4f¹⁴5d¹⁰6s²6p³

84 Po
Polonium
(209)
-2,2,4
135/108
575/610
s, Po, Po⁴⁺ cub
[Xe]4f¹⁴5d¹⁰6s²6p⁴

85 At
Astatine
(210)
-1,1
127/n.a.
575/610
n.a., n.a., n.a. fcc
[Xe]4f¹⁴5d¹⁰6s²6p⁵

86 Rn
Radon
(222)
2
120
202/211.5
g, Rn
[Xe]4f¹⁴5d¹⁰6s²6p⁶

87 Fr
Francium
(223)
1
n.a./n.a.
n.a./n.a.
n.a., n.a., n.a. bcc
[Rn]7s¹

88 Ra
Radium
(226)
2
n.a./162
973/2010
s, Ra, Ra²⁺ bcc
[Rn]7s²

104 Rf
Rutherfordium
(267)
4
n.a./n.a.
2400/5800
s, n.a., n.a. hcp
[Rn]5f¹⁴6d²7s²

105 Db
Dubnium
(268)
5
n.a./n.a.
n.a./n.a.
n.a., n.a., n.a. bcc
[Rn]5f¹⁴6d³7s²

106 Sg
Seaborgium
(269)
6
n.a./n.a.
n.a./n.a.
n.a., n.a., n.a. bcc
[Rn]5f¹⁴6d⁴7s²

107 Bh
Bohrium
(270)
7
n.a./n.a.
n.a./n.a.
n.a., n.a., n.a. hcp
[Rn]5f¹⁴6d⁵7s²

108 Hs
Hassium
(269)
8
n.a./n.a.
n.a./n.a.
n.a., n.a., n.a. hcp
[Rn]5f¹⁴6d⁶7s²

109 Mt
Meitnerium
(278)
n.a.
n.a./n.a.
n.a./n.a.
n.a., n.a., n.a. fcc
[Rn]5f¹⁴6d⁷7s²

110 D