PERIODIC TABLE

ALBANY COLLEGE OF PHARMACY AND HEALTH SCIENCES

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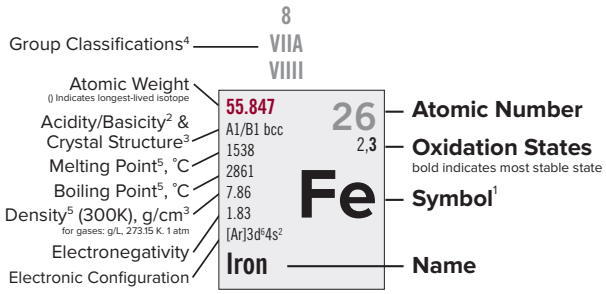

ACIDITY & BASICITY OF REPRESENTATIVE OXIDES:
A=acid; **B**=basic; **A/B**=amphoteric.
RELATIVE STRENGTH: 1=low; **2**=moderate; **3**=high.

CRYSTAL STRUCTURES: mcl=monoclinic; **orh**=orthorhombic; **tet**=tetragonal; **bct**=body-centered tetragonal; **cub**=cubic; **hex**=hexagonal; **rhm**=rhombohedral; **fcc**=faced-centered cubic; **bcc**=body-centered cubic; **hcp**=hexagonal close-packed; **dcp**=dodecahedral close-packed.

GROUP CLASSIFICATION: Two older group classification systems still in use today rely on an A/B coding scheme to categorize periodic properties (i.e., VIIA, IIB, etc.). Because of the potential for confusion between these two systems, the International Union of Pure & Applied Chemistry (IUPAC) recommends the use of a **1–18** group classification system.

MELTING & BOILING POINTS: Unless otherwise stated, melting and boiling points are at 1 atm. Superscripts on selected values are defined as: **SP**=sublimation point at 1 atm; **TP**=triple point. Brackets indicate approximate value.

1																	18
1.00794 A1/B1 hcp -259.34 -252.87 0.0899 2.20 1s¹ **H** Hydrogen	2											3 B3 bcc 180.5 1342 0.534 0.98 [He] 2s¹ **Li** Lithium	4 A1/B1 hcp 1287 2471 1.8477 1.57 [He]2s² **Be** Beryllium	5 A2 tet 2075 4000 2.31 2.04 [He]2s²p¹ **B** Boron	6 A2 hex 4492[SP] 3825[SP] 2.25 2.55 [He]2s²p² **C** Carbon	7 A3 hex -210.00 -195.79 1.25046 3.04 [He]2s²p³ **N** Nitrogen	8 cub -218.79 -182.95 1.429 3.44 [He]2s²p⁴ **O** Oxygen	9 mon -219.62 -188.12 1.69 3.98 [He]2s²p⁵ **F** Fluorine	10 fcc -248.59 -246.08 0.9002 — [He]2s²p⁶ **Ne** Neon
22.989768 B3 bcc 97.72 883 0.97 0.93 [Ne]3s¹ **Na** Sodium	11 1	24.3050 B3 hcp 650 1090 1.74 1.31 [Ne]3s² **Mg** Magnesium	12 2											26.9815385 A1/B1 fcc 660.32 2519 2.702 1.61 [Ne]3s²p¹ **Al** Aluminum	13 3	28.0855 A1/B1 fcc 1414 3265 2.33 1.90 [Ne]3s²p² **Si** Silicon	14 4	30.973761998 A2 cub 44.15 277 1.82 2.19 [Ne]3s²p³ **P** Phosphorus	15 ±3,4,5	32.066 A3 orh 115.21 444.60 2.07 2.58 [Ne]3s²p⁴ **S** Sulfur	16 ±2,4,6	35.4527 A3 tet -101.5 -34.04 3.214 3.16 [Ne]3s²p⁵ **Cl** Chlorine	17 ±1,3,5,7	39.948 fcc -189.35 -185.85 1.784 — [Ne]3s²p⁶ **Ar** Argon	18
39.0983 B3 bcc 63.38 759 0.86 0.82 [Ar]4s¹ **K** Potassium	19 1	40.078 B3 fcc 842 1484 1.54 1.00 [Ar]4s² **Ca** Calcium	20 2	44.955908 B1 hcp 1541 2830 2.989 1.36 [Ar]3d¹4s² **Sc** Scandium	21 3	47.867 A1/B1 hcp 1668 3287 4.5 1.54 [Ar]3d²4s² **Ti** Titanium	22 3,4	50.9415 A1/B1 bcc 1910 3407 5.96 1.63 [Ar] 3d³4s² **V** Vanadium	23 2,3,4,5	51.9961 A3 bcc 1907 2671 7.20 1.66 [Ar]3d⁵4s¹ **Cr** Chromium	24 2,3,6	54.938044 A3 cub 1246 2061 7.47 1.55 [Ar]3d⁵4s² **Mn** Manganese	25 2,3,4,6,7	55.847 A1/B1 bcc 1538 2861 7.86 1.83 [Ar]3d⁶4s² **Fe** Iron	26 2,3	58.933194 A1/B1 fcc 1495 2927 8.92 1.88 [Ar]3d⁷4s² **Co** Cobalt	27 2,3	58.6934 B2 fcc 1455 2913 8.90 1.91 [Ar]3d⁸4s² **Ni** Nickel	28 2,3	63.546 B2 fcc 1084.62 2562 8.94 1.90 [Ar]3d¹⁰4s¹ **Cu** Copper	29 1,2	65.39 A1/B1 hcp 419.53 907 7.14 25°C 1.65 [Ar]3d¹⁰4s² **Zn** Zinc	30 2	69.723 A1/B1 orh 29.76 2204 6.095 1.81 [Ar]3d¹⁰4s²p¹ **Ga** Gallium	31 3	72.61 A1/B1 fcc 938.25 2833 5.35 2.01 [Ar]3d¹⁰4s²p² **Ge** Germanium	32 4	74.921595 A2 rhm 817[SP] 614[SP] 5.727 25°C 2.18 [Ar]3d¹⁰4s²p³ **As** Arsenic	33 ±3,5	78.971 A3 hex 221 685 4.81 2.55 [Ar]3d¹⁰4s²p⁴ **Se** Selenium	34 -2,4,6	79.904 A3 orh -7.2 58.8 3.119 2.96 [Ar]3d¹⁰4s²p⁵ **Br** Bromine	35 ±1,5	83.80 fcc -157.36 -153.22 3.74 — [Ar]3d¹⁰4s²p⁶ **Kr** Krypton	36
85.4678 B3 bcc 39.31 688 1.532 0.82 [Kr]5s¹ **Rb** Rubidium	37 1	87.62 B3 fcc 777 1382 2.6 0.95 [Kr]5s² **Sr** Strontium	38 2	88.90584 B1 hcp 1526 3336 4.469 1.22 [Kr]4d¹5s² **Y** Yttrium	39 3	91.224 A1/B1 hcp 1855 4409 6.49 1.33 [Kr]4d²5s² **Zr** Zirconium	40 4	92.90637 A2 bcc 2477 4744 8.57 1.6 [Kr]4d⁴5s¹ **Nb** Niobium	41 3,5	95.95 A3 bcc 2623 4639 10.2 2.16 [Kr]4d⁵5s¹ **Mo** Molybdenum	42 2,3,4,5,6	(97.9072) A3 hcp 2157 4265 11.5 1.9 [Kr]4d⁵5s² **Tc** Technetium	43 7	101.07 A2 hcp 2334 4150 12.3 2.2 [Kr]4d⁷5s¹ **Ru** Ruthenium	44 2,3,4,6,8	102.90550 A1/B1 fcc 1964 3695 12.4 2.28 [Kr]4d⁸5s¹ **Rh** Rhodium	45 2,3,4	106.42 B2 fcc 1554.9 2963 12.02 2.20 [Kr]4d¹⁰ **Pd** Palladium	46 2,4	107.8682 A1/B2 fcc 961.78 2162 10.5 1.93 [Kr]4d¹⁰5s¹ **Ag** Silver	47 1	112.414 B2 hcp 321.07 767 8.642 1.69 [Kr]4d¹⁰5s² **Cd** Cadmium	48 2	114.818 A1/B2 tet 156.60 2072 7.30 1.78 [Kr]4d¹⁰5s²p¹ **In** Indium	49 3	118.710 A1/B1 fcc 231.93 2602 7.28 1.96 [Kr]4d¹⁰5s²p² **Sn** Tin	50 2,4	121.760 A2 rhm 630.63 1587 6.684 25°C 2.05 [Kr]4d¹⁰5s²p³ **Sb** Antimony	51 ±3,5	127.60 A2 hcp 449.51 988 6.25 2.1 [Kr]4d¹⁰5s²p⁴ **Te** Tellurium	52 -2,4,6	126.90447 A3 orh 113.7 184.4 4.93 2.66 [Kr]4d¹⁰5s²p⁵ **I** Iodine	53 ±1,5,7	131.29 fcc -111.75 -108.04 5.89 — [Kr]4d¹⁰5s²p⁶ **Xe** Xenon	54
132.90545196 B3 bcc 28.44 671 1.879 0.79 [Xe]6s¹ **Cs** Caesium	55 1	137.327 B3 bcc 727 1897 3.594 0.89 [Xe]6s² **Ba** Barium	56 2	57-71 lanthanoids		178.49 A1/B1 hcp 2233 4603 13.31 1.3 [Xe]4f¹⁴5d²6s² **Hf** Hafnium	72 4	180.9479 A2 bcc 3017 5458 16.6 1.5 [Xe]4f¹⁴5d³6s² **Ta** Tantalum	73 5	183.84 A2 bcc 3422 5555 19.35 2.36 [Xe]4f¹⁴5d⁴6s² **W** Tungsten	74 2,3,4,5,6	186.207 A2 hcp 3186 5596 20.5 1.9 [Xe]4f¹⁴5d⁵6s² **Re** Rhenium	75 -1,2,4,6,7	190.23 A2 hcp 3033 5012 22.61 2.2 [Xe]4f¹⁴5d⁶6s² **Os** Osmium	76 2,3,4,6,8	192.217 B2 fcc 2446 4428 22.65 2.20 [Xe]4f¹⁴5d⁷6s² **Ir** Iridium	77 2,3,4,6	195.08 B2 fcc 1768.4 3825 21.45 2.28 [Xe]4f¹⁴5d⁹6s¹ **Pt** Platinum	78 2,4	196.966569 A1/B1 fcc 1064.18 2856 19.31 2.54 [Xe]4f¹⁴5d¹⁰6s¹ **Au** Gold	79 1,3	200.59 B2 rhm -38.83 356.73 13.546 2.00 [Xe]4f¹⁴5d¹⁰6s² **Hg** Mercury	80 1,2	204.3833 B2 hcp 304 1473 11.85 2.04 [Xe]4f¹⁴5d¹⁰6s²p¹ **Tl** Thallium	81 1,3	207.2 A1/B1 fcc 327.46 1749 11.34 2.33 [Xe]4f¹⁴5d¹⁰6s²p² **Pb** Lead	82 2,4	208.98037 A2 rhm 271.40 1564 9.78 2.02 [Xe]4f¹⁴5d¹⁰6s²p³ **Bi** Bismuth	83 3,5	(208.9824) A1/B1 cub 254 962 9.196 2.0 [Xe]4f¹⁴5d¹⁰6s²p⁴ **Po** Polonium	84 2,4	(209.9871) — 302 337 — 2.2 [Xe]4f¹⁴5d¹⁰6s²p⁵ **At** Astatine	85 ±1,3,5,7	(222.0176) fcc -71 -61.7 9.73 — [Xe]4f¹⁴5d¹⁰6s²p⁶ **Rn** Radon	86
(223.0197) B3 bcc 27 677 — 0.7 [Rn]7s¹ **Fr** Francium	87 1	(226.0254) B3 bcc 700 <1140 5.8 0.9 [Rn]7s² **Ra** Radium	88 2	89-103 Actinoids		(261) — — — — [Rn]5f¹⁴6d²7s² **Rf** Rutherfordium*	104 4	(262) — — — — [Rn]5f¹⁴6d³7s² **Db** Dubnium*	105 —	(263) — — — — [Rn]5f¹⁴6d⁴7s² **Sg** Seaborgium*	106 —	(262) — — — — [Rn]5f¹⁴6d⁵7s² **Bh** Bohrium*	107 —	(265) — — — — [Rn]5f¹⁴6d⁶7s² **Hs** Hassium*	108 —	(266) — — — — [Rn]5f¹⁴6d⁷7s² **Mt** Meitnerium*	109 —	(281.162) — — — — [Rn]5f¹⁴6d⁸7s² **Ds** Darmstadtium	110 —	(280.164) — — — — [Rn]5f¹⁴6d⁹7s² **Rg** Roentgenium	111 —	(285.18) — — — — [Rn]5f¹⁴6d¹⁰7s² **Cn** Copernicium	112 —	(286.19) — — — — [Rn]5f¹⁴6d¹⁰7s²7p¹ **Nh** Nihonium	113 —	(289.19) — — — — [Rn]5f¹⁴6d¹⁰7s²7p² **Fl** Flerovium	114 —	(289.19) — — — — [Rn]5f¹⁴6d¹⁰7s²7p³ **Mc** Moscovium	115 —	(293.20) — — — — [Rn]5f¹⁴6d¹⁰7s²7p⁴ **Lv** Livermorium	116 —	(294.21) — — — — [Rn]5f¹⁴6d¹⁰7s²7p⁵ **Ts** Tennessine	117 —	(294.21) — — — — [Rn]5f¹⁴6d¹⁰7s²7p⁶ **Og** Oganesson	118 —

138.9055 B3 hex 920 3455 6.146 1.10 [Xe]5d¹6s² **La** Lanthanum	57 3	140.115 B2 fcc 799 3424 6.770 1.12 [Xe]4f¹5d¹6s² **Ce** Cerium	58 3,4	140.90766 B2 hex 931 3510 6.773 1.13 [Xe]4f³6s² **Pr** Praseodymium	59 3,4	144.24 B2 hex 1016 3066 7.00 1.14 [Xe]4f⁴6s² **Nd** Neodymium	60 3	(144.9127) B2 dcp 1042 3000 7.264 1.13 [Xe]4f⁵6s² **Pm** Promethium	61 3	150.36 B2 rhm 1072 1790 7.536 1.17 [Xe]4f⁶6s² **Sm** Samarium	62 2,3	151.965 B2 bcc 822 1596 5.244 1.2 [Xe]4f⁷6s² **Eu** Europium	63 2,3	157.25 B2 hcp 1314 3264 7.901 1.20 [Xe]4f⁷5d¹6s² **Gd** Gadolinium	64 3	158.92534 B1 hcp 1359 3221 8.230 1.2 [Xe]4f⁹6s² **Tb** Terbium	65 3,4	162.50 B1 hcp 1411 2561 8.551 1.22 [Xe]4f¹⁰6s² **Dy** Dysprosium	66 3	164.93 B1 hcp 1472 2694 8.80 1.23 [Xe]4f¹¹6s² **Ho** Holmium	67 3	167.26 B1 hcp 1529 2862 9.066 1.24 [Xe]4f¹²6s² **Er** Erbium	68 3	168.93 B1 hcp 1545 1946 9.321 1.25 [Xe]4f¹³6s² **Tm** Thulium	69 2,3	173.05 B1 fcc 824 1194 6.966 1.1 [Xe]4f¹⁴6s² **Yb** Ytterbium	70 2,3	174.97 B1 hcp 1663 3393 9.84 1.27 [Xe]4f¹⁴5d¹6s² **Lu** Lutetium	71 3
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(227.0278) fcc 1051 3198 10.07 1.1 [Rn]6d¹7s² **Ac** Actinium	89 3	232.0377 B1 fcc 1750 4788 11.72 1.3 [Rn]6d²7s² **Th** Thorium	90 4	231.0359 B1 bct 1572 — 15.37 1.5 [Rn]5f²6d¹7s² **Pa** Protactinium	91 4,5	238.0289 A1/B1 bcc 1135 4131 19.05 ± 0.02 1.38 [Rn]5f³6d¹7s² **U** Uranium	92 3,4,5,6	(237.0482) A1/B1 orh 644 — 20.45 1.36 [Rn]5f⁴6d¹7s² **Np** Neptunium	93 3,4,5,6	(244.0642) A1/B1 mcl 640 3228 19.816 1.28 [Rn]5f⁶7s² **Pu** Plutonium	94 3,4,5,6	(243.0614) A1/B1 hcp 1176 2607 13.67 1.3 [Rn]5f⁷7s² **Am** Americium	95 3,4,5,6	(247.0703) A1/B1 dcp 1345 — 13.51 1.3 [Rn]5f⁷6d¹7s² **Cm** Curium	96 3	(247.0703) dcp 1050 — 14.78 1.3 [Rn]5f⁹7s² **Bk** Berkelium	97 3,4	(251.08) — 900 — — 1.3 [Rn]5f¹⁰7s² **Cf** Californium	98 3	(252.08) — 860 — — 1.3 [Rn]5f¹¹7s² **Es** Einsteinium	99 3	(257.10) — 1527 — — 1.3 [Rn]5f¹²7s² **Fm** Fermium	100 3	(258.10) — 827 — — 1.3 [Rn]5f¹³7s² **Md** Mendelevium	101 2,3	(259.10) — 827 — — 1.3 [Rn]5f¹⁴7s² **No** Nobelium	102 2,3	(266.12) — 1627 — — — [Rn]5f¹⁴6d¹7s² **Lr** Lawrencium	103 3

Element Coding

- Solid
- Gas
- Liquid
- Synthetically prepared

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IMPORTANT FORMULAS AND EQUATIONS

DENSITY

$$d = \frac{m}{V}$$

d = density m = mass V = volume

MOLE CALCULATION

$$\text{number of moles} = \frac{\text{given mass (g)}}{\text{gram-formula mass}}$$

PERCENT ERROR

$$\%\ \text{error} = \frac{\text{measured value} - \text{accepted value}}{\text{accepted value}} \times 100$$

PERCENT COMPOSITION

$$\%\ \text{composition by mass} = \frac{\text{mass of part}}{\text{mass of whole}} \times 100$$

CONCENTRATION

$$\text{parts per million} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 1\,000\,000$$

$$\text{molarity} = \frac{\text{moles of solute}}{\text{liters of solution}}$$

COMBINED GAS LAW

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

P = pressure
V = volume
T = temperature (K)

TITRATION

$M_AV_A = M_BV_B$

M_A = molarity of H+
V_A = volume of acid
M_B = molarity of OH–
V_B = volume of base

HEAT

$q = mC\Delta T$
$q = mH_f$
$q = mH_v$

**The units of mass must be the same*

q = heat
m = mass
C = specific heat capacity
ΔT = change in temperature
H_f = heat of fusion
H_v = heat of vaporization

TEMPERATURE

$K = °C + 273$

K = Kelvin
°C = degrees Celsius

RADIOACTIVE DECAY

$$\text{fraction remaining} = \left(\frac{1}{2}\right)^{\frac{t}{T}}$$

t = total time elapsed
T= half-life

$$\text{number of half-life periods} = \frac{t}{T}$$