```
R_{\rm gas\text{-}law} = 0.0821 \frac{\text{L} \cdot \text{atm}}{\cdot}
                                                                               L \cdot kPa \vee J
                                                  L·mmHg
                                                                                                                 Periodic Table of Elements
                                        = 62.4
                                                                    = 8.314
                           mol · K
                                                                                 mol · K
 453.6~\mathrm{g}
                2.54 \text{ cm} 0.946 \text{ L} 6.022 \times 10^{23} \text{ units} 22.4 \text{ L}
                                                                                                       [J] = kg m^2 s^{-2}, [N] = kg m s
                                                                                                                                                                                                                                    Soluble with
                                                                                                                                                                                                                                                                     Precipitates with
                    1 in
                                     1 \mathsf{qt}
                                                                                                       [Pa] = N m^{-2}, kg(ms)^{-1}, [V] = JC^{-1}
                                                                                                                                                                                                        NO<sub>2</sub> Nitrate
                                                                                                                                                                                                                                    Most cations
                                                                                                                                                                                                                                                                  No common cations
                         P_{\mathsf{sea}}
  1 \, \mathsf{g}_{\mathsf{water}}
                                                                                    1 kcal
                                                                                                     PV = nRT and \left[P + \frac{an^2}{V^2}\right] \left[V - nb\right] = nRT
                                              1 \mathsf{\ atm}
                                                                  1 \mathsf{\ atm}
                                                                                                                                                                                                              CIO_4^-
                                                                                                                                                                                                                                    Most cations
                                                                                                                                                                                                                                                                  No common cations
                   =\frac{1}{101325} = \frac{1}{760} = \frac{1}{760} = \frac{1}{14.7} = \frac{
                                                                                                                                                                          k = Ae^{-\frac{E_a}{RT}}
                                                                                 4.184 kJ
  1 \text{ mL}_{\text{water}}
                                                                                                     PV \propto 1 and VT \propto 1 (Boyle and Charle).
                                                                                                                                                                                                              CIO
                                                                                                                                                                                                                                    Most cations
                                                                                                                                                                                                                                                                  No common cations
                                                                                                             \frac{\text{moles solute}}{\text{and } m} \text{ and } m =
                                                                                                                                                                          [A]_t = [A]_0 - kt
                                                                                                                                              moles solute
                                                                                                                                                                                                            C_2H_3O_2
                                                                                                                                                                                                                                    Most cations
                                                                                                                                                                                                                                                                         Ag^{+}, Hg_{2}^{2+}
                                                                                                                                                                                                                                                                                                                     \boxed{\varepsilon = E_{\rm cell}^{\circ} = E_{\rm red}^{\circ}({\rm cathode}) - E_{\rm red}^{\circ}({\rm anode}), \text{ and } E_{\rm cell\, voltaic}^{\circ} > 0.}
  {}^{\circ}\mathsf{C} = \frac{5}{9}({}^{\circ}\mathsf{F} - 32) and {}^{\circ}\mathsf{F} = \frac{9}{5}{}^{\circ}\mathsf{C} + 32 and 1\mathsf{V} = \frac{\mathsf{J}}{\mathsf{C}}
                                                                                                                                                                          [A]_t = [A]_0 e^{-kt}
                                                                                                                                                                                                                                                                              Cr<sup>3+</sup>
                                                                                                               L solution
                                                                                                                                                  kg solvent
                                                                                                                                                                                                               \mathsf{F}^-
                                                                                                                                                                                                                                   Most cations
                                                                                                                                                                          [A]_t = \frac{1}{kt + \frac{1}{|A|_0}}
                                                                                                     X_{\rm mol\ fraction} = \frac{\rm mol\ component}{\rm mol\ total}
                                                                                                                                                                                                                                                                                                                      \triangle G = -nFE, where F = 96485 \text{ C(mol)}^{-1} = 96485 \text{J (Vmol)}^{-1}.
                                                                                                                                                                                                                                                               (Ag, TI)^+, Pb^{2+,4+}, Hg_2^{2-}
 h = 6.626 \times 10^{-34} \text{Js} \vee \text{kgm}^2 \text{s}^{-1} \text{ and } c = 3.00 \times 10^8 \text{ ms}^{-1}
                                                                                                                                                                                                               CI<sup>-</sup>
                                                                                                                                                                                                                                   Most cations
                                                                                                                                                                                                                                                                                                                       -nFE = -nFE^{\circ} + RT \ln Q, so E = E^{\circ} - \frac{RT}{nF} \ln Q (Nernst).
                                                                                                                                                                                                                                                                (Ag, TI)^+, Pb^{2+,4+}, Hg_2^2
                                                                                                                                                                                                               Br⁻
                                                                                                                                                                                                                                   Most cations
                                                                                                      \frac{\rm [H_3O^+][A^-]}{\rm [HA]} and K_b=\frac{\rm [HB][OH^-]}{\rm [B^-]}, in water, \rm K_aK_b=1.0\times10^{-14}
                                                                                                                                                                                                                                                                                                                      \triangle G = w_{\rm max} = -nFE. \ \ {\rm And} \ \ w = nFE_{\rm applied}. \ \ {\rm Also,} \ \ Q = It.
                            \triangle H_{\rm vap} = 40.67 {\rm kJ~mol}^{-1}
                                                                                                                                                                                                                                                               \frac{(Ag, TI)^+, Pb^{2+,4+}, Hg_2^2}{(Ag, TI)^+, Pb^{2+,4+}, Hg_2^2}
                                                                                                                                                                                                                                   Most cations
         1 IA
                                                                                                                                                                                                                                                                                                                                                                                                                                             18 VIIIA
                            \begin{vmatrix} \triangle H_{\rm fus} = 6.01 {\rm kJ~mol}^{-1} & \frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}} \\ C_{\rm ice} = 2.11 {\rm J~(gK)}^{-1} & \frac{r_2}{r_2} = \sqrt{\frac{M_2}{M_1}} \\ \end{vmatrix} 
                                                                                                                                                                                                                                                                     Ag^{+}, Ba^{2+}, Sr^{2+}
                                                                                                  pH = -\log_{10}[H^+], pOH = -\log_{10}[OH^-], pK_a = -\log_{10}[K_a]
                                                                                                                                                                                                                                   Most cations
                                                                                                                                                                                                                                                                  Pb^{2+,4+}, Ca^{2+}, Hg_2^{2+}
                2.20
                                                                                              pH + pOH = 14, and K_c = \frac{[product]}{[reactant]}, K_{eq}, K_{sp} \leftrightarrow K_p = K_c (RT)^{\triangle n}
                            \begin{vmatrix} C_{\text{water}} = 4.184 \text{ J (gK)}^{-1} v_{\text{rms}} = \sqrt{\frac{3RT}{M}} \\ C_{\text{steam}} = 1.865 \text{ J (gK)}^{-1} \end{aligned} 
                                                                                                                                                                                                                                                                  Ba<sup>2+</sup>, Sr<sup>2+</sup>, Pb<sup>2+,4+</sup>
          H_2
                                                                                                                                                                                                                                                                                                                Li^+, K^+, Ba^{2+}, Ca^{2+}, Na^+, Mg^{2+}, Al^{3+}, Mn^{+2}, Zn^{2+}, Cr^{3+,2+}, Fe^{3+,2+},
                                                                                                                                                                                                             CrO_4^2
                                                                                                                                                                                                                                                                                                                                                                                                                                                He
                                                                                                                                                                                                                                    Most cations
                                                                                                 K_{a-acetic} = 1.8 \times 10^{-5}, and in buffer pH = pK<sub>a</sub> + \log_{10} \left( \frac{[A^-]}{[HA]} \right)
                                                                                                                                                                                                                                                                         \mathsf{Ca}^{2+},\mathsf{Hg}_2^{2+}
                                                                                                                                                                                                                                                                                                                Co^{2+}, Ni^+, Sn^{2+}, Pb^{2+}, 2H^+, Cu^{2+,+}, Ag^+, Hg^{2+}, Pt^{2+}, Au^{3+,+}
       Hydrogen
                                                                                                                                                                                                                                                                                                                                                                                                                                               Helium
                                                                                                                                                                                                                                  Na^+, K^+, NH_4^+
                                                                                                                                                                                                                                                                    Most other cations
                                                                                                                                                                                                                                                                                                                                                                                                                                                4.00
          1.01
                                  2 IIA
                                                                                                                                                                                                                                                                                                                 13 IIIA
                                                                                                                                                                                                                                                                                                                                          14 IVA
                                                                                                                                                                                                                                                                                                                                                                    15 VA
                                                                                                                                                                                                                                                                                                                                                                                            16 VIA
                                                                                                                                                                                                                                                                                                                                                                                                                    17 VIIA
                                                     E_{\rm photon} = hf = \frac{hc}{\lambda} and \lambda = \frac{h}{2\pi m^2}
                                                                                                                                                                                                                                      \mathrm{Li}^+,\mathrm{Sr}^{2+}
                                                                                                               \triangle E = q + w = q - P \triangle V and \triangle H = \triangle E + P \triangle V
                                                    E_n = -\frac{R_H}{n^2}
                                                                                                                                                                                                              OH
                                                                                                                                                                                                                               Na^+, K^+, NH_4^+, Li^-
                                                                                                                                                                                                                                                                    Most other cations
                                        1.57
                0.98
                                                                                                                                                                                                                                                                                                                         2.04
                                                                                                                                                                                                                                                                                                                                                  2.55
                                                                                                                                                                                                                                                                                                                                                                          3.14
                                                                                                                                                                                                                                                                                                                                                                                         8
                                                                                                                                                                                                                                                                                                                                                                                                   3.44
                                                                                                                                                                                                                                                                                                                                                                                                                            3.98
                                                                                                               Isotherm, \triangle S = \frac{q_{\text{if-reverse}}}{T}, or S = k \ln W (micro-state)
                                                    R_{H_{\text{Rydberg}}} = 2.18 \times 10^{-18} \text{ J}
                                                                                                                                                                                                                                 Sr<sup>2+</sup>, Ba<sup>2+</sup>, Ca<sup>2+</sup>
                                                                                                                                                                                                                                                                                                                                                                                             O_2
                                   Be
                                                                                                                                                                                                                                                                                                                      B
                                                                                                                                                                                                                                                                                                                                              C
                                                                                                                                                                                                                                                                                                                                                                                                                        F_2
                                                                                                                                                                                                                                                                                                                                                                                                                                                Ne
                                                                                                                                                                                                                                                                                                                                                                      N_2
                                                                                                               k = 1.38 \times 10^{-23} \text{ JK}^{-1}
                                                    \triangle E = R_H \left( \frac{1}{n_i^2} - \frac{1}{n_f^2} \right)
                                                                                                                                                                                                              CO_2^2
                                                                                                                                                                                                                                (Na, K, NH_4, Li)^+
                                                                                                                                                                                                                                                                    Most other cations
                                                                                                                                                                                                                                                                                                                                                                   Nitrogen
         Lithium
                                Beryllium
                                                                                                                                                                                                                                                                                                                   Boron
                                                                                                                                                                                                                                                                                                                                           Carbon
                                                                                                                                                                                                                                                                                                                                                                                            Oxygen
                                                                                                                                                                                                                                                                                                                                                                                                                     Fluorine
                                                                                                                                                                                                                                                                                                                                                                                                                                                Neon
                                                                                                               \Delta S = k \ln \left( rac{W_{
m final}}{W_{
m initial}} 
ight) and \Delta S_{
m surr.} = -rac{\Delta H^{\circ}}{T}
                                                                                                                                                                                                             PO<sup>3</sup>
                                                                                                                                                                                                                                  Na^+, K^+, NH_4^+
                                                                                                                                                                                                                                                                    Most other cations
                                   9.01
                                                                                                                                                                                                                                                                                                                    10.81
                                                                                                                                                                                                                                                                                                                                            12.01
                                                                                                                                                                                                                                                                                                                                                                                                                      19.00
                                                                                                                                                                                                                                                                                                                                                                                                                                                20.18
          6.94
                                                                                                                                                                                                                                                                                                                                                                    14.01
                                                                                                                                                                                                                                                                                                                                                                                              16.00
                                                       i = Van't Hoff
                                                                                                                                                                                                               O^2
                                                                                                                                                                                                                                 No<sub>common</sub> cations
                                                                                                                                                                                                                                                                        Most cations
                                                                                                                -T\triangle S_{\text{universe}} = \triangle H_{\text{system}} - T\triangle S_{\text{system}}
                                                      (K_b, K_f) = (0.512, 1.86)^{\circ} \text{C/m}
                                                                                                                                                                                                         (Na,K,NH_4)^{-}
                                                                                                                                                                                                                                   Most Anions
                                                                                                                                                                                                                                                                        (NH_4)_2C_2O_4
                                                                                                                                                                                                                                                                                                                                                                                                                  17 3.16
    11
             0.93
                             12
                                                                                                                                                                                                                                                                                                              13
                                                                                                                                                                                                                                                                                                                      1.61
                                                                                                                                                                                                                                                                                                                                                                15
                                                                                                                                                                                                                                                                                                                                                                                         16
                                    1.31
                                                                                                               \triangle G := -T \triangle S_{\text{universe}} = \triangle H - T \triangle S
                                                                                                                                                                                                                                                                                                                                       14
                                                                                                                                                                                                                                                                                                                                                1.90
                                                                                                                                                                                                                                                                                                                                                                         2.19
                                                                                                                                                                                                                                                                                                                                                                                                 2.38
                                                                                                                                                                                                                                                                                                                                                                                                                                          18
                                                      \triangle T_f = K_f mi and \triangle T_b = K_b mi
                                                                                                                                                                                                              \mathsf{Bi}^3
                                                                                                                                                                                                                                       Nothing
                                                                                                                                                                                                                                                                        Most anions
                                                                                                               \triangle G = \triangle G^{\circ} + RT \ln(Q), so at eq., K_{\text{eq}} = e^{-\triangle G^{\circ}/RT}
                                                                                                                                                                                                                                                                                                                                              Si
                                                                                                                                                                                                                                                                                                                                                                       P
                                                                                                                                                                                                                                                                                                                                                                                                S
                                                                                                                                                                                                                                                                                                                     ΑI
                                                                                                                                                                                                                                                                                                                                                                                                                       Cl<sub>2</sub>
          Na
                                  Mg
                                                     \Pi = iMRT and S_a = kP_a
                                                                                                                                                                                                                                                                                                                                                                                                                                                Ar
                                                                                                                                                                                                              \mathsf{As}^3
                                                                                                                                                                                                                                                                        Most anions
         Sodium
                              Magnesium
                                                                                                                                                                                                              Sb<sup>3+</sup>
                                                                                                                                                                                                                                          Cl
                                                                                                                                                                                                                                                                                                                Aluminium
                                                                                                                                                                                                                                                                                                                                            Silicon
                                                                                                                                                                                                                                                                                                                                                                 Phosphorus
                                                                                                                                                                                                                                                                                                                                                                                            Sulphur
                                                                                                                                                                                                                                                                                                                                                                                                                     Chlorine
                                                                                                                                                                                                                                                                                                                                                                                                                                                Argon
                                                                                                                                                                                                                                                                        Most anions
          22.99
                                  24.31
                                                                                                                                                                                                                                                                                                                   26.98
                                                                                                                                                                                                                                                                                                                                            28.09
                                                                                                                                                                                                                                                                                                                                                                     30.97
                                                                                                                                                                                                                                                                                                                                                                                              32.10
                                                                                                                                                                                                                                                                                                                                                                                                                      35.45
                                                                                                                                                                                                                                                                                                                                                                                                                                                39.95
                                                          3 IIIA
                                                                                   4 IVB
                                                                                                             5 VB
                                                                                                                                     6 VIB
                                                                                                                                                             7 VIIB
                                                                                                                                                                                     8 VIIIB
                                                                                                                                                                                                              9 VIIIB
                                                                                                                                                                                                                                      10 VIIIB
                                                                                                                                                                                                                                                                 11 IB
                                                                                                                                                                                                                                                                                         12 IIB
                                                                                                                                24
                                                                                                                                           1.66
                                                      21 1.36
                                                                                                                                                                                                                                                             29
                                                                                                                                                                                                                                                                        1.90
    19
             0.82
                                    1.00
                                                                               22
                                                                                       1.54
                                                                                                       23
                                                                                                                 1.63
                                                                                                                                                          25 1.55
                                                                                                                                                                                          1.83
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                                                                                                                                                                                                                  1.88
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                                                                                                                                                                                                                                                                                                                     1.81
                                                                                                                                                                                                                                                                                                                                       32
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                                                                                                                                                                                                                                                                                                                                                                                                                                           36
                                                                                                                                                                                                                                                                                                                                                                                                                                                   3.00
                                                            Sc
                                                                                                               V
                                                                                                                                     Cr*
                                                                                                                                                                                                                                                                                                                                                                                               Se
                                                                                                                                                                                                                                                                                                                                                                                                                      Br<sub>2</sub>
            K
                                   Ca
                                                                                      Ti
                                                                                                                                                              Mn
                                                                                                                                                                                         Fe
                                                                                                                                                                                                                 Co
                                                                                                                                                                                                                                          Ni
                                                                                                                                                                                                                                                                Cu*
                                                                                                                                                                                                                                                                                           Zn
                                                                                                                                                                                                                                                                                                                    Ga
                                                                                                                                                                                                                                                                                                                                             Ge
                                                                                                                                                                                                                                                                                                                                                                      As
                                                                                                                                                                                                                                                                                                                                                                                                                                                Kr
                                                                                                                                                                                                                                                                                        Zinc^{(2+)}
      Potassium
                                 Calcium
                                                        Scandium
                                                                                 Titanium
                                                                                                          Vanadium
                                                                                                                                                           Manganese
                                                                                                                                                                                         Iron
                                                                                                                                                                                                               Cobalt
                                                                                                                                                                                                                                         Nickel
                                                                                                                                                                                                                                                                                                                  Gallium
                                                                                                                                                                                                                                                                                                                                        Germanium
                                                                                                                                                                                                                                                                                                                                                                    Arsenic
                                                                                                                                                                                                                                                                                                                                                                                            Selenium
                                                                                                                                                                                                                                                                                                                                                                                                                     Bromine
                                                                                                                                                                                                                                                                                                                                                                                                                                              Krypton
                                                                                                                                  Chromium
                                                                                                                                                                                                                                                                Copper
          39.10
                                  40.08
                                                           44.96
                                                                                    47.87
                                                                                                             50.94
                                                                                                                                                              54.94
                                                                                                                                                                                       55.85
                                                                                                                                                                                                                58.93
                                                                                                                                                                                                                                         58.69
                                                                                                                                                                                                                                                                                          65.38
                                                                                                                                                                                                                                                                                                                   69.72
                                                                                                                                                                                                                                                                                                                                            72.63
                                                                                                                                                                                                                                                                                                                                                                    74.92
                                                                                                                                                                                                                                                                                                                                                                                              78.97
                                                                                                                                                                                                                                                                                                                                                                                                                       79.90
                                                                                                                                                                                                                                                                                                                                                                                                                                               83.80
                                                                                                                                     52.00
                                                                                                                                                                                                                                                                  63.55
                                                                                                                                                                                  44
                                                                                                                    1.6
                                                                                                                                42
                                                                                                                                           2.16
                                                                                                                                                          43
                                                                                                                                                                                               2.2
                                                                                                                                                                                                           45
                                                                                                                                                                                                                      2.28
            0.82
                             38
                                     0.95
                                                      39
                                                              1.22
                                                                               40
                                                                                       1.33
                                                                                                                                                                      1.9
                                                                                                                                                                                                                                    46
                                                                                                                                                                                                                                               2.20
                                                                                                                                                                                                                                                                   1.93
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                                                                                                                                                                                                                                                                                                                                                                                                 2.1
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                                                                                                           Nb<sup>⋆</sup>
                                                                                                                                   Mo*
                                                                                                                                                                                                                                     Pd**
                                                                                                                                                                                                                                                                  Ag
                                                                                                                                                                                                                                                                                                                                                                                              Te
          Rb
                                    Sr
                                                              Y
                                                                                     Zr
                                                                                                                                                                Tc
                                                                                                                                                                                      Ru★
                                                                                                                                                                                                               Rh*
                                                                                                                                                                                                                                                                                           Cd
                                                                                                                                                                                                                                                                                                                                          Sn*
                                                                                                                                                                                                                                                                                                                                                                      Sb
                                                                                                                                                                                                                                                                                                                                                                                                                                                Xe
                                                                                                                                                                                                                                                                                                                     In
                                                                                                                                                                                                                                                                                                                                                                                                                        12
                                                                                                                                                          Technetium
                                                         Yttrium
                                                                                                                                                                                                                                                               Silver<sup>(1+)</sup>
                                                                                                                                                                                                                                                                                        Cadmium
       Rubidium
                               Strontium
                                                                                 Zirconium
                                                                                                                                                                                                                                                                                                                   Indium
                                                                                                                                                                                                                                                                                                                                                                   Antimony
                                                                                                                                                                                                                                                                                                                                                                                           Tellurium
                                                                                                                                                                                                                                                                                                                                                                                                                       lodine
                                                                                                                                                                                                                                                                                                                                                                                                                                               Xenon
                                                                                                           Niobium
                                                                                                                                 Molvbdenum
                                                                                                                                                                                    Ruthenium
                                                                                                                                                                                                              Rhodium
                                                                                                                                                                                                                                      Palladium
                                                                                                                                                                                                                                                                                                                                             Tin
                                                                                                                                                                (98)
          85.47
                                  87.62
                                                           88.91
                                                                                    91.22
                                                                                                                                                                                                                                                                107.87
                                                                                                                                                                                                                                                                                         112.41
                                                                                                                                                                                                                                                                                                                   114.82
                                                                                                                                                                                                                                                                                                                                                                    121.76
                                                                                                                                                                                                                                                                                                                                                                                             127.60
                                                                                                                                                                                                                                                                                                                                                                                                                      126.90
                                                                                                                                                                                                                                                                                                                                                                                                                                               131.29
                                                                                                             92.91
                                                                                                                                     95.95
                                                                                                                                                                                      101.07
                                                                                                                                                                                                               102.91
                                                                                                                                                                                                                                        106.42
                                                                                                                                                                                                                                                                                                                                           118.71
     55
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                0.79
                             56
                                        0.89
                                                      57-71
                                                                               72
                                                                                       1.3
                                                                                                       73
                                                                                                                  1.5
                                                                                                                                74
                                                                                                                                                          75
                                                                                                                                                                     1.9
                                                                                                                                                                                  76
                                                                                                                                                                                               2.2
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                                                                                                                                         2.36
                                                                                                                                                                                                           77
                                                                                                                                                                                                                   2.20
                                                                                                                                                                                                                                   78
                                                                                                                                                                                                                                            2.28
                                                                                                                                                                                                                                                                                                                                                                        2.02
                                                                                                                                                                                                                                                                                                                                                                                              Po
                                   Ba
                                                       La-Lu
                                                                                    Hf
                                                                                                                                       W
                                                                                                                                                               Re
                                                                                                                                                                                        Os
                                                                                                                                                                                                                                          Pt
                                                                                                                                                                                                                                                                                          Hg
                                                                                                                                                                                                                                                                                                                     TI
                                                                                                                                                                                                                                                                                                                                             Pb
                                                                                                                                                                                                                                                                                                                                                                       Bi
                                                                                                                                                                                                                                                                                                                                                                                                                        At
                                                                                                                                                                                                                                                                                                                                                                                                                                                Rn
           Cs
                                                                                                              Ta
                                                                                                                                                                                                                  Ir
                                                                                                                                                                                                                                                                Au★
                                                        Lanthanide
                                                                                  Hafnium
                                                                                                                                                            Rhenium
                                                                                                                                                                                      Osmium
                                                                                                                                                                                                                                       Platinum
                                                                                                                                                                                                                                                                                                                 Thallium
                                                                                                                                                                                                                                                                                                                                                                                           Polonium
                                                                                                                                                                                                                                                                                                                                                                                                                     Astatine
                                                                                                                                                                                                                                                                                                                                                                                                                                               Radon
        Caesium
                                 Barium
                                                                                                          Tantalum
                                                                                                                                   Tungsten
                                                                                                                                                                                                               Iridium
                                                                                                                                                                                                                                                                                         Mercury
                                                                                                                                                                                                                                                                                                                                            Lead
                                                                                                                                                                                                                                                                                                                                                                   Bismuth
                                                                                                                                                                                                                                                                  Gold
                                                                                                                                                                                                                                                                                                                                                                                              (209)
                                                                                                                                                                                                                                                                                                                                                                                                                       (210)
                                                                                                                                                                                                                                                                                                                                                                                                                                               (222)
         132.91
                                 137.33
                                                                                   178.49
                                                                                                            180.95
                                                                                                                                     183.84
                                                                                                                                                             186.21
                                                                                                                                                                                      190.23
                                                                                                                                                                                                               192.22
                                                                                                                                                                                                                                        195.08
                                                                                                                                                                                                                                                                                          200.59
                                                                                                                                                                                                                                                                                                                  204.38
                                                                                                                                                                                                                                                                                                                                            207.2
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                                                                                                                                                                                                                                                                 196.97
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                                                      89-103
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           Fr
                                   Ra
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        Francium
                                 Radium
                                                                               Rutherfordium
                                                                                                          Dubnium
                                                                                                                                 Seaborgium
                                                                                                                                                            Bohrium
                                                                                                                                                                                     Hassium
                                                                                                                                                                                                            Meitnerium
                                                                                                                                                                                                                                    Darmstadtium
                                                                                                                                                                                                                                                             Roentgenium
                                                                                                                                                                                                                                                                                     Copernicium
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                                                                                                                                                                                                                                                                                                                                         Flerovium
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                                                         Actinide
          (223)
                                  (226)
                                                                                    (267)
                                                                                                             (268)
                                                                                                                                      (269)
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         Super<sup>7</sup>
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                         Alkali Metal
                                                                 E.N.
                                                                               57
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CO | HBr
                         Metal
CO_2 HCI
                                                                                Lanthanum
                                                                                                            Cerium
                                                                                                                                                                                   Promethium
                                                                                                                                                                                                             Samarium
                                                                                                                                                                                                                                                              Gadolinium
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                                                                                                                                                                                                                                                                                                                                          Holmium
                                                                                                                                                                                                                                                                                                                                                                                            Thulium
                                                                                                                                                                                                                                                                                                                                                                                                                    Ytterbium
                                                           Name
                                                                                                                                 Praseodymium
                                                                                                                                                          Neodymium
                                                                                                                                                                                                                                      Europium
                                                                                                                                                                                                                                                                                                                                                                    Erbium
                                                                                                                                                                                                                                                                                                                                                                                                                                             Lutetium
                         Metalloid
CH<sub>4</sub> HNO<sub>3</sub>
                                                                                                                                                                                       (145)
                                                                                  138.91
                                                                                                            140.12
                                                                                                                                     140.91
                                                                                                                                                              144.24
                                                                                                                                                                                                               150.36
                                                                                                                                                                                                                                        151.96
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                        Non-metal
C_2H_6 H_2SO_4
                         Halogen
C<sub>3</sub>H<sub>8</sub> HClO<sub>3</sub>
                                                                                                                                                                                                                                    95 1.13
                                                                                                                                                                                                                                                                                                                                                                                                                                           103 1.3
                                                                                                                                                                                   93 1.36
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                         Noble Gas
C_4H_{10}HCIO_4
                                                                                                                                                                                                                                                                                           Bk
                                                                                                                                                                                                                                                                                                                     Cf
                        Lanthanide/Actinide
                                                                                     Ac
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                                                                                                                                                                U
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NO NO<sub>2</sub>
                         Synthetic
                                                                                                                                                                                                                                                                                                               Californium
                                                                                  Actinium
                                                                                                                                                                                    Neptunium
                                                                                                                                                                                                             Plutonium
                                                                                                                                                                                                                                      Americium
                                                                                                                                                                                                                                                                Curium
                                                                                                                                                                                                                                                                                        Berkelium
                                                                                                                                                                                                                                                                                                                                        Einsteinium
                                                                                                                                                                                                                                                                                                                                                                   Fermium
                                                                                                                                                                                                                                                                                                                                                                                         Mendelevium
                                                                                                                                                                                                                                                                                                                                                                                                                    Nobelium
                                                                                                                                                                                                                                                                                                                                                                                                                                           Lawrencium
                                                                                                           Thorium
                                                                                                                                                            Uranium
                                                                                                                                 Protactinium
N<sub>2</sub>O NH<sub>3</sub>
                     ★ Aufbau Exception
                                                                                    (227)
                                                                                                                                                                                       (237)
                                                                                                                                                                                                                 (244)
                                                                                                                                                                                                                                         (243)
                                                                                                                                                                                                                                                                  (247)
                                                                                                                                                                                                                                                                                           (247)
                                                                                                                                                                                                                                                                                                                    (251)
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                                                                                                                                                                                                                                                                                                                                                                     (257)
                                                                                                                                                                                                                                                                                                                                                                                              (258)
                                                                                                                                                                                                                                                                                                                                                                                                                       (259)
                                                                                                                                                                                                                                                                                                                                                                                                                                                (266)
                                                                                                            232.04
                                                                                                                                     231.04
                                                                                                                                                              238.03
SO<sub>3</sub> SO<sub>2</sub>
                        EN, IE, EA, & \mathbb{Z}_{eff} increase \rightarrow \uparrow
H<sub>2</sub>S HCl
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Radius & Metallic increase ←↓