

STAAR CHEMISTRY REFERENCE MATERIALS



ATOMIC STRUCTURE

$$\text{Speed of light} = (\text{frequency})(\text{wavelength}) \quad c = f\lambda$$

$$\text{Energy} = (\text{Planck's constant})(\text{frequency}) \quad E_{\text{photon}} = hf$$

$$\text{Energy} = \frac{(\text{Planck's constant})(\text{speed of light})}{(\text{wavelength})} \quad E_{\text{photon}} = \frac{hc}{\lambda}$$

BEHAVIOR OF GASES

$$\text{Total pressure of a gas} = \left(\begin{array}{l} \text{sum of the partial pressures} \\ \text{of the component gases} \end{array} \right) \quad P_T = P_1 + P_2 + P_3 + \dots$$

$$(\text{Pressure})(\text{volume}) = (\text{moles})(\text{ideal gas constant})(\text{temperature}) \quad PV = nRT$$

$$\frac{(\text{Initial pressure})(\text{initial volume})}{(\text{Initial moles})(\text{initial temperature})} = \frac{(\text{final pressure})(\text{final volume})}{(\text{final moles})(\text{final temperature})} \quad \frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

$$(\text{Initial pressure})(\text{initial volume}) = (\text{final pressure})(\text{final volume}) \quad P_1V_1 = P_2V_2$$

$$\frac{(\text{Initial volume})}{(\text{Initial temperature})} = \frac{(\text{final volume})}{(\text{final temperature})} \quad \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{(\text{Initial volume})}{(\text{Initial moles})} = \frac{(\text{final volume})}{(\text{final moles})} \quad \frac{V_1}{n_1} = \frac{V_2}{n_2}$$

SOLUTIONS

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{liter of solution}} \quad M = \frac{\text{mol}}{\text{L}}$$

$$\text{Ionization constant of water} = \left(\begin{array}{l} \text{hydrogen ion} \\ \text{concentration} \end{array} \right) \left(\begin{array}{l} \text{hydroxide ion} \\ \text{concentration} \end{array} \right) \quad K_w = [\text{H}^+][\text{OH}^-]$$

$$\left(\begin{array}{l} \text{Volume of} \\ \text{solution 1} \end{array} \right) \left(\begin{array}{l} \text{molarity of} \\ \text{solution 1} \end{array} \right) = \left(\begin{array}{l} \text{volume of} \\ \text{solution 2} \end{array} \right) \left(\begin{array}{l} \text{molarity of} \\ \text{solution 2} \end{array} \right) \quad V_1M_1 = V_2M_2$$

$$\text{pH} = -\log(\text{hydrogen ion concentration}) \quad \text{pH} = -\log[\text{H}^+]$$

THERMOCHEMISTRY

$$\text{Heat gained or lost} = (\text{mass}) \left(\begin{array}{l} \text{specific} \\ \text{heat} \end{array} \right) \left(\begin{array}{l} \text{change in} \\ \text{temperature} \end{array} \right) \quad Q = mc_p\Delta T$$

$$\text{Enthalpy of reaction} = \left(\begin{array}{l} \text{enthalpy} \\ \text{of products} \end{array} \right) - \left(\begin{array}{l} \text{enthalpy} \\ \text{of reactants} \end{array} \right) \quad \Delta H = \Delta H_f^{\circ}(\text{products}) - \Delta H_f^{\circ}(\text{reactants})$$

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OTHER FORMULAS

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

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

$$\text{Percent error} = \left(\frac{\text{accepted value} - \text{experimental value}}{\text{accepted value}} \right) (100)$$

$$\text{Percent yield} = \left(\frac{\text{actual yield}}{\text{theoretical yield}} \right) (100)$$

CONSTANTS AND CONVERSIONS

$$\text{Avogadro's number} = 6.02 \times 10^{23} \text{ particles per mole}$$

$$h = \text{Planck's constant} = 6.63 \times 10^{-34} \text{ J} \cdot \text{s}$$

$$c = \text{speed of light} = 3.00 \times 10^8 \frac{\text{m}}{\text{s}}$$

$$K_w = \text{ionization constant of water} = 1.00 \times 10^{-14} \left(\frac{\text{mol}}{\text{L}} \right)^2$$

$$\text{alpha particle } (\alpha) = {}_2^4\text{He} \quad \text{beta particle } (\beta) = {}_{-1}^0\text{e} \quad \text{neutron} = {}_0^1\text{n}$$

$$\text{standard temperature and pressure (STP)} = 0^\circ\text{C and 1 atm}$$

$$0^\circ\text{C} = 273 \text{ K}$$

$$\text{volume of ideal gas at STP} = 22.4 \frac{\text{L}}{\text{mol}}$$

$$1 \text{ cm}^3 = 1 \text{ mL} = 1 \text{ cc}$$

$$1 \text{ atm} = 760 \text{ mm Hg} = 101.3 \text{ kPa}$$

$$R = \text{ideal gas constant} = 0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} = 8.31 \frac{\text{L} \cdot \text{kPa}}{\text{mol} \cdot \text{K}} = 62.4 \frac{\text{L} \cdot \text{mm Hg}}{\text{mol} \cdot \text{K}}$$

$$1 \text{ calorie (cal)} = 4.18 \text{ joules (J)}$$

$$1000 \text{ calories (cal)} = 1 \text{ Calorie (Cal)} = 1 \text{ kilocalorie (kcal)}$$

RULES FOR SIGNIFICANT FIGURES

1. Non-zero digits and zeros between non-zero digits are always significant.
2. Leading zeros are not significant.
3. Zeros to the right of all non-zero digits are only significant if a decimal point is shown.
4. For values written in scientific notation, the digits in the coefficient are significant.
5. In a common logarithm, there are as many digits after the decimal point as there are significant figures in the original number.

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| | | SOLUBILITY OF COMMON IONIC COMPOUNDS IN WATER | | |
|--------------------|-----------------------------|--|---|---------------------|
| Acetate | $C_2H_3O_2^-$, CH_3COO^- | <u>Soluble</u> <u>compounds contain</u> | <u>Common exceptions</u> | <u>Metal</u> |
| Ammonium | NH_4^+ | $C_2H_3O_2^-$, CH_3COO^- | None | Lithium |
| Carbonate | CO_3^{2-} | NH_4^+ | None | Potassium |
| Chlorate | ClO_3^- | NO_3^- | None | Barium |
| Chlorite | ClO_2^- | CN^- | None | Calcium |
| Chromate | CrO_4^{2-} | ClO^- | None | Sodium |
| Cyanide | CN^- | ClO_2^- | None | Magnesium |
| Dichromate | $Cr_2O_7^{2-}$ | ClO_3^- | None | Aluminum |
| Hydrogen carbonate | HCO_3^- | ClO_4^- | None | Manganese |
| Hydroxide | OH^- | Br^- | Compounds of Ag^+ , Pb^{2+} , and Hg_2^{2+} | Zinc |
| Hypochlorite | ClO^- | Cl^- | Compounds of Ag^+ , Pb^{2+} , and Hg_2^{2+} | Chromium |
| Nitrate | NO_3^- | I^- | Compounds of Ag^+ , Pb^{2+} , and Hg_2^{2+} | Iron |
| Nitrite | NO_2^- | SO_4^{2-} | Compounds of Sr^{2+} , Ba^{2+} , Pb^{2+} , and Hg_2^{2+} | Cobalt |
| Perchlorate | ClO_4^- | <u>Insoluble</u> <u>compounds contain</u> | <u>Common exceptions</u> | Nickel |
| Permanganate | MnO_4^- | CO_3^{2-} | Compounds of NH_4^+ and the alkali metal cations | Tin |
| Phosphate | PO_4^{3-} | PO_4^{3-} | Compounds of NH_4^+ and the alkali metal cations | Lead |
| Sulfate | SO_4^{2-} | CrO_4^{2-} | Compounds of NH_4^+ and the alkali metal cations | (Hydrogen) |
| Sulfite | SO_3^{2-} | $Cr_2O_7^{2-}$ | Compounds of NH_4^+ and the alkali metal cations | Copper |
| | | OH^- | Compounds of NH_4^+ , the alkali metal cations, Ca^{2+} , Sr^{2+} , and Ba^{2+} | Mercury |
| | | S^{2-} | Compounds of NH_4^+ , the alkali metal cations, Ca^{2+} , Sr^{2+} , and Ba^{2+} | Silver |
| | | | | Platinum |
| | | | | Gold |



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PERIODIC TABLE OF THE ELEMENTS

| | | | | | | | | | | | | | | | | | | |
|---|---------------------------------------|--|---|--|--|---|--|--|---|---|--|--|--|--|--|--|--------------------------------------|--------------------------------------|
| | 1A | | | | | | | | | | | | | | | | | 8A |
| 1 | 1 H 1.008 Hydrogen | | | | | | | | | | | | | | | | | 2 He 4.003 Helium |
| 2 | 3 Li 6.941 Lithium | 4 Be 9.012 Beryllium | | | | | | | | | | 5 B 10.812 Boron | 6 C 12.011 Carbon | 7 N 14.007 Nitrogen | 8 O 15.999 Oxygen | 9 F 18.998 Fluorine | 10 Ne 20.180 Neon | |
| 3 | 11 Na 22.990 Sodium | 12 Mg 24.305 Magnesium | | | | | | | | | | 13 Al 26.982 Aluminum | 14 Si 28.086 Silicon | 15 P 30.974 Phosphorus | 16 S 32.066 Sulfur | 17 Cl 35.453 Chlorine | 18 Ar 39.948 Argon | |
| 4 | 19 K 39.098 Potassium | 20 Ca 40.078 Calcium | 21 Sc 44.956 Scandium | 22 Ti 47.867 Titanium | 23 V 50.942 Vanadium | 24 Cr 51.996 Chromium | 25 Mn 54.938 Manganese | 26 Fe 55.845 Iron | 27 Co 58.933 Cobalt | 28 Ni 58.693 Nickel | 29 Cu 63.546 Copper | 30 Zn 65.38 Zinc | 31 Ga 69.723 Gallium | 32 Ge 72.64 Germanium | 33 As 74.922 Arsenic | 34 Se 78.96 Selenium | 35 Br 79.904 Bromine | 36 Kr 83.798 Krypton |
| 5 | 37 Rb 85.468 Rubidium | 38 Sr 87.62 Strontium | 39 Y 88.906 Yttrium | 40 Zr 91.224 Zirconium | 41 Nb 92.906 Niobium | 42 Mo 95.96 Molybdenum | 43 Tc (98) Technetium | 44 Ru 101.07 Ruthenium | 45 Rh 102.906 Rhodium | 46 Pd 106.42 Palladium | 47 Ag 107.868 Silver | 48 Cd 112.412 Cadmium | 49 In 114.818 Indium | 50 Sn 118.711 Tin | 51 Sb 121.760 Antimony | 52 Te 127.60 Tellurium | 53 I 126.904 Iodine | 54 Xe 131.294 Xenon |
| 6 | 55 Cs 132.905 Cesium | 56 Ba 137.328 Barium | 71 Lu 174.967 Lutetium | 72 Hf 178.49 Hafnium | 73 Ta 180.948 Tantalum | 74 W 183.84 Tungsten | 75 Re 186.207 Rhenium | 76 Os 190.23 Osmium | 77 Ir 192.217 Iridium | 78 Pt 195.085 Platinum | 79 Au 196.967 Gold | 80 Hg 200.59 Mercury | 81 Tl 204.383 Thallium | 82 Pb 207.2 Lead | 83 Bi 208.980 Bismuth | 84 Po (209) Polonium | 85 At (210) Astatine | 86 Rn (222) Radon |
| 7 | 87 Fr (223) Francium | 88 Ra (226) Radium | 103 Lr (262) Lawrencium | 104 Rf (267) Rutherfordium | 105 Db (268) Dubnium | 106 Sg (271) Seaborgium | 107 Bh (272) Bohrium | 108 Hs (270) Hassium | 109 Mt (276) Meitnerium | 110 Ds (281) Darmstadtium | 111 Rg (280) Roentgenium | Mass numbers in parentheses are those of the most stable or most common isotope. | | | | | | |

Atomic number — 14
Symbol — **Si**
Atomic mass — 28.086
Name — Silicon

Lanthanide Series

| | | | | | | | | | | | | | |
|---|--------------------------------------|--|---|--|---------------------------------------|--|---|---------------------------------------|--|---------------------------------------|--------------------------------------|---------------------------------------|---|
| 57 La 138.905 Lanthanum | 58 Ce 140.116 Cerium | 59 Pr 140.908 Praseodymium | 60 Nd 144.242 Neodymium | 61 Pm (145) Promethium | 62 Sm 150.36 Samarium | 63 Eu 151.964 Europium | 64 Gd 157.25 Gadolinium | 65 Tb 158.925 Terbium | 66 Dy 162.500 Dysprosium | 67 Ho 164.930 Holmium | 68 Er 167.259 Erbium | 69 Tm 168.934 Thulium | 70 Yb 173.055 Ytterbium |
|---|--------------------------------------|--|---|--|---------------------------------------|--|---|---------------------------------------|--|---------------------------------------|--------------------------------------|---------------------------------------|---|

Actinide Series

| | | | | | | | | | | | | | |
|--------------------------------------|---------------------------------------|--|--------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|------------------------------------|---------------------------------------|---|---|--------------------------------------|--|---------------------------------------|
| 89 Ac (227) Actinium | 90 Th 232.038 Thorium | 91 Pa 231.036 Protactinium | 92 U 238.029 Uranium | 93 Np (237) Neptunium | 94 Pu (244) Plutonium | 95 Am (243) Americium | 96 Cm (247) Curium | 97 Bk (247) Berkelium | 98 Cf (251) Californium | 99 Es (252) Einsteinium | 100 Fm (257) Fermium | 101 Md (258) Mendelevium | 102 No (259) Nobelium |
|--------------------------------------|---------------------------------------|--|--------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|------------------------------------|---------------------------------------|---|---|--------------------------------------|--|---------------------------------------|