

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

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

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

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

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

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

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

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

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

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

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

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

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

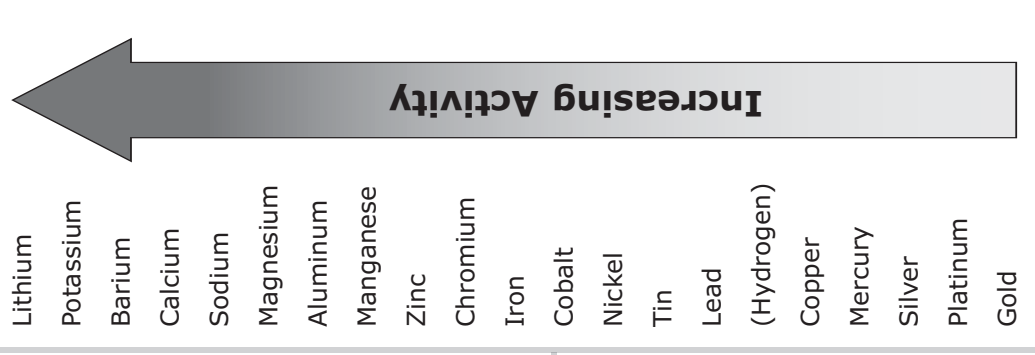
$$1000 \text{ calories (cal)} = 1 \text{ Calorie (Cal)} = 1 \text{ kilocalorie (kcal)}$$

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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POLYATOMIC IONS	SOLUBILITY OF COMMON IONIC COMPOUNDS IN WATER		ACTIVITY SERIES
Acetate	<u>Soluble</u> compounds contain	<u>Common exceptions</u>	
Ammonium	C ₂ H ₃ O ₂ ⁻ , CH ₃ COO ⁻	None	
Carbonate	NH ₄ ⁺	None	
Chlorate	CO ₃ ²⁻	None	
Chlorite	ClO ₃ ⁻	None	
Chromate	ClO ₂ ⁻	None	
Cyanide	CrO ₄ ²⁻	None	
Dichromate	CN ⁻	None	
Hydrogen carbonate	Cr ₂ O ₇ ²⁻	Compounds of Ag ⁺ , Pb ²⁺ , and Hg ₂ ⁺	
Hydroxide	HCO ₃ ⁻	Compounds of Ag ⁺ , Pb ²⁺ , and Hg ₂ ⁺	
Hypochlorite	OH ⁻	Compounds of Sr ²⁺ , Ba ²⁺ , Pb ²⁺ , and Hg ₂ ⁺	
Nitrate	ClO ⁻	<u>Common exceptions</u>	
Nitrite	CO ₃ ²⁻	Compounds of NH ₄ ⁺ and the alkali metal cations	
Perchlorate	NO ₃ ⁻	Compounds of NH ₄ ⁺ and the alkali metal cations	
Permanganate	NO ₂ ⁻	Compounds of NH ₄ ⁺ and the alkali metal cations	
Phosphate	ClO ₄ ⁻	Compounds of NH ₄ ⁺ and the alkali metal cations	
Sulfate	MnO ₄ ⁻	Compounds of NH ₄ ⁺ , the alkali metal cations, Ca ²⁺ , Sr ²⁺ , and Ba ²⁺	
Sulfite	PO ₄ ³⁻	Compounds of NH ₄ ⁺ , the alkali metal cations, Ca ²⁺ , Sr ²⁺ , and Ba ²⁺	
	SO ₄ ²⁻	Compounds of NH ₄ ⁺ , the alkali metal cations, Ca ²⁺ , Sr ²⁺ , and Ba ²⁺	
	SO ₃ ²⁻		

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PERIODIC TABLE OF THE ELEMENTS

1 1A	2 2A	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9	10	11 1B	12 2B	13 3A	14 4A	15 5A	16 6A	17 7A	18 8A																																																																																	
1 H 1.008 Hydrogen	2 He 4.003 Helium	3 Li 6.941 Lithium	4 Be 9.012 Beryllium	5 Na 22.990 Sodium	6 Mg 24.305 Magnesium	7 Al 26.982 Aluminum	8 Si 28.086 Silicon	9 P 30.974 Phosphorus	10 S 32.066 Sulfur	11 Cl 35.453 Chlorine	12 Ar 39.948 Argon	13 K 39.098 Potassium	14 Ca 40.078 Calcium	15 Sc 44.956 Scandium	16 Ti 47.867 Titanium	17 V 50.942 Vanadium	18 Cr 51.996 Chromium	19 Mn 54.938 Manganese	20 Fe 55.845 Iron	21 Co 58.933 Cobalt	22 Ni 58.693 Nickel	23 Cu 63.546 Copper	24 Zn 65.38 Zinc	25 Ga 69.723 Gallium	26 Ge 72.64 Germanium	27 As 74.922 Arsenic	28 Se 78.96 Selenium	29 Br 79.904 Bromine	30 Kr 83.798 Krypton	31 Rb 85.468 Rubidium	32 Sr 87.62 Strontium	33 Y 88.906 Yttrium	34 Zr 91.224 Zirconium	35 Nb 92.906 Niobium	36 Mo 95.96 Molybdenum	37 Tc (98) Technetium	38 Ru 101.07 Ruthenium	39 Rh 102.906 Rhodium	40 Pd 106.42 Palladium	41 Ag 107.868 Silver	42 Cd 112.412 Cadmium	43 In 114.818 Indium	44 Sn 118.711 Tin	45 Sb 121.760 Antimony	46 Te 127.60 Tellurium	47 I 126.904 Iodine	48 Xe 131.294 Xenon	49 Cs 132.905 Cesium	50 Ba 137.328 Barium	51 La 138.905 Lanthanum	52 Pr 140.908 Praseodymium	53 Ce 140.116 Cerium	54 Nd 144.242 Neodymium	55 Pm (145) Promethium	56 Sm 150.36 Samarium	57 Eu 151.964 Europium	58 Gd 157.25 Gadolinium	59 Tb 158.925 Terbium	60 Dy 162.500 Dysprosium	61 Ho 164.930 Holmium	62 Er 167.259 Erbium	63 Tm 168.934 Thulium	64 Yb 173.055 Ytterbium	65 Lu 174.967 Lutetium	66 Ac (227) Actinium	67 Th 232.038 Thorium	68 Pa 231.036 Protactinium	69 U 238.029 Uranium	70 Np (237) Neptunium	71 Pu (244) Plutonium	72 Am (243) Americium	73 Cm (247) Curium	74 Bk (247) Berkelium	75 Cf (251) Californium	76 Es (252) Einsteinium	77 Fm (257) Fermium	78 Md (258) Mendelevium	79 No (259) Nobelium	80 Rn (222) Radon	81 Fr (223) Francium	82 Ra (226) Radium	83 Lr (262) Lawrencium	84 Lu (262) Lutetium	85 Hf 178.49 Hafnium	86 Ta 180.948 Tantalum	87 W 183.84 Tungsten	88 Re 186.207 Rhenium	89 Os 190.23 Osmium	90 Ir 192.217 Iridium	91 Pt 195.085 Platinum	92 Au 196.967 Gold	93 Hg 200.59 Mercury	94 Tl 204.383 Thallium	95 Pb 207.2 Lead	96 Bi 208.980 Bismuth	97 Po (209) Polonium	98 At (210) Astatine	99 Rn (222) Radon

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

Mass numbers in parentheses are those of the most stable or most common isotope.

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
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

Lanthanide Series

Actinide Series