

# 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

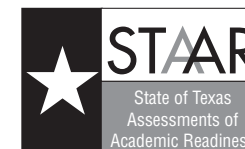
1. Non-zero digits and zeros between non-zero digits are always significant.
2. Leading zeros are not significant.
3. Zeros to the right of all non-zero digits are only significant if a decimal point is shown.
4. For values written in scientific notation, the digits in the coefficient are significant.
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	$C_2H_3O_2^-$ , $CH_3COO^-$	<b><u>Soluble</u></b> <b><u>compounds contain</u></b>	<b><u>Common exceptions</u></b>	<b><u>Metal</u></b>
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	$ClO_4^-$	<b><u>Insoluble</u></b> <b><u>compounds contain</u></b>	<b><u>Common exceptions</u></b>	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

	<b>1A</b>																	<b>8A</b>	
1	1 <b>H</b> 1.008 Hydrogen	2 <b>He</b> 4.003 Helium																	
2	3 <b>Li</b> 6.941 Lithium	4 <b>Be</b> 9.012 Beryllium										5 <b>B</b> 10.812 Boron	6 <b>C</b> 12.011 Carbon	7 <b>N</b> 14.007 Nitrogen	8 <b>O</b> 15.999 Oxygen	9 <b>F</b> 18.998 Fluorine	10 <b>Ne</b> 20.180 Neon		
3	11 <b>Na</b> 22.990 Sodium	12 <b>Mg</b> 24.305 Magnesium	3 <b>B</b>	4 <b>B</b>	5 <b>B</b>	6 <b>B</b>	7 <b>B</b>	8 <b>B</b>	9 <b>B</b>	10 <b>B</b>	11 <b>B</b>	12 <b>B</b>	13 <b>Al</b> 26.982 Aluminum	14 <b>Si</b> 28.086 Silicon	15 <b>P</b> 30.974 Phosphorus	16 <b>S</b> 32.066 Sulfur	17 <b>Cl</b> 35.453 Chlorine	18 <b>Ar</b> 39.948 Argon	
4	19 <b>K</b> 39.098 Potassium	20 <b>Ca</b> 40.078 Calcium	21 <b>Sc</b> 44.956 Scandium	22 <b>Ti</b> 47.867 Titanium	23 <b>V</b> 50.942 Vanadium	24 <b>Cr</b> 51.996 Chromium	25 <b>Mn</b> 54.938 Manganese	26 <b>Fe</b> 55.845 Iron	27 <b>Co</b> 58.933 Cobalt	28 <b>Ni</b> 58.693 Nickel	29 <b>Cu</b> 63.546 Copper	30 <b>Zn</b> 65.38 Zinc	31 <b>Ga</b> 69.723 Gallium	32 <b>Ge</b> 72.64 Germanium	33 <b>As</b> 74.922 Arsenic	34 <b>Se</b> 78.96 Selenium	35 <b>Br</b> 79.904 Bromine	36 <b>Kr</b> 83.798 Krypton	
5	37 <b>Rb</b> 85.468 Rubidium	38 <b>Sr</b> 87.62 Strontium	39 <b>Y</b> 88.906 Yttrium	40 <b>Zr</b> 91.224 Zirconium	41 <b>Nb</b> 92.906 Niobium	42 <b>Mo</b> 95.96 Molybdenum	43 <b>Tc</b> (98) Technetium	44 <b>Ru</b> 101.07 Ruthenium	45 <b>Rh</b> 102.906 Rhodium	46 <b>Pd</b> 106.42 Palladium	47 <b>Ag</b> 107.868 Silver	48 <b>Cd</b> 112.412 Cadmium	49 <b>In</b> 114.818 Indium	50 <b>Sn</b> 118.711 Tin	51 <b>Sb</b> 121.760 Antimony	52 <b>Te</b> 127.60 Tellurium	53 <b>I</b> 126.904 Iodine	54 <b>Xe</b> 131.294 Xenon	
6	55 <b>Cs</b> 132.905 Cesium	56 <b>Ba</b> 137.328 Barium	71 <b>Lu</b> 174.967 Lutetium	72 <b>Hf</b> 178.49 Hafnium	73 <b>Ta</b> 180.948 Tantalum	74 <b>W</b> 183.84 Tungsten	75 <b>Re</b> 186.207 Rhenium	76 <b>Os</b> 190.23 Osmium	77 <b>Ir</b> 192.217 Iridium	78 <b>Pt</b> 195.085 Platinum	79 <b>Au</b> 196.967 Gold	80 <b>Hg</b> 200.59 Mercury	81 <b>Tl</b> 204.383 Thallium	82 <b>Pb</b> 207.2 Lead	83 <b>Bi</b> 208.980 Bismuth	84 <b>Po</b> (209) Polonium	85 <b>At</b> (210) Astatine	86 <b>Rn</b> (222) Radon	
7	87 <b>Fr</b> (223) Francium	88 <b>Ra</b> (226) Radium	103 <b>Lr</b> (262) Lawrencium	104 <b>Rf</b> (267) Rutherfordium	105 <b>Db</b> (268) Dubnium	106 <b>Sg</b> (271) Seaborgium	107 <b>Bh</b> (272) Bohrium	108 <b>Hs</b> (270) Hassium	109 <b>Mt</b> (276) Meitnerium	110 <b>Ds</b> (281) Darmstadtium	111 <b>Rg</b> (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 <b>La</b> 138.905 Lanthanum	58 <b>Ce</b> 140.116 Cerium	59 <b>Pr</b> 140.908 Praseodymium	60 <b>Nd</b> 144.242 Neodymium	61 <b>Pm</b> (145) Promethium	62 <b>Sm</b> 150.36 Samarium	63 <b>Eu</b> 151.964 Europium	64 <b>Gd</b> 157.25 Gadolinium	65 <b>Tb</b> 158.925 Terbium	66 <b>Dy</b> 162.500 Dysprosium	67 <b>Ho</b> 164.930 Holmium	68 <b>Er</b> 167.259 Erbium	69 <b>Tm</b> 168.934 Thulium	70 <b>Yb</b> 173.055 Ytterbium
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Actinide Series

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