

# STAAR CHEMISTRY REFERENCE MATERIALS



## ATOMIC STRUCTURE

$$\text{Speed of light} = (\text{frequency})(\text{wavelength})$$

$$c = f\lambda$$

$$\text{Energy} = (\text{Planck's constant})(\text{frequency})$$

$$E_{\text{photon}} = hf$$

$$\text{Energy} = \frac{(\text{Planck's constant})(\text{speed of light})}{(\text{wavelength})}$$

$$E_{\text{photon}} = \frac{hc}{\lambda}$$

## BEHAVIOR OF GASES

$$\text{Total pressure of a gas} = \left( \begin{array}{l} \text{sum of the partial pressures} \\ \text{of the component gases} \end{array} \right)$$

$$P_T = P_1 + P_2 + P_3 + \dots$$

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

$$PV = nRT$$

$$\frac{(\text{Initial pressure})(\text{initial volume})}{(\text{Initial moles})(\text{initial temperature})} = \frac{(\text{final pressure})(\text{final volume})}{(\text{final moles})(\text{final temperature})}$$

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

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

$$P_1V_1 = P_2V_2$$

$$\frac{(\text{Initial volume})}{(\text{Initial temperature})} = \frac{(\text{final volume})}{(\text{final temperature})}$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{(\text{Initial volume})}{(\text{Initial moles})} = \frac{(\text{final volume})}{(\text{final moles})}$$

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

## SOLUTIONS

$$\text{Molarity} = \frac{\text{moles of solute}}{\text{liter of solution}}$$

$$M = \frac{\text{mol}}{\text{L}}$$

$$\text{Ionization constant of water} = \left( \begin{array}{l} \text{hydrogen ion} \\ \text{concentration} \end{array} \right) \left( \begin{array}{l} \text{hydroxide ion} \\ \text{concentration} \end{array} \right)$$

$$K_w = [\text{H}^+][\text{OH}^-]$$

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

$$V_1M_1 = V_2M_2$$

$$\text{pH} = -\log(\text{hydrogen ion concentration})$$

$$\text{pH} = -\log[\text{H}^+]$$

## THERMOCHEMISTRY

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

$$Q = mc_p\Delta T$$

$$\text{Enthalpy of reaction} = \left( \begin{array}{l} \text{enthalpy} \\ \text{of products} \end{array} \right) - \left( \begin{array}{l} \text{enthalpy} \\ \text{of reactants} \end{array} \right)$$

$$\Delta H = \Delta H_f^{\circ}(\text{products}) - \Delta H_f^{\circ}(\text{reactants})$$

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



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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 9B		10 10		11 1B		12 2B		13 3A		14 4A		15 5A		16 6A		17 7A		18 8A																																																																												
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1 H 1.008 Hydrogen	2 He 4.003 Helium	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	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	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	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	55 Cs 132.905 Cesium	56 Ba 137.328 Barium	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	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	87 Fr (223) Francium	88 Ra (226) Radium	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	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.

Lanthanide Series

Actinide Series