

ATOMIC STRUCTURE	
Speed of light = (frequency)(wavelength)	$c = f\lambda$
Energy = (Planck's constant)(frequency)	$E_{\rm photon} = hf$
$Energy = \frac{(Planck's constant)(speed of light)}{(wavelength)}$	$E_{\text{photon}} = \frac{hc}{\lambda}$
BEHAVIOR OF GASES	
Total pressure of a gas = $\begin{pmatrix} \text{sum of the partial pressures} \\ \text{of the component gases} \end{pmatrix}$ $P_{\text{T}} = R_{\text{T}}$	$P_1 + P_2 + P_3 + \dots$
(Pressure)(volume) = (moles)(ideal gas constant)(temperature)	PV = nRT
$\frac{\text{(Initial pressure)(initial volume)}}{\text{(Initial moles)(initial temperature)}} = \frac{\text{(final pressure)(final volume)}}{\text{(final moles)(final temperature)}}$	$\frac{\frac{P_1V_1}{n_1T_1}}{\frac{P_2V_2}{n_1T_2}} = \frac{\frac{P_2V_2}{n_2T_2}}{\frac{P_2V_2}{n_2T_2}}$
(Initial pressure)(initial volume) = (final pressure)(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	
$Molarity = \frac{moles \text{ of solute}}{liter \text{ of solution}}$	$M = \frac{\text{mol}}{\text{L}}$
$Ionization \ constant \ of \ water = \left( \begin{array}{l} \text{hydrogen ion} \\ \text{concentration} \end{array} \right) \!\! \left( \begin{array}{l} \text{hydroxide ion} \\ \text{concentration} \end{array} \right)$	$K_{\rm w} = [{\rm H}^+][{\rm OH}^-]$
	$V_1 M_1 = V_2 M_2$
pH = –logarithm (hydrogen ion concentration)	$pH = -log[H^+]$
THERMOCHEMISTRY	
Heat gained or lost = $(mass)$ $\binom{specific}{heat}$ $\binom{change in}{temperature}$	$Q = mc_p \Delta T$
Enthalpy of reaction = $\begin{pmatrix} \text{enthalpy} \\ \text{of products} \end{pmatrix} - \begin{pmatrix} \text{enthalpy} \\ \text{of reactants} \end{pmatrix}$ $\Delta H = \Delta H_f^0 \text{(products)}$	$\Delta H_{\rm f}^{\rm o}$ (reactants)



#### **OTHER FORMULAS**

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

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

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

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

#### **CONSTANTS AND CONVERSIONS**

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

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

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

$$K_{\rm w} = \text{ionization constant of water} = 1.00 \times 10^{-14} \left(\frac{\text{mol}}{\text{I}}\right)^2$$

alpha particle (
$$\alpha$$
) =  ${}_{2}^{4}$ He

beta particle (
$$\beta$$
) =  ${0 \atop -1}$ e neutron =  ${1 \atop 0}$ n

neutron = 
$$\frac{1}{0}$$
n

standard temperature and pressure (STP) = 0°C and 1 atm

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

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

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

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

1000 calories (cal) = 1 Calorie (Cal) = 1 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.



POLYATOMIC IONS		SOLUBILITY OF CO	ACTIVITY SERIES	
Acetate C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> -	, сн <sub>у</sub> соо-	Soluble	Common exceptions	Metal
Ammonium	NH <sup>+</sup> <sub>4</sub>	C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> , CH <sub>3</sub> COO <sup>-</sup>	None	Lithium
Carbonate	CO <sub>3</sub> -	NH <sup>+</sup> <sub>4</sub>	None	Potassium
Chlorate	CIO <sub>3</sub>	NO <sub>3</sub>	None None	Barium Calcium
Chlorite	CIO <sub>2</sub>	CIO-	None	Sodium
Chromate	CrO <sub>4</sub> <sup>2-</sup>	CIO <sub>2</sub>	None	Magnesium
Cyanide	CNT	CIO <sub>3</sub>	None None	Aluminum Manganese
Dichromate	Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup>	Br <sup>-</sup>	Compounds of Ag+, Pb2+, and Hg2+	
Hydrogen carbonate	HCO3	CI <sup>-</sup>	Compounds of Ag <sup>+</sup> , Pb <sup>2+</sup> , and Hg <sup>2+</sup> Compounds of Ag <sup>+</sup> , Pb <sup>2+</sup> , and Hg <sup>2+</sup>	Chromium Iron
Hydroxide	OH-	SO <sub>4</sub> <sup>2-</sup>	Compounds of Sr <sup>2+</sup> , Ba <sup>2+</sup> , Pb <sup>2+</sup> , and Hg <sub>2</sub> <sup>2+</sup>	
Hypochlorite	CIO-	Insoluble	Common exceptions	Cobalt Di Cobalt
Nitrate	NO <sub>3</sub>	compounds contain CO <sub>3</sub> <sup>2</sup>	Compounds of NH <sup>+</sup> and the alkali metal cations	Tin 60
Nitrite	NO <sub>2</sub>	PO <sub>4</sub> <sup>3</sup> -	Compounds of NH <sub>4</sub> and the alkali metal cations	Nickel Signature Cobalt Nickel
Perchlorate	CIO <sub>4</sub>	CrO <sub>4</sub> <sup>2-</sup>	Compounds of NH <sub>4</sub> and the alkali metal cations	(Hydrogen)
Permanganate	MnO <sub>4</sub>	Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup>	Compounds of $\mathrm{NH_4^+}$ and the alkali metal cations	Copper
Phosphate	PO <sub>4</sub> 3-	OH-	Compounds of NH <sub>4</sub> , the alkali metal cations,	Mercury Silver
Sulfate	SO <sub>4</sub> <sup>2-</sup>	S <sup>2</sup> -	Ca <sup>2+</sup> , Sr <sup>2+</sup> , and Ba <sup>2+</sup> Compounds of NH <sup>+</sup> , the alkali metal cations,	Platinum
Sulfite	SO <sub>3</sub> <sup>2</sup> -	3	Ca <sup>2+</sup> , Sr <sup>2+</sup> , and Ba <sup>2+</sup>	Gold



## PERIODIC TABLE OF THE ELEMENTS

1 2	1 1A 1 H 1.008 Hydrogen 3 Li 6.341 Lithium	2 2A 4 Be 9.012 Beryllun	Atomic number ————————————————————————————————————											14 4A 6 C 12.011 Carton	15 5A 7 N 14,007 Niregen	16 6A 8 O 15,229 Oxygen	17 7A 9 F 18.298 Flusine	18 8A 2 He 4,003 Hellum 10 Ne 20,180 Neon	
3	Na 22.990 Sodium	Mg 24305 Vagordum	3 38	4 4B	5 5B	6 6B	7 7B	.8.	9 8B	10	11 1B	12 2B	13 Al 26562 Aluminum	Si 28.086 Silicon	15 P 30.974 Phosphorus	16 S 32.066 Suitur	17 CI 35.453 Chlorine	18 Ar 39.948 Argon	
4	19 K 39.098	Ca Ca 40.078	21 Sc 44.956 Scandium	22 Ti 47.867 Titanium	23 V 50.942	Cr 51.996	Mn 54.938	26 Fe 55.845	27 Co 58,933 Cotat	28 Ni Sa.693	29 Cu 63.546 Copper	30 Zn 65.38	31 Ga 69.723	Ge 72.64 Germanium	33 As 74,922 Amenic	Se 78.95 Selenium	35 Br 79.904 Frances	36 Kr 83.798 Kopton	
5	37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 85.96	43 Tc (28)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112,412	49 In 114,818	50 Sn 118.711	51 Sb 121.760	52 Te 127.60	53 I 126.904	54 Xe 131.294	
6	55 Cs 132,905	56 Ba 137,328	71 Lu 174,967	72 Hf 178.49	73 Ta 180,948	74 W 183,84	75 Re 186,207	76 Os 190,23	77 Ir 192,217	78 Pt 195,065	79 Au 196,967	80 Hg 200.50	81 TI 204,383	82 Pb	83 Bi 208,980	Po (209)	85 At (210)	86 Rn (222)	
7	87 Fr (223)	88 Ra (226)	103 Lr (262)	104 Rf (267)	105 Db (268)	106 Sg (271)	107 Bh (272)	108 Hs (270)	109 Mt (276)	110 Ds (281)	111 Rg (280)	Mass num							
	Francium			57 La 138905 Lastanum	58 Ce 140.116 Cesiun 90	59 Pr 140.908 Praecoprium	60 Nd 144,242 Neodymium 92	61 Pm (145) Promethium	62 Sm 150.36 Sanurium 94	63 Eu 151.964 Europium 95	64 Gd 157.25 Gadelnium 96	65 Tb 158.925 Teckun	66 Dy 162,500 Dyspresium 98	67 Ho 164,930 Holmium	68 Er 167,259 Erbium 100	69 Tm 168,934 Thulun	70 Yb 173.055 Yzerbium 102		
	Actini	ide Serie	s \	Ac (227) Actinium	Th 232,038 Thorum	Pa 231.036 Protectinium	238.029 Utanium	Np (237) Neptunium	Pu (244) Plutonium	Am (243) Americian	Cm (247) Curium	Bk (247) Bertelium	Cf (251) Californium	Es (252) Einsteinium	Fm (257) Fernium	Md (258) Mendelesium	No (259) Nobelium		

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