Name _____ Date _____

Santa Clara High School - AP Chemistry Summer Review Packet SUMMER ~~2019~~ 2020

Instructions:

1. Join the AP Chemistry ~~2018~~ Google Classroom by going to classrooms.google.com, logging into your **school account**, and using the class code ~~wkenz~~ shfc3qw
   a. **Watch the videos** posted on the stream to help with the summer assignment.
2. **Memorize the polyatomic ions** on the sheet "Chemistry I Polyatomic ions" found at the end of this packet
3. **Memorize the 7 strong acids** and recognize the other acids.
4. Complete all sections of the assignment thoroughly.

***There will be a test on Sections 1-6 on the second or third day of class.**

Section 1: Polyatomic ions - You should know the symbols, names, and charges for the common polyatomic ions, including the ones below.

Write the name of the ion in the box with its formula

NH_4^+	CrO_4^{2-}	OH^-	ClO_3^-	$H_2PO_4^-$	CN^-
ClO^-	PO_4^{3-}	HS^-	HCO_3^-	HSO_3^-	MnO_4^-
$C_2H_3O_2^-$	$Cr_2O_7^{2-}$	$C_2O_4^{2-}$	ClO_4^-	PO_3^{3-}	CH_3COO^-
ClO_2^-	HPO_4^{2-}	O_2^{2-}	NO_2^-	SO_4^{2-}	SiO_3^{2-}
CO_3^{2-}	SO_3^{2-}	SCN^-	NO_3^-	HSO_4^-	

Section 2: Name and Formulas of Ionic Compounds – *For each of the following compounds, write*

a. The correct name (including a roman numeral if applicable)
b. The formula of the ions in the compound (with the charge) **& the number of each ion in one molecule of that compound**

1. $CoBr_2$ cobalt (II)bromide $Co^{2+} + 2\ Br^-$
2. $Al(OH)_3$ aluminum hydroxide $Al^{3+} + 3\ OH^-$
3. $Fe_2(SO_4)_3$ _____
4. CsF _____
5. $CaCO_3$ _____
6. $NiSO_4$ _____
7. Au_2S _____
8. Cu_3N_2 _____
9. $Sc(CH_3COO)_3$ _____
10. Cu_2SO_4 _____

14. $Y(CN)_3$ _____

15. $Zn(MnO_4)_2$ _____

16. $NaCl$ _____

17. $Fe(CH_3COO)_3$ _____

18. $Co_2(CrO_4)_3$ _____

19. NH_4NO_3 _____

20. $CaCl_2$ _____

21. GaN _____

22. $Ti(SO_4)_2$ _____

23. Ag_3P _____

24. $SrCr_2O_7$ _____

25. HgO _____

26. K_3PO_4 _____

27. $LiCl$ _____

28. $Ra(NO_2)_2$ _____

29. $Sn(CN)_2$ _____

30. K_2CrO_4 _____

Section 3: ***Ionic Compound Formulas (Binary, Polyatomic, Transition Metals)***
Write the chemical formula for each of the following compounds.

1. sodium hydroxide — 1. _____
2. mercury (II) sulfate — 2. _____
3. lead (II) phosphate — 3. _____
4. ammonium sulfide — 4. _____
5. aluminum chlorate — 5. _____
6. copper (I) carbonate — 6. _____
7. manganese (IV) oxide — 7. _____
8. manganese (II) sulfate — 8. _____
9. iron (III) oxide — 9. _____
10. magnesium nitrate — 10. _____
11. calcium sulfide — 11. _____

12. potassium oxide	12. _____
13. magnesium chloride	13. _____
14. chromium (III) oxide	14. _____
15. gold (III) bromide	15. _____
16. beryllium fluoride	16. _____
17. yttrium (III) sulfide	17. _____
18. rubidium oxide	18. _____
19. aluminum dichromate	19. _____
20. iron (II) phosphide	20. _____
21. iron (III) nitrate	21. _____
22. chromium (III) sulfate	22. _____
23. tin (IV) nitride	23. _____
24. lead (II) permanganate	24. _____
25. niobium (V) oxalate	25. _____

Acid Nomenclature Practice

Write the name or chemical formula for the following acids. Assume all compounds are dissolved in water.

1. HBr _____
2. $HBrO_3$ _____
3. HNO_2 _____
4. H_3PO_4 _____
5. H_2CO_3 _____
6. H_3PO_3 _____
7. H_2SO_3 _____
8. HNO_3 _____
9. HI _____
10. HF _____
11. H_2S _____
12. $HClO_3$ _____
13. sulfuric acid _____
14. chlorous acid _____

15. hydrochloric acid_____

16. hypochlorous acid_____

17. acetic acid_____

18. perchloric acid _____

19. carbonic acid _____

Section 4: *Errors in Chemical Nomenclature*

Each of the following formulas or names is incorrect. Correct each. There might be more than one right way to correct the error.

1. aluminum(III) iodide
2. Al_3O_2
3. $BrNH_4$
4. lead(II) monoxide
5. lead sulfide
6. tin(IV) bromine
7. calcium dioxide
8. $K(BrO_2)$
9. $(OH)_3Al$
10. $Pb(NO_3)_3$
11. copper(I) chlorine
12. iron oxide
13. $Ni\ [NO_3]_2$
14. $Cr_1(CN)_2$
15. Mg_2F
16. cobalt oxide
17. zinc(II) fluoride
18. FNa
19. Ca_2O_2
20. potassium(I) iodate
21. dinickel trisulfide
22. mononitrogen dioxide
23. magnesium nitrogenide
24. strontium dichloride
25. ammonium(I) bromate
26. silver(I) dichromate
27. NO_3Na
28. chromium(III) sulfide(III)
29. lithium sulfur tetroxide
30. bromine silveride

Section 5: ***Chemical Word Equations***

Directions: Write an ***unbalanced*** *chemical equation for each of the word equations below. Include states of matter (s,l,g,aq) after each of the chemical formulas.* ***Don't forget about the 7 diatomic elements- BrINClHOF!***

a. Aqueous sodium chloride reacts with aqueous lead (II) nitrate to yield solid lead (II) chloride and aqueous sodium nitrate.

b. Aqueous barium nitrate reacts with sulfuric acid to yield solid barium sulfate and nitric acid

c. Silver nitrate reacts in solution with potassium chromate to yield solid silver chromate and aqueous potassium nitrate

d. Solid calcium carbonate reacts with hydrochloric acid to yield aqueous calcium chloride, carbon dioxide gas, and liquid water

e. Aqueous zinc chloride reacts with dihydrogen monosulfide gas to yield solid zinc sulfide and hydrochloric acid

f. Magnesium nitrate reacts in solution with potassium hydroxide to yield solid magnesium hydroxide and aqueous potassium nitrate

g. Solid aluminum hydroxide reacts with nitric acid to yield soluble aluminum nitrate and liquid water

h. Aqueous lead (IV) nitrate reacts with aqueous sodium sulfate to yield solid lead (IV) sulfate precipitate and aqueous sodium nitrate

i. Aqueous sodium hydroxide reacts with carbon dioxide gas to yield aqueous sodium carbonate and liquid water

j. Solid magnesium oxide reacts with hydrochloric acid to yield a solution of magnesium chloride and liquid water

k. Solid zinc metal reacts with sulfuric acid to yield aqueous zinc sulfate and hydrogen gas

l. Solid iron (III) oxide reacts with solid aluminum metal to yield solid aluminum oxide and solid iron metal

Section 6: Balancing Chemical Equations

*Directions: First, balance each of the chemical equations below. Then, classify each reaction as **synthesis**, **decomposition**, **single-replacement**, or **double-replacement**.*

	Balance the equation...	**...and classify it.**
a.	____ Sb + ____ Cl_2 → ____ $SbCl_3$	_____
b.	____ $SrBr_2$ + ____ $(NH_4)_2CO_3$ → ____ $SrCO_3$ + ____ NH_4Br	_____
c.	____ Al + ____ $Pb(NO_3)_2$ → ____ $Al(NO_3)_3$ + ____ Pb	_____
d.	____ $NaClO_3$ → ____ $NaCl$ + ____ O_2	_____
e.	____ Fe + ____ HCl → ____ $FeCl_2$ + ____ H_2	_____
f.	____ CuO + ____ H_2 → ____ Cu + ____ H_2O	_____
f.	____ Al + ____ H_2SO_4 → ____ $Al_2(SO_4)_3$ + ____ H_2	_____
h.	____ $MgBr_2$ + ____ Cl_2 → ____ $MgCl_2$ + ____ Br_2	_____
i.	____ $Ba(OH)_2$ → ____ BaO + ____ H_2O	_____
j.	____ $Pb(NO_3)_2$ + ____ H_2S → ____ PbS + ____ HNO_3	_____
k.	____ NH_4NO_2 → ____ N_2 + ____ H_2O	_____
l.	____ $KClO_3$ → ____ KCl + ____ O_2	_____
m.	____ Fe_3O_4 + ____ H_2 → ____ Fe + ____ H_2O	_____

Section 7: Chemical Calculations- Average Atomic Mass, Mole Calculations, Stoichiometry, Percent Composition and determining Empirical/Molecular Formulas

Complete these questions on lined paper. You MUST SHOW ALL WORK CLEARLY AND COMPLETELY for each of the following questions to receive credit.

No work, no credit! *Also, where applicable, round your answers to the correct number of significant figures.*

1. An element has four isotopes, with percent abundances and masses, as shown below. Calculate the atomic weight and identify the element. 4.35% (49.9460 amu) 9.50% (52.9407 amu) 83.79% (51.9405 amu) 2.36% (53.9389 amu)

2. Copper has an average atomic mass of 63.546 amu. Its two isotopes are Cu-63 (which is 69.17% abundant and has a mass of 62.9296 amu) and Cu-65. From this information, calculate the mass of Cu-65.

3. How many nitrogen atoms are in 18.8 g of barium nitride?

4. How many oxygen atoms are in 7.25 g of calcium nitrate?

5. Find the percent composition and mass of each element present in a 0.5625 g sample of ammonium cyanide.

6. Sodium sulfate has the formula Na_2SO_4.
   a) What is the mass percentage of each element in sodium sulfate?
   b) How many grams of this compound contain 2.00 grams sulfur?
   c) How many grams of oxygen are in 15.0 g of the compound?
   d) How many grams of the compound contain 17.90 grams of sodium?

7. Cholesterol is 83.94% carbon, 11.92% hydrogen, and 4.15% oxygen by mass. Find cholesterol's empirical formula.

8. Codeine is 72.24% carbon, 7.02% hydrogen, 16.05% oxygen, and 4.68% nitrogen by mass. Find codeine's empirical formula.

9. A sample of a compound is found to contain 23.03 g phosphorus, 5.22 g nitrogen, and 26.39 g chlorine. The compound's molar mass is 441 g/mol. Find its molecular formula.

10. Lactic acid is a ternary oxyacid that is 40.00% carbon and 6.67% hydrogen. If 0.377 moles of lactic acid have a mass of 33.93 g, find the molecular formula of lactic acid.

11. Find the mass percent of nitrogen in each of the following compounds:
    a. NO b. NO_2 c. N_2O_4 d. N_2O

12. Benzene contains only carbon and hydrogen and has a molar mass of 78.1 g/mol. Analysis shows the compound to be 7.44% hydrogen by mass. Find the empirical and molecular formula of benzene.

13. A 0.941 gram piece of magnesium metal is heated and reacts with oxygen. The resulting magnesium oxide weighed 1.560 grams. Determine the percent composition of each element in the compound.

14. A 2.500 gram sample of uranium was heated in air. The resulting oxide weighed 2.949 gram. Determine the empirical formula of the oxide. {Hint: Carry out the calculations to four decimal places}.

15. **Calcium carbonate decomposes upon heating, producing calcium oxide and carbon dioxide.**

a) Write a balanced chemical equation for this reaction.

b) How many grams of calcium oxide will be produced after 12.25 grams of calcium carbonate are completely decomposed?

c) What volume of carbon dioxide gas is produced from 12.25 grams of calcium carbonate at **STP**?

d) What is the volume of carbon dioxide in L if the pressure is 785 mmHg and the temperature is 30.0°C? (R=0.08206). *Hint- The ideal gas law is helpful here!*

16. **Hydrogen gas and bromine gas react to form hydrogen bromide gas.**

a) Write a balanced equation for this reaction.

b) 3.2 grams of hydrogen reacts with 9.5 grams of bromine. Which is the limiting reactant?

c) What volume of HBr, measured at STP is produced in (b)?

17. If 25.0 g of carbon monoxide react with 8.50 g of ammonia and 10.0 g of hydrogen to produce water and acetonitrile (CH_3CN), what mass of each excess reactant is left over after the reaction is complete?

18. **Octane undergoes complete combustion to form carbon dioxide and water.**

a) Balance the following chemical equation for the combustion of octane:

$$C_8H_{18}(l) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$$

b) How many moles of CO_2 are produced from the combustion of 101 grams of octane?

c) How many molecules of water are produced by the combustion of 2.1 grams of octane?

d) What is the percent yield if 3.70 g of CO_2 are produced starting from 1.62 g C_8H_{18}?

19. In the reaction between red phosphorus (P_4) and fluorine, phosphorus trifluoride is produced. If the percent yield is 82.6%, what mass of fluorine is needed to produce 152 g of phosphorus trifluoride?

20. A gaseous compound has the empirical formula of CH_3Br and a density of 6.00 g/L, at 375 K and .983 atm. Using these data, determine the following:

a) The molar mass of the compound. *(HINT- P=DRT/MM)*

b) The molecular formula of the compound.

MEMORIZE THE HIGHLIGHTED POLYATOMIC IONS (NAMES AND FORMULAS)

Chemistry I
Polyatomic Ions

Here's a list of common polyatomic ions and acids:

Ion	*Name*	*Acid Formula*	*Acid Name*
NH_4^+	Ammonium*		
NO_3^-	Nitrate	HNO_3	Nitric Acid
NO_2^-	Nitrite	HNO_2	Nitrous Acid
OH^-	Hydroxide*	HOH	Water (not really an acid)
CN^-	Cyanide	HCN	Hydrocyanic Acid
SCN^-	Thiocyanate	HSCN	Thiocyanic Acid
ClO_4^-	Perchlorate*	$HClO_4$	Perchloric Acid
ClO_3^-	Chlorate*	$HClO_3$	Chloric Acid
ClO_2^-	Chlorite*	$HClO_2$	Chlorous Acid
ClO^-	Hypochlorite*	HClO	Hypochlorous Acid
$C_2H_3O_2^-$	Acetate	$HC_2H_3O_2$	Acetic Acid
MnO_4^-	Permanganate	$HMnO_4$	Permanganic Acid
SO_4^{2-}	Sulfate*	H_2SO_4	Sulfuric Acid
SO_3^{2-}	Sulfite*	H_2SO_3	Sulfurous Acid
HSO_4^-	Hydrogen sulfate or Bisulfate*	H_2SO_4	Sulfuric Acid
$S_2O_3^{2-}$	Thiosulfate	$H_2S_2O_3$	Thiosulfuric Acid
CO_3^{2-}	Carbonate	H_2CO_3	Carbonic Acid
HCO_3^-	Hydrogen carbonate or bicarbonate	H_2CO_3	Carbonic Acid
CrO_4^{2-}	Chromate	H_2CrO_4	Chromic Acid
$Cr_2O_7^{2-}$	Dichromate	$H_2Cr_2O_7$	
O_2^{2-}	Peroxide	H_2O_2	Hydrogen Peroxide (not really an acid)
$C_2O_4^{2-}$	Oxalate	$H_2C_2O_4$	Oxalic Acid
PO_4^{3-}	Phosphate*	H_3PO_4	Phosphoric Acid
HPO_4^{2-}	Hydrogen Phosphate*	H_3PO_4	Phosphoric Acid
$H_2PO_4^-$	Dihydrogen Phosphate*	H_3PO_4	Phosphoric Acid

Hints to help you remember these ions:

- For the asterisked (*) ions, you can figure out their charge from the non-oxygen element and the periodic table. Example: ClO_3^- : Cl corresponds to a 1- charge on the periodic table.
- Changing the number of Oxygens does not change the charge. Example: ClO_4^-, ClO_3^-, ClO_2^-, ClO^-
- Adding Hydrogens increases the charge by +1. Examples: PO_4^{3-}, HPO_4^{2-}, $H_2PO_4^-$
- Ammonium (NH_4^+) is the only + polyatomic ion you need to know.
- Phosphate (PO_4^{3-}) is the only 3- polyatomic ion you need to know.
- "Per-X-ate" → loses oxygen → "X-ate" → loses oxygen → "X-ite" → loses oxygen→ "hypo-X-ite"

Hints to help you remember the acids:

- "Per-X-ate" ion corresponds to "Per-X-ic Acid"
- "X-ate" ion corresponds to "X-ic Acid"
- "X-ite" ion corresponds to "X-ous Acid"
- "Hypo-X-ite" ion corresponds to "hypo-X-ous Acid"

What about acids of mono-atomic anions? (Where anion ends in –ide) Like HCl? Or HF? "Hydro-X-ic Acid"

HCl	Hydrochloric Acid
HF	Hydrofluoric Acid
HCN	Hydrocyanic Acid

MEMORIZE THESE 7 STRONG ACIDS (NAMES AND FORMULAS)

The 7 Strong Acids

Completely Ionized in Water to Give One (*or more*) Protons per Acid Molecule

HI	hydroiodic acid	$H^+(aq) + I^-(aq)$	
HBr	hydrobromic acid	$H^+(aq) + Br^-(aq)$	
$HClO_4$	perchloric acid	$H^+(aq) + ClO_4^-(aq)$	
HCl	hydrochloric acid	$H^+(aq) + Cl^-(aq)$	
$HClO_3$	chloric acid	$H^+(aq) + ClO_3^-(aq)$	
H_2SO_4	sulfuric acid	$H^+(aq) + HSO_4^-(aq)$	*(HSO_4^- is a weak acid that contributes additional protons)*
HNO_3	nitric acid	$H^+(aq) + NO_3^-(aq)$	

The 8 Strong Bases

Completely Ionized in Water to Give One (*or more*) Hydroxides per Base Molecule

NaOH	sodium hydroxide	$Na^+(aq) + OH^-(aq)$	
KOH	potassium hydroxide	$K^+(aq) + OH^-(aq)$	
LiOH	lithium hydroxide	$Li^+(aq) + OH^-(aq)$	
RbOH	rubidium hydroxide	$Rb^+(aq) + OH^-(aq)$	
CsOH	cesium hydroxide	$Cs^+(aq) + OH^-(aq)$	
$Ca(OH)_2$	calcium hydroxide	$Ca^{2+}(aq) + 2OH^-(aq)$	*(but not very soluble)*
$Ba(OH)_2$	barium hydroxide	$Ba^{2+}(aq) + 2OH^-(aq)$	*(but not very soluble)*
$Sr(OH)_2$	strontium hydroxide	$Sr^{2+}(aq) + 2OH^-(aq)$	*(but not very soluble)*

DO NOT DETACH FROM BOOK.

PERIODIC TABLE OF THE ELEMENTS

1																	18
1 **H** 1.008	2											13	14	15	16	17	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.30	3	4	5	6	7	8	9	10	11	12	13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.87	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.38	31 **Ga** 69.72	32 **Ge** 72.63	33 **As** 74.92	34 **Se** 78.97	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.95	43 **Tc** (97)	44 **Ru** 101.1	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57 ***La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **†Ac** (227)	104 **Rf** (267)	105 **Db** (270)	106 **Sg** (271)	107 **Bh** (270)	108 **Hs** (277)	109 **Mt** (276)	110 **Ds** (281)	111 **Rg** (282)	112 **Cn** (285)	113 **Uut** (285)	114 **Fl** (289)	115 **Uup** (288)	116 **Lv** (293)	117 **Uus** (294)	118 **Uuo** (294)

*Lanthanoid Series	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.05	71 **Lu** 174.97
†Actinoid Series	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (262)

AP® CHEMISTRY EQUATIONS AND CONSTANTS

Throughout the exam the following symbols have the definitions specified unless otherwise noted.

L, mL	=	liter(s), milliliter(s)	mm Hg	=	millimeters of mercury
g	=	gram(s)	J, kJ	=	joule(s), kilojoule(s)
nm	=	nanometer(s)	V	=	volt(s)
atm	=	atmosphere(s)	mol	=	mole(s)

ATOMIC STRUCTURE

$E = h\nu$

$c = \lambda\nu$

E = energy
ν = frequency
λ = wavelength

Planck's constant, $h = 6.626 \times 10^{-34}$ J s
Speed of light, $c = 2.998 \times 10^{8}$ m s^{-1}
Avogadro's number = 6.022×10^{23} mol^{-1}
Electron charge, $e = -1.602 \times 10^{-19}$ coulomb

EQUILIBRIUM

$K_c = \dfrac{[C]^c[D]^d}{[A]^a[B]^b}$, where $a\,A + b\,B \rightleftarrows c\,C + d\,D$

$K_p = \dfrac{(P_C)^c(P_D)^d}{(P_A)^a(P_B)^b}$

$K_a = \dfrac{[H^+][A^-]}{[HA]}$

$K_b = \dfrac{[OH^-][HB^+]}{[B]}$

$K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$ at 25°C

$= K_a \times K_b$

$pH = -\log[H^+]$, $pOH = -\log[OH^-]$

$14 = pH + pOH$

$pH = pK_a + \log\dfrac{[A^-]}{[HA]}$

$pK_a = -\log K_a$, $pK_b = -\log K_b$

Equilibrium Constants

K_c (molar concentrations)
K_p (gas pressures)
K_a (weak acid)
K_b (weak base)
K_w (water)

KINETICS

$\ln[A]_t - \ln[A]_0 = -kt$

$\dfrac{1}{[A]_t} - \dfrac{1}{[A]_0} = kt$

$t_{1/2} = \dfrac{0.693}{k}$

k = rate constant
t = time
$t_{1/2}$ = half-life

GASES, LIQUIDS, AND SOLUTIONS

$$PV = nRT$$

$$P_A = P_{\text{total}} \times X_A, \text{ where } X_A = \frac{\text{moles A}}{\text{total moles}}$$

$$P_{total} = P_A + P_B + P_C + \ldots$$

$$n = \frac{m}{M}$$

$$K = {}^\circ C + 273$$

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

$$KE \text{ per molecule} = \frac{1}{2}mv^2$$

Molarity, M = moles of solute per liter of solution

$$A = abc$$

P = pressure
V = volume
T = temperature
n = number of moles
m = mass
M = molar mass
D = density
KE = kinetic energy
v = velocity
A = absorbance
a = molar absorptivity
b = path length
c = concentration

Gas constant, $R = 8.314 \text{ J mol}^{-1}\text{K}^{-1}$
$= 0.08206 \text{ L atm mol}^{-1}\text{ K}^{-1}$
$= 62.36 \text{ L torr mol}^{-1}\text{ K}^{-1}$
1 atm = 760 mm Hg = 760 torr
STP = 273.15 K and 1.0 atm
Ideal gas at STP = 22.4 L mol^{-1}

THERMODYNAMICS / ELECTROCHEMISTRY

$$q = mc\Delta T$$

$$\Delta S^\circ = \sum S^\circ \text{ products} - \sum S^\circ \text{ reactants}$$

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

$$\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$
$$= -RT \ln K$$
$$= -nFE^\circ$$

$$I = \frac{q}{t}$$

q = heat
m = mass
c = specific heat capacity
T = temperature
S° = standard entropy
H° = standard enthalpy
G° = standard Gibbs free energy
n = number of moles
E° = standard reduction potential
I = current (amperes)
q = charge (coulombs)
t = time (seconds)

Faraday's constant, F = 96,485 coulombs per mole of electrons

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$$