

## Academy for Advance Studies AP Chemistry Pre-AP Assignment

AP Chemistry is an extremely fast paced course and it is necessary that you come to this course ready to work from Day 1. It will be very important for you to **read each and every chapter** several times in order to get the maximum benefit out of this course. We will begin by reviewing what you have done in Chemistry I. This is basically the first three chapters of the book. We will have a test over these three chapters the second week of school. I will ask that you thoroughly read and take notes on the first two chapters prior to the first day of class, so that you are well prepared to take on even more challenges as the days and weeks go on. Note-cards can be a valuable tool as you begin to get into college level work. These cards should contain important notes and explanations on one side, with key words on the other. It is important that you be able to explain processes as well as solve problems. In addition, you may want to review your Chemistry I notes pertaining to each section and place these on note cards as well (I strongly encourage you to do this, since it will be expected that you remember details that were covered in Chem. I).

The following assignment will be reviewed in class beginning on the first day of school. I will take questions on any problems you may have had from this assignment on the first few days of class. Therefore, you need to have your material with you on the first day. Please come prepared.

If you have any questions, please email me at [charlena.raines@henry.k12.ga.us](mailto:charlena.raines@henry.k12.ga.us) or send questions through the AP chemistry remind [text @ap-chemaas to 81010]. Do not wait until the last minute to do these assignment as it will take a while to complete. You will not be able to do all of this the week before school starts.

### Optional Mental Math Practice

Note that calculators are not allowed for multiple choice questions. Students need to be able to do basic mental math and estimate. There is an optional mental math posted on Ms. Raines web page in addition to an online AP Chemistry textbook. <https://schoolwires.henry.k12.ga.us/Page/110741>

### Items to Memorize:

#### Name and charges for elements in the following groups.

Group 1: Alkali Metals all have +1 charge but Hydrogen can be +1 or -1

Group 2: Alkaline Earth Metals all have +2 charge

Group 17 Halogens all have -1 charge, and name ends in -ide [example: Chloride is  $\text{Cl}^{-1}$ ]

Group 18: Noble Gases

#### Strong Acids and Strong Bases (shown in table on last page)

#### Solubility Rules

- Group 1 (Alkali Metals) always soluble
- Nitrates, acetates, and ammonium always soluble
- Precipitates to know:  $\text{BaSO}_4$ ,  $\text{AgCl}$ ,  $\text{PbI}_2$

**Required Pre-AP Assignment. For any items, involving calculations show ALL calculations with units and chemical formulas. Students need to use dimensional analysis (factor label method) on any and ALL conversions.**

### I. Significant Figures

How many significant figures are in each of the following?

Reference video: <https://www.youtube.com/watch?v=7b60RZqut0U>

- |                                 |              |
|---------------------------------|--------------|
| 1) 1.92 mm                      | 6) 100       |
| 2) 0.030100 kJ                  | 7) 1001      |
| 3) $6.022 \times 10^{23}$ atoms | 8) 0.001     |
| 4) 460.00 L                     | 9) 0.0101    |
| 5) $0.00036 \text{ cm}^3$       | 10) 0.010100 |

Calculate the following to the correct number of significant figures.

Reference video 1: <https://www.youtube.com/watch?v=o5BmoMDJLRY> [multiplication and division]

Reference video 2: <https://www.youtube.com/watch?v=2eXC6s9X6Wc> [addition and subtraction]

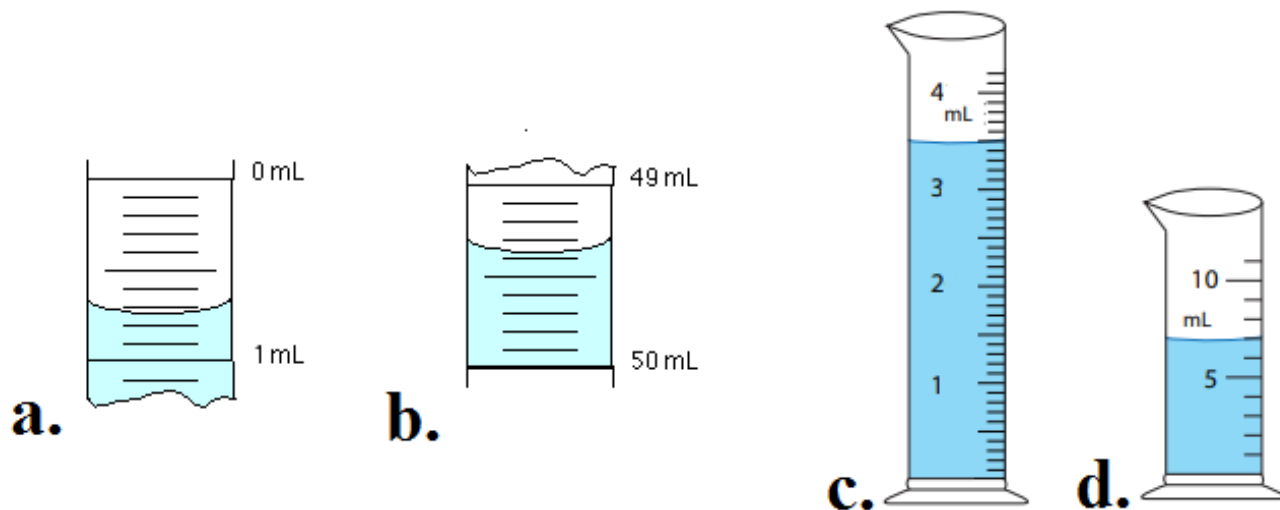
Reference video 3: <https://www.youtube.com/watch?v=Ma4nDAOP6Gk> [counted quantities]

- |                    |                                  |
|--------------------|----------------------------------|
| 1) $1.27 / 5.296$  | 5) $2.1 \times 3.21$             |
| 2) $12.235 / 1.01$ | 6) $200.1 \times 120$            |
| 3) $12.2 + 0.38$   | 7) $17.6 + 2.838 + 2.3 + 110.77$ |
| 4) $17.3 + 2.785$  | 8) $3.28 (2.45 - 6.6)$           |

Record the following measurements to the correct Significant figures.

Reference video: [https://www.youtube.com/watch?v=gzvzvDv\\_BnA](https://www.youtube.com/watch?v=gzvzvDv_BnA) [burette]

Reference video: <https://www.youtube.com/watch?v=7ewRaV5baik> [graduated cylinder]



## II. Scientific Notation

Reverence video: <https://www.youtube.com/watch?v=Dme-G4rc6NI&t=328s>

Record the following in correct scientific notation:

- |                    |                          |
|--------------------|--------------------------|
| 1) 350,000,000 cal | 3) 0.0000000809 Å        |
| 2) 0.0000721 mol   | 4) 765,400,000,000 atoms |

Performing the following calculations (without calculator) and write the answers using scientific notation

Reference video: <https://www.youtube.com/watch?v=ciFOLirz4Js>

- |   |   |
|---|---|
| 1) $(5.3 \times 10^3) \times (2.0 \times 10^4)$ | 3) $(1.3 \times 10^4) \times (3.1 \times 10^4)$ |
| 2) $(8.4 \times 10^6) / (2.0 \times 10^4)$      | 4) $(8.8 \times 10^3) / (4.4 \times 10^8)$      |

## III. Metric & time Conversions

Use factor labeling method to convert the following: Must show your work using dimensional analysis

Reference video: <https://www.youtube.com/watch?v=IYgTiQ-ZIf0>

Equalities you MUST know. base to mili, base to kilo, base to nano, base to centi, and time

- |   |                                   |
|---|-----------------------------------|
| 1. 515 m = ___ nm (nanometers)                  | 5. 10 kilometers into meters      |
| 2. 200 mm (millimeter) = ___ meters             | 6. 15,050 milligrams into grams   |
| 3. 325 hours = _____ seconds.                   | 7. 3,264 milliliters into liters  |
| 4. 200.0 centijoule (cJ) = _____ kilojoule (kJ) | 8. 9,674,444 grams into kilograms |

## IV. Matter

**Describe each** of the following AND give at least **one example**

1. States of matter
  - a. Solid
  - b. Liquid
  - c. gas
2. classification of matter
  - a. pure substance
  - b. element
  - c. compound
  - d. mixture
  - e. homogeneous mixture
  - f. heterogeneous mixture
  - g. solution
3. changes
  - a. describe:
    - i. endothermic
    - ii. exothermic
  - b. Describe: physical change
  - c. Give three 3 examples of physical changes
- d. For each phase change below give the states of matter it is occurring between and specific if it is an endothermic or exothermic process
  - i. melting
  - ii. Boiling
  - iii. Condensation
  - iv. Freezing
  - v. Sublimation
  - vi. deposition
- e. describe each of the following separation techniques
  - i. manual separation
  - ii. distillation
  - iii. Filtration
  - iv. Evaporation
  - v. Paper chromatography
- f. Describe chemical change
- g. Give 3 examples of chemical changes

4. Density Solve the following density problems [Density = mass/ volume]
- Mercury metal is poured into a graduated cylinder that holds exactly 22.5 mL. The mercury used to fill the cylinder weighs 306.0 g. From this information, calculate the density of mercury.
  - What is the mass of the ethyl alcohol that exactly fills a 200.0 mL container? The density of ethyl alcohol is 0.789 g/mL.
  - A rectangular block of copper metal weighs 1896 g. The dimensions of the block are 8.4 cm by 5.5 cm by 4.6 cm. From this data, what is the density of copper?
  - What volume of silver metal will weigh exactly 2500.0 g. The density of silver is 10.5 g/cm<sup>3</sup>.
  - What is the density of CO gas if 0.196 g occupies a volume of 100 ml?
  - Find the mass of 250.0 mL of benzene. The density of benzene is 0.8786 g/mL
  - Given that the density of Hg is about 16.5 g mL<sup>-1</sup>, what is the volume of one mole of Hg?
  - What is the density of oxygen gas at STP (standard temperature and pressure)? [HINT: use molar mass and molar volume]

## V. Electron Structure and Periodicity

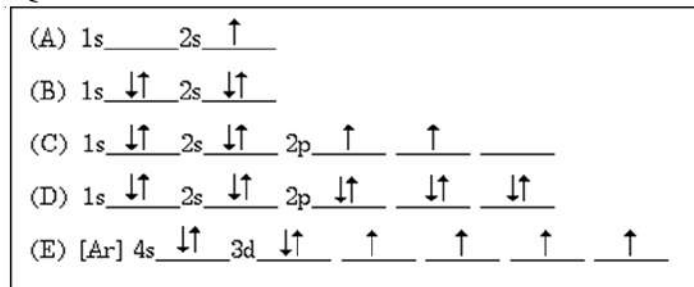
- Draw the orbital (arrow) notation for nickel.
- How many unpaired electrons are in arsenic?
- Write the electron configuration for palladium.
- How many valence electrons are in mercury?
- Write the noble gas electron configuration for californium (Cf).
- Write the noble gas electron configuration for lead.
- Which is more electronegative, sulfur or chlorine, **and why?**
- Which has a larger atomic radius, potassium or bromine, **and why?**
- Which has the smaller ionization energy, nitrogen or phosphorus, **and why?**
- Write the noble gas electron configuration for nickel

**Use these answers for the next 4 questions**

- (A)  $1s^2 2s^2 2p^5 3s^2 3p^5$       (B)  $1s^2 2s^2 2p^6 3s^2 3p^6$       (C)  $1s^2 2s^2 2p^6 2d^{10} 3s^2 3p^6$   
 (D)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$       (E)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$

- An impossible electronic configuration
- The ground-state configuration for the atoms of a transition element
- The ground-state configuration of a negative ion of a halogen
- The ground-state configuration of a common ion of an alkaline earth element

**Use the following image to answer the next 4 questions**



- Represents an atom that is chemically unreactive
- Represents an atom in an excited state
- Represents an atom that has four valence electrons.
- Represents an atom of a transition metal.
- What is the average atomic mass of silicon given the following abundance information on the isotopes of silicon?

Mass number	Abundance
Si-28	92.21 %
Si-29	4.70 %
Si-30	3.09 %

20. Given the data below determine the average atomic mass

Isotope	% Abundance	Isotopic Mass
Sb-121	57.25%	120.9038 amu
Sb-123	42.75%	122.0041 amu

## VI. Reactions

In each of the equations below, the reactants are written correctly. You must write the correct products and then balance the equation. Identify the type of chemical reaction before writing the products.

- $CaCO_3 \rightarrow$
- $Al + O_2 \rightarrow$
- $Fe + CuSO_4 \rightarrow$
- $C_6H_{12} + O_2 \rightarrow$
- $Zn + H_2SO_4 \rightarrow$
- $Cl_2 + MgI_2 \rightarrow$
- $NaOH \rightarrow$
- $Fe + HCl \rightarrow$
- $NaOH + H_3PO_4 \rightarrow$
- $(NH_4)_2SO_4 + Ca(OH)_2 \rightarrow$
- $AgNO_3 + K_2SO_4 \rightarrow$
- $Mg(OH)_2 + H_3PO_4 \rightarrow$
- $Na + H_2O \rightarrow$
- $KClO_3 \rightarrow$
- $Al_2(SO_4)_3 + Ca_3(PO_4)_2 \rightarrow$
- $SO_2 + H_2O \rightarrow$
- $(NH_4)_3PO_4 + Ba(OH)_2 \rightarrow$
- $Ca(OH)_2 + HNO_3 \rightarrow$
- $C_3H_8 + O_2 \rightarrow$
- $Li + S \rightarrow$
- Solid sodium bicarbonate is mixed with copper (II) nitrate.
- Magnesium oxide is heated.
- Acetic acid is added to a solution of ammonia.
- Iron (III) chloride is mixed with silver sulfite.
- A solid piece of aluminum is put into a solution of nickel (II) chloride.
- A solution of lithium chloride is added to a solution of lead (IV) nitrite.
- Sulfuric acid is added to a solution of aluminum hydroxide.
- Cadmium nitrate is added to sodium sulfide.
- Chromium (III) sulfate is added to ammonium carbonate.
- Methane combusts with oxygen in air.

## VII. Mole Concept Sample Problems

- Convert each of the following to moles.
  - 12.64 g  $NaOH$
  800. g  $CaBr_2$
  - $3.00 \times 10^{24}$  atoms  $Au$
  - $3.011 \times 10^{22}$  molecules  $H_2O$
  - 40.0 L of  $Ne$  gas
  - 6.78 L of  $Ar$  gas
- Given 0.250 moles of Sulfur trioxide determine
  - the mass
  - the number of atoms
  - the volume at STP
- How many molecules are in 100.0 L of Carbon dioxide at STP?
- If you have 3.45 mole of a gas at STP how many liters do you have?
- How many moles are in  $3.02 \times 10^{26}$  molecules of water?
- If you have 0.00982 mole of water how many molecules of water?  
Molecular and Empirical Formula reference:  
[http://www.cabrillo.edu/~aromero/CHEM\\_1A/1A\\_Handouts/Empirical%20Formulas.pdf](http://www.cabrillo.edu/~aromero/CHEM_1A/1A_Handouts/Empirical%20Formulas.pdf)
- A pure sample of an oxide of sulfur contains 40.0 % sulfur and 60.0 % oxygen by mass. What is the empirical formula of the oxide?
- A compound contains 18.8% sodium, 29.0% chlorine, and 52.2% oxygen, by mass. If the molar mass of the compound is 122.44 g/mol, determine the empirical and molecular formulas.
- Find the empirical and molecular formulas for a compound containing 11.66 g iron and 5.01 g oxygen if the molar mass of the compound is 320 g/mol.
- Find the empirical and molecular formulas for a compound containing 5.28 g of tin and 3.37 g of fluorine if the molar mass of the compound is 584.1 g/mol.

## VIII. Stoichiometry

- 30.5 g of sodium metal reacts with a solution of excess lithium bromide. How many grams of lithium metal are produced?  $Na + LiBr \rightarrow NaBr + Li$
- Propane,  $C_3H_8$ , undergoes combustion. How many grams of propane are needed to produce 45.9 g of water?  
 $C_3H_8 + 5 O_2 \rightarrow 3 CO_2 + 4 H_2O$
- Using the equation in number 2 if 13.5 L of oxygen is combusted at 150°C how many grams of water is produced. (density of  $O_2$  @ 150°C = 0.922 g/L).
- A solution of 3.50 g of sodium phosphate is mixed with a solution containing 6.40 g of barium nitrate. How many grams of barium phosphate can be formed?  $2 Na_3PO_4 + 3 Ba(NO_3)_2 \rightarrow Ba_3(PO_4)_2 + 6 NaNO_3$

5. Octane,  $C_8H_{18}$ , undergoes combustion. How many grams of oxygen are needed to burn 10.0 g of octane?  
 $2 C_8H_{18} + 25 O_2 \rightarrow 16 CO_2 + 18 H_2O$
9. Sodium azide,  $NaN_3$ , decomposes into its elements. How many grams of sodium azide are required to form 34.8 g of nitrogen gas?  $2 NaN_3 \rightarrow 2 Na + 3 N_2$
10. If you produce 26.04 g of barium phosphate how many grams of sodium phosphate was consumed.  
 $2 Na_3PO_4 + 3 Ba(NO_3)_2 \rightarrow Ba_3(PO_4)_2 + 6 NaNO_3$
11. Ammonia reacts with oxygen gas to form nitrogen monoxide and water. How many grams of nitrogen monoxide are formed when 1.50 g of ammonia react with 2.75 g of oxygen gas?  $4 NH_3 + 5 O_2 \rightarrow 4 NO + 6 H_2O$

### IX. Molarity [ Molarity(M) = mole/liter ]

Reference Video: <https://www.youtube.com/watch?v=SXf9rDnVFao> [calculating molarity]

Reference video: <https://www.youtube.com/watch?v=KLjWa9cE2uk> [using molarity]

Reference video: <https://www.youtube.com/watch?v=sWfn8hbXRp8> [using molarity]

1. What is the molarity of a 0.550 L solution containing 25 g sodium chloride [NaCl]?
2. What is the mass of HI used to create 2.50L of a 0.48 M solution of hydroiodic acid [HI]?
3. How many moles of aluminum hydroxide [Al(OH)<sub>3</sub>] are needed to make 755 mL of 0.250 M solution?
4. If you have 2.50 moles of sulfuric acid [H<sub>2</sub>SO<sub>4</sub>] and want to make a 0.50 M solution how many liters of water do you need?
5. How many grams of Mg<sub>3</sub>(PO<sub>4</sub>)<sub>2</sub> do you need to make 2750 mL of a 4.50 M solution?
6. How many milliliters is needed to make use 48.0 g calcium sulfide [CaS] to make a 0.250 M solution?

### Polyatomic ions and transition metal exceptions

Frequently given the chemical formula and chemical name will be given to you in the prompt. But will need to know the charge of polyatomic ions in addition to the charge (oxidation state) of the representative groups.. Check out video for trick in remembering polyatomics. [T43 trick

[https://www.youtube.com/watch?v=BxJXe0\\_dBOQ](https://www.youtube.com/watch?v=BxJXe0_dBOQ) ]

Name	Formula	Name	Formula	Name	Formula
silver	Ag <sup>+</sup>	nitrate	NO <sub>3</sub> <sup>-1</sup>	<b>Strong Acids</b>	
Zinc	Zn <sup>2+</sup>	nitrite	NO <sub>2</sub> <sup>-1</sup>	Hydrochloric acid	HCl
ammonium	NH <sub>4</sub> <sup>+1</sup>	hydronium	H <sub>3</sub> O <sup>+1</sup>	Hydrobromic acid	HBr
bicarbonate	HCO <sub>3</sub> <sup>-1</sup>	hydroxide	OH <sup>-1</sup>	Hydroiodic acid	HI
bisulfate	HSO <sub>4</sub> <sup>-1</sup>	hypobromite	BrO <sup>-1</sup>	Sulfuric acid	H <sub>2</sub> SO <sub>4</sub>
bisulfide	HS <sup>-1</sup>	hypochlorite	ClO <sup>-1</sup>	Nitric acid	HNO <sub>3</sub>
bisulfite	HSO <sub>3</sub> <sup>-1</sup>	hypoiodite	IO <sup>-1</sup>	Chloric acid	HClO <sub>3</sub>
bromate	BrO <sub>3</sub> <sup>-1</sup>	iodate	IO <sub>3</sub> <sup>-1</sup>	Perchloric acid	HClO <sub>4</sub>
bromite	BrO <sub>2</sub> <sup>-1</sup>	iodite	IO <sub>2</sub> <sup>-1</sup>	<b>Strong Bases</b>	
carbonate	CO <sub>3</sub> <sup>-2</sup>	cyanide	CN <sup>-</sup>	Lithium hydroxide	LiOH
chlorate	ClO <sub>3</sub> <sup>-1</sup>	dichromate	Cr <sub>2</sub> O <sub>7</sub> <sup>-2</sup>	Sodium hydroxide	NaOH
chlorite	ClO <sub>2</sub> <sup>-1</sup>	sulfate	SO <sub>4</sub> <sup>-2</sup>	Potassium hydroxide	KOH
chromate	CrO <sub>4</sub> <sup>-2</sup>	sulfite	SO <sub>3</sub> <sup>-2</sup>	Rubidium hydroxide	RbOH
oxalate	C <sub>2</sub> O <sub>4</sub> <sup>-2</sup>	periodate	IO <sub>4</sub> <sup>-</sup>	Cesium hydroxide	CsOH
perbromate	BrO <sub>4</sub> <sup>-</sup>	permanganate	MnO <sub>4</sub> <sup>-</sup>	Calcium hydroxide	Ca(OH) <sub>2</sub>
perchlorate	ClO <sub>4</sub> <sup>-</sup>	peroxide	O <sub>2</sub> <sup>-2</sup>	Strontium hydroxide	Sr(OH) <sub>2</sub>
acetate	C <sub>2</sub> H <sub>3</sub> O <sub>2</sub> <sup>-1</sup>	phosphite	PO <sub>3</sub> <sup>-3</sup>	Barium hydroxide	Ba(OH) <sub>2</sub>
phosphate	PO <sub>4</sub> <sup>-3</sup>	thiocyanate	SCN <sup>-</sup>		

**AP Periodic Table and Formula Sheets on Next few pages**



## AP<sup>®</sup> CHEMISTRY EQUATIONS AND CONSTANTS

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

L, mL = liter(s), milliliter(s)  
 g = gram(s)  
 nm = nanometer(s)  
 atm = atmosphere(s)

mm Hg = millimeters of mercury  
 J, kJ = joule(s), kilojoule(s)  
 V = volt(s)  
 mol = mole(s)

### ATOMIC STRUCTURE

$$E = h\nu$$

$$c = \lambda\nu$$

$E$  = energy  
 $\nu$  = frequency  
 $\lambda$  = wavelength

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

### EQUILIBRIUM

$$K_c = \frac{[C]^c [D]^d}{[A]^a [B]^b}, \text{ where } aA + bB \rightleftharpoons cC + dD$$

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

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

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

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

$$= K_a \times K_b$$

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

$$14 = \text{pH} + \text{pOH}$$

$$\text{pH} = \text{p}K_a + \log \frac{[A^-]}{[HA]}$$

$$\text{p}K_a = -\log K_a, \text{ p}K_b = -\log K_b$$

#### Equilibrium Constants

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

### KINETICS

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

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

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

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

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

## GASES, LIQUIDS, AND SOLUTIONS

$$PV = nRT$$

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

$$P_{\text{total}} = P_A + P_B + P_C + \dots$$

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

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

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

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

Molarity,  $M$  = moles of solute per liter of solution

$$A = \epsilon bc$$

$P$  = pressure

$V$  = volume

$T$  = temperature

$n$  = number of moles

$m$  = mass

$M$  = molar mass

$D$  = density

$KE$  = kinetic energy

$v$  = velocity

$A$  = absorbance

$\epsilon$  = molar absorptivity

$b$  = path length

$c$  = concentration

Gas constant,  $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$

$= 0.08206 \text{ L atm mol}^{-1} \text{ K}^{-1}$

$= 62.36 \text{ L torr mol}^{-1} \text{ K}^{-1}$

$1 \text{ atm} = 760 \text{ mm Hg} = 760 \text{ torr}$

STP = 273.15 K and 1.0 atm

Ideal gas at STP =  $22.4 \text{ L mol}^{-1}$

## THERMODYNAMICS/ELECTROCHEMISTRY

$$q = mc\Delta T$$

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

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

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

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$$

$$= -RT \ln K$$

$$= -nFE^\circ$$

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

$$E_{\text{cell}} = E_{\text{cell}}^\circ - \frac{RT}{nF} \ln Q$$

$q$  = heat

$m$  = mass

$c$  = specific heat capacity

$T$  = temperature

$S^\circ$  = standard entropy

$H^\circ$  = standard enthalpy

$G^\circ$  = standard Gibbs free energy

$n$  = number of moles

$E^\circ$  = standard reduction potential

$I$  = current (amperes)

$q$  = charge (coulombs)

$t$  = time (seconds)

$Q$  = reaction quotient

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

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