

# AP Chemistry Summer Assignment

For each problem below show your work. Always use units and box your final answer.

## Can you work with significant figures and scientific notation?

Round each of the following numbers to four significant figures, and express the result in scientific notation:

300.235800

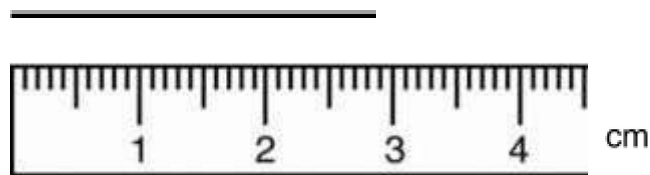
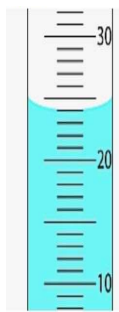
456,500

0.006543210

- 0.000957830

- 0.035000

Record the measurement to the correct number of significant figures.



Carry out the following operations, and express the answers with the appropriate number of significant figures:

$1.24056 + 75.80$

\_\_\_\_\_

$75 - 45.88$

\_\_\_\_\_

$890,000 \times 112.3$

\_\_\_\_\_

$78,132 / 2.50$

\_\_\_\_\_

## Can you use dimensional analysis (FLM) to convert measurements to other units?

Perform the following conversions. Watch your significant figures. If the answer is less than 0.001 or greater than 1000, put the answer in scientific notation:

8.60 cm to nm

\_\_\_\_\_

3.00 days to s

\_\_\_\_\_

75.00 km/hr to m/s

\_\_\_\_\_

$55.35 \text{ m}^3$  to  $\text{cm}^3$

\_\_\_\_\_

1.08 atm to kPa

\_\_\_\_\_

900.0 mmHg to atm

\_\_\_\_\_

**Can you use density as a conversion factor in a FLM problem?**

- a. The density of pure silver is  $10.5 \text{ g/cm}^3$  at  $20^\circ\text{C}$ . If  $5.25 \text{ g}$  of pure silver pellets are added to a graduated cylinder containing  $11.2 \text{ mL}$  of water, to what volume level will the water in the cylinder rise?
- b. The density of air at ordinary atmospheric pressure and  $25^\circ\text{C}$  is  $1.19 \text{ g/L}$ . What is the mass, in kilograms, of the air in a room that measures  $12.5 \times 15.5 \times 8.0 \text{ ft}$ ? (Note:  $1 \text{ foot} = 0.3048 \text{ m}$ )

**Do you have a good understanding of atomic theory?**

1. Let's pretend you are holding two atoms of carbon that are isotopes. Describe what the two atoms have in common and what they have different.

2. Fill in the gaps in the following table, assuming each column represents a neutral atom:

Symbol	${}^{39}_{19}\text{K}$				
Protons		25			82
Neutrons		30	64		
Electrons			48	56	
Mass #				137	207

3. Write the correct symbol, with both superscripts and subscripts, for each of the following :

- (a) the isotope of sodium with mass 23 \_\_\_\_\_
- (b) the atom of vanadium that contains 28 neutrons \_\_\_\_\_
- (c) the isotope of chlorine with mass 37 \_\_\_\_\_
- (d) an atom of magnesium that has an equal number of protons and neutrons \_\_\_\_\_

**Do you know the order of sublevels in an electron configuration (without a cheat sheet- only the PT)?**

1. Write the full electron configuration for the following atoms. Underline the valence electrons.

Mg :

Br :

2. Draw an orbital diagram (lines and arrows) for the following atoms.

P :

Co:

**Do you know your way around the Periodic Table?**

On the diagram of the Periodic Table below, identify the location for:

metals                  nonmetals                  semimetals(metalloids)                  transition metals                  lanthanides

**Periodic Table of the Elements**

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K Potassium 39.098																		Ca Calcium 40.078																		Sc Scandium 44.956																		Ti Titanium 47.88																		V Vanadium 50.942																		Cr Chromium 51.996																		Mn Manganese 54.938																		Fe Iron 55.933																		Co Cobalt 58.933																		Ni Nickel 58.693																		Cu Copper 63.546																		Zn Zinc 65.39																		Ga Gallium 69.723																		Ge Germanium 72.61																		As Arsenic 74.922																		Se Selenium 78.09																		Br Bromine 79.904																		Kr Krypton 84.80																	
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Cs Cesium 132.905																		Ba Barium 137.327																		Lanthanides																		Hf Hafnium 178.49																		Ta Tantalum 180.948																		W Tungsten 183.85																		Re Rhenium 186.207																		Os Osmium 190.23																		Ir Iridium 192.22																		Pt Platinum 195.08																		Au Gold 196.967																		Hg Mercury 200.59																		Tl Thallium 204.383																		Pb Lead 207.2																		Bi Bismuth 208.980																		Po Polonium (209)																		At Astatine 209																		Rn Radon 222.018																	
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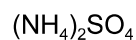
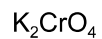
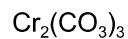
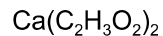
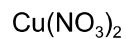
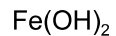
**Do you understand how to calculate average atomic mass?**

1. What isotope is used as the standard in establishing the atomic mass scale?
2. The atomic weight of magnesium is reported as 24.3, yet no atom of magnesium has the mass of 24.3 amu. Explain.
3. Only two isotopes of copper occur naturally, Cu-63 (abundance 69.09 percent) and Cu-65 (abundance 30.91 percent). Calculate the average atomic mass of copper.

**Do you know your nomenclature rules?**

**Note: See attached ion list to memorize. There will be quizzes during the first week of school to see if you know your ions.**

Give the name for each of the following ionic compounds:



Write the chemical formula for each of the following compounds:

copper (I) oxide

aluminum hydroxide

zinc nitrate

mercury (I) bromide

iron (III) carbonate

sodium hypobromite

Give the name or chemical formula, as appropriate, for each of the following acids:



hypochlorous acid

iodic acid

sulfurous acid

Give the name or chemical formula, as appropriate, for each of the following molecular substances:



dinitrogen tetroxide

hydrogen cyanide

tetraphosphorous hexasulfide

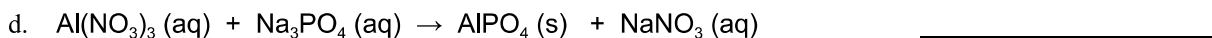
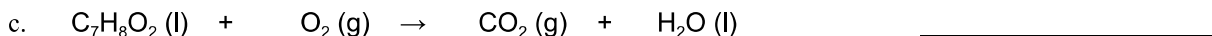
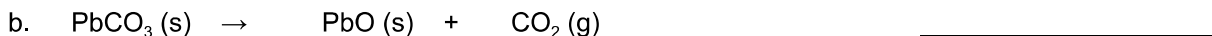
**Can you calculate percent mass? (show your work!)**

Calculate the percentage by mass of oxygen in the following compounds:



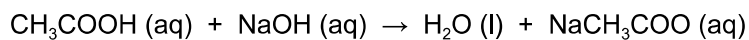
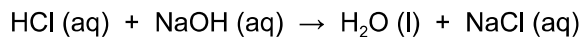
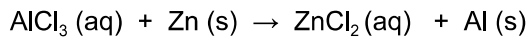
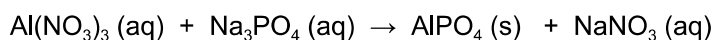
**Can you balance a chemical equation and identify the type of reaction it illustrates?**

Balance the following equations, and indicate what type of reaction each one is:



**Can you write a net ionic equation for a reaction?**

Write a net ionic equation for the reactions below.



**Can you predict the products of a chemical reaction?**

Write a balanced chemical equation, including phase notations, for each of the reactions described.

Octane,  $\text{C}_8\text{H}_{18} \text{ (l)}$ , is burned in air.

The metallic element calcium is heated in an oxygen rich environment.

A solution of silver nitrate is added dropwise to a solution of sodium sulfate. A white precipitate forms.

Sulfuric acid solution is neutralized with a solution of barium hydroxide.

**Can you imagine a chemical reaction?**

Write balanced chemical equations, including phase notations, to correspond to each of the following descriptions. Then draw a picture of what you would see if you were watching the reaction occur in the lab. Label all of the substances in the drawing.

Solid calcium carbide,  $\text{CaC}_2$ , reacts with water to form an aqueous solution of calcium hydroxide and acetylene gas,  $\text{C}_2\text{H}_2$ .

When solid potassium chlorate is heated, it decomposes to form solid potassium chloride and oxygen gas.

Solid zinc metal reacts with sulfuric acid to form hydrogen gas and an aqueous solution of zinc sulfate.

When liquid phosphorous trichloride is added to water, it reacts to form a solution of phosphorous acid and hydrochloric acid.

When hydrogen sulfide gas is passed over solid hot iron (III) hydroxide, the reaction produces solid iron (III) sulfide and gaseous water.

A solution of acetic acid ( $\text{CH}_3\text{COOH}$ ) is titrated with a solution of sodium hydroxide.

**Can you work with mass, moles and particle number in conversions?**

1. The molecular formula of aspartame, the artificial sweetener marketed as NutraSweet, is  $C_{14}H_{18}N_2O_5$ .
  - a. What is the molar mass of aspartame?
  - b. How many moles of aspartame are present in 1.00 mg of aspartame?
  - c. How many molecules of aspartame are present in 1.00 mg of aspartame?
  - d. How many hydrogen atoms are present in 1.00 mg of aspartame?

**Can you determine the empirical and molecular formula of a compound from mass or %mass data?**

1. Determine the empirical formula of each of the following compounds if a sample contains
  - a. 10.4 percent C, 27.8 percent S, and 61.7 percent Cl
  - b. 21.7 percent C, 9.6 percent O, and 68.7 percent F

2. Determine the empirical and molecular formulas of each of the following substances:
- Ibuprofen, a headache remedy contains 75.69 percent C, 8.80 percent H, and 15.51 percent O by mass; molar mass about 206 g
  - Benzene contains only carbon and hydrogen and is 7.74% hydrogen by mass. The molar mass of benzene is 78.1 g/mol.

**Can you perform stoichiometry calculations to predict quantities involved in reactions?**

1. Automotive air bags inflate when sodium azide,  $\text{NaN}_3$ , rapidly decomposes to its component elements:



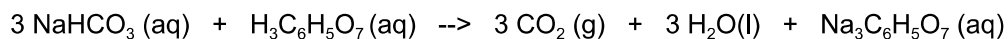
- How many moles of  $\text{N}_2$  are produced by the decomposition of 1.50 moles of  $\text{NaN}_3$ ?
- How many grams of  $\text{NaN}_3$  are required to form 5.00 g of nitrogen gas?
- How many grams of  $\text{NaN}_3$  are required to produce 10.0 L of nitrogen gas if the gas has a density of 1.25 g/L?



2. A piece of aluminum foil 0.550 mm thick and 1.00 cm square is allowed to react with bromine to form aluminum bromide.
- How many moles of aluminum were used? (The density of aluminum is 2.699 g/cm<sup>3</sup>.)
  - How many grams of aluminum bromide form, assuming that the aluminum reacts completely?

**Can you find the limiting reactant and theoretical yield for a reaction?**

1. The fizz produced when an Alka-Seltzer tablet is dissolved in water is due to the reaction between sodium bicarbonate, NaHCO<sub>3</sub>, and citric acid, H<sub>3</sub>C<sub>6</sub>H<sub>5</sub>O<sub>7</sub>:



In a certain experiment 1.00 g of sodium bicarbonate and 1.00 g of citric acid are allowed to react.

- Which reactant is the limiting reactant? You must show work to support your answer.
- What is the theoretical yield of carbon dioxide (in grams)?
- How much of the limiting reactant is left when the reaction is complete?
- How many grams of the excess reactant remain after the reaction is complete?

2. When hydrogen sulfide gas is bubbled into a solution of sodium hydroxide, the reaction forms sodium sulfide and water. What is the theoretical yield of sodium sulfide if 2.50 g of hydrogen sulfide is bubbled into 150.0 mL of a 0.300 M solution of sodium hydroxide? Assume that the limiting reagent is completely consumed.

3. A student reacts benzene,  $C_6H_6$ , with bromine,  $Br_2$ , to prepare bromobenzene,  $C_6H_5Br$ , and  $HBr$ .

a. What is the theoretical yield of bromobenzene in this reaction when 30.0 g of benzene reacts with 65.0 g of bromine?

b. If the actual yield of bromobenzene was 56.7 g, what was the percent yield?

4. Hydrogen peroxide is oxidized with permanganate solution to produce oxygen gas by the following reaction.
- $$2 \text{H}^+ (\text{aq}) + \text{H}_2\text{O}_2 (\text{aq}) + 2 \text{MnO}_4^{1-} (\text{aq}) \rightarrow 2 \text{MnO}_2 (\text{aq}) + 4 \text{H}_2\text{O} + 3 \text{O}_2 (\text{g})$$

In the lab a student mixed 30.0 mL of 0.30 M hydrogen peroxide solution with 30.0 mL of 0.30 M potassium permanganate solution. The oxygen that was produced was collected by water displacement at 298 K and 1.00 atm of pressure. The volume of oxygen collected was 178 mL. (Ignore the effect of water vapor in the collection tube here.)

- a. What is the limiting reactant?
- b. What is the theoretical yield of oxygen gas, in milliliters?
- c. What is the percent yield of oxygen gas?

**Can you assign oxidation numbers?**

Determine the oxidation number of the atoms indicated in the compound/molecule.

In  $\text{KMnO}_4$                       K:                      Mn:

In  $\text{CaSO}_4$                       S:                      O:

In  $\text{NaOCl}$                       O:                      Cl:

In  $\text{F}_2$                               F:

$\text{SO}_2$                               S:                      O:

**Can you work with concentrations?**

1. a) What is the concentration of a copper (II) chloride solution where 5.00 g of copper(II) chloride solid is placed in a volumetric flask and dissolved in deionized water up to the 250 mL mark?

b) What is the concentration of copper(II) ions in the solution above?

c) What is the concentration of chloride ions in the solution above?

2. A student is given a stock solution of sodium acetate that is 8.000 M.

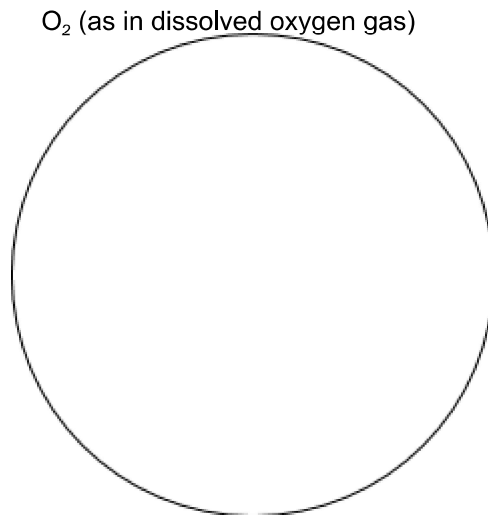
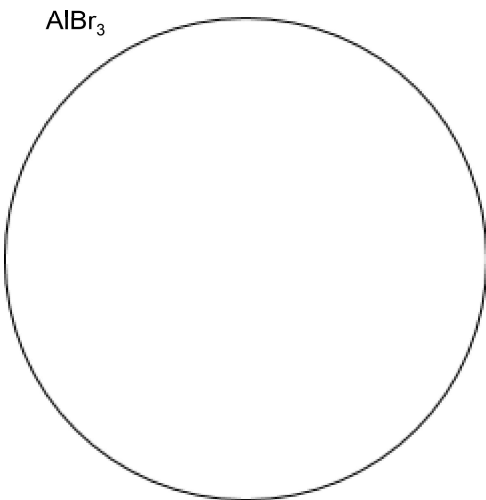
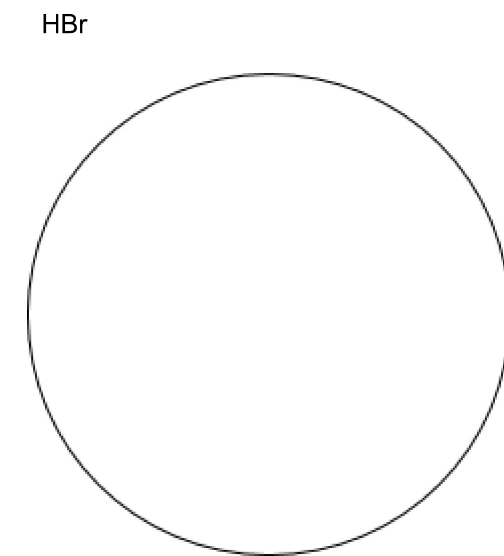
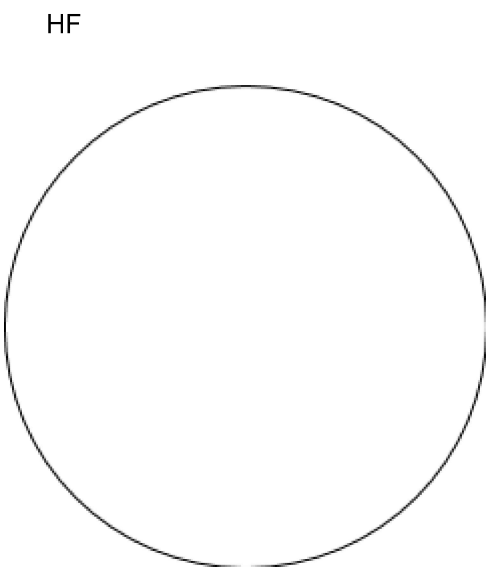
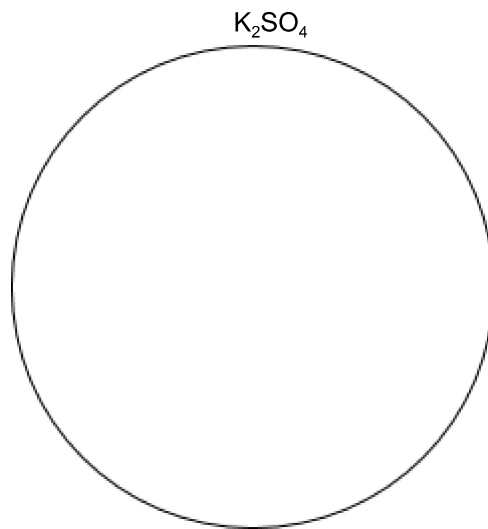
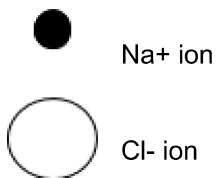
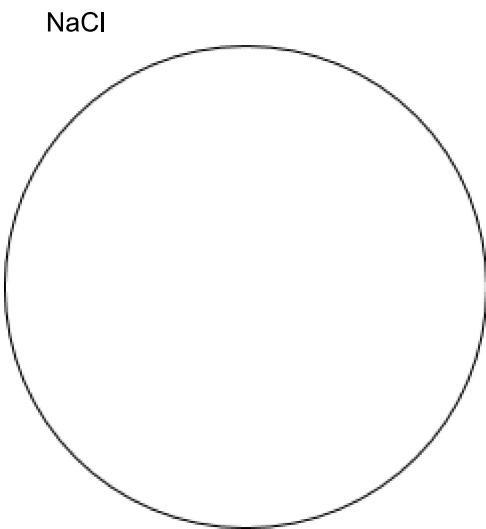
a) If 25.00 mL of the stock solution was placed in a 100 mL volumetric flask and filled to the line with distilled water, what would be the concentration of the new solution?

b) How many milliliters of the stock solution would be needed if the student wanted to make 1.00 L of 0.250 M sodium acetate?

c) Describe the procedure, including the specific glassware or tools that would be needed for the student to make the solution described in part b).

**Can you draw particulate drawings of solutions?** (Hint: Consider the effect of strong and weak electrolytes.)

Consider the relative size and number of ions. Show at least four formula units of the substance in the bubble. You do not need to include water molecules. Include a legend for each shaped used. The first one is done for you as an example.



# Names and Electrical Charges of Common Inorganic Ions

(note: students will always have a periodic table for all quizzes and tests, including ion quizzes)

## CATIONS

### Cations (1+ charge)

H <sup>1+</sup>	hydrogen ion
Li <sup>1+</sup>	lithium ion
Na <sup>1+</sup>	sodium ion
K <sup>1+</sup>	potassium ion
Rb <sup>1+</sup>	rubidium ion
Cs <sup>1+</sup>	cesium ion
Fr <sup>1+</sup>	francium ion
Ag <sup>1+</sup>	silver ion
NH <sub>4</sub> <sup>1+</sup>	ammonium ion
H <sub>3</sub> O <sup>1+</sup>	hydronium ion

### Cations (2+ charge)

Be <sup>2+</sup>	beryllium ion
Mg <sup>2+</sup>	magnesium ion
Ca <sup>2+</sup>	calcium ion
Sr <sup>2+</sup>	strontium ion
Ba <sup>2+</sup>	barium ion
Ra <sup>2+</sup>	radium ion
Zn <sup>2+</sup>	zinc ion
Cd <sup>2+</sup>	cadmium

### Cations (3+ charge)

Al <sup>3+</sup>	aluminum ion
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### Transition Metal Ions (cations with variable oxidation numbers)

Cu <sup>1+</sup>	copper(I) or cuprous ion	Cu <sup>2+</sup>	copper(II) or cupric ion
Fe <sup>2+</sup>	iron(II) or ferrous ion	Fe <sup>3+</sup>	iron(III) or ferric ion
*Hg <sub>2</sub> <sup>+2</sup>	mercury(I) or mercurous ion	Hg <sup>2+</sup>	mercury(II) or mercuric ion
Sn <sup>2+</sup>	tin(II) or stannous ion	Sn <sup>4+</sup>	tin(IV) or stannic ion
Cr <sup>2+</sup>	chromium(II) ion	Cr <sup>3+</sup>	chromium(III) ion
Mn <sup>2+</sup>	manganese(II) ion	Mn <sup>3+</sup>	manganese(III) ion
Co <sup>2+</sup>	cobalt(II) ion	Co <sup>3+</sup>	cobalt(III) ion
Ni <sup>2+</sup>	nickel(II) ion		
Tl <sup>1+</sup>	thallium(I) ion	Tl <sup>3+</sup>	thallium(III) ion

\*Note: mercury(I) ion exists as a diatomic ion and is written as Hg<sub>2</sub><sup>+2</sup> and not Hg<sup>1+</sup>.

## ANIONS

### Anions (1- charge)

$F^{-1}$	fluoride ion
$Cl^{-1}$	chloride ion
$Br^{-1}$	bromide ion
$I^{-1}$	iodide ion
$H^{-1}$	hydride ion
$CN^{-1}$	cyanide ion
$OH^{-1}$	hydroxide ion
** $XO^{-1}$	hypohalite ion
** $XO_2^{-1}$	halite ion
** $XO_3^{-1}$	halate ion
** $XO_4^{-1}$	perhalate ion
$MnO_4^{-1}$	permanganate ion
$C_2H_3O_2^{-1}$	acetate ion (also seen as $CH_3COO^{-1}$ )
$H_2PO_4^{-1}$	dihydrogen phosphate ion
$NO_2^{-1}$	nitrite ion
$NO_3^{-1}$	nitrate ion
$HCO_3^{-1}$	hydrogen carbonate ion (bicarbonate ion)
$HSO_4^{-1}$	hydrogen sulfate ion (bisulfate ion)
$HSO_3^{-1}$	hydrogen sulfite ion (bisulfite ion)

### Anions (2- charge)

$O^{2-}$	oxide ion
$S^{2-}$	sulfide ion
$CrO_4^{2-}$	chromate ion
$Cr_2O_7^{2-}$	dichromate ion
$CO_3^{2-}$	carbonate ion
$SO_3^{2-}$	sulfite ion
$SO_4^{2-}$	sulfate ion
$S_2O_3^{2-}$	thiosulfate ion
$HPO_4^{2-}$	monohydrogen phosphate ion
$O_2^{2-}$	peroxide ion ("O" has -1 ox. state here)

### Anions (3- charge)

$PO_4^{3-}$	phosphate ion	$P^{3-}$	phosphide ion	$N^{3-}$	nitride ion
$PO_3^{3-}$	phosphite ion				

\*\*Note: X = halogen other than F (Cl, Br, I).

Examples:  $ClO^{-1}$  = hypochlorite ion     $BrO_2^{-1}$  = bromite ion     $IO_3^{-1}$  = iodate ion  
 $IO_4^{-1}$  = periodate ion