2024-2025 Summer Work for AP Chemistry Contact: jamesc@wcs.edu christopherm1@wcs.edu david.moriarty@wcs.edu

Future AP Chemistry Students Schoology Group Access Code:

PHS:~~XSJP-FVR6-93BGK~~ IHS:~~W6MR-75MC-96F92~~ SHS:4827-BZD9-8ZHHD

You are expected to be familiar with certain concepts of chemistry before the year begins. This assignment is formative and will not be counted for a grade. Due to the magnitude of content covered in class and the limited timeframe to complete it, we will complete the first unit, Unit 0: Intro to Chemistry, at an accelerated pace. The goal of the assignment below is to allow your teacher to know what topics to emphasize during instructional time, and for you to know what questions to ask. We will discuss this assignment and the corresponding unit during the first days of class. You are expected to attempt all the problems on your own as this is the only way you can get an understanding of your level of knowledge, and so your teacher can judge how well the class is doing based on student's performance on this summer assignment. **The assignment will not be graded but is due for feedback purposes on the fourth day of school (Thursday, August 8th).** You are expected to know the list of polyatomic ions and strong acids below with a **quiz on the sixth day of school (Monday, August 12th).**

The first test will be Tuesday, August 13th. The test will cover material completed in this summer assignment.

Join the SHS Schoology group above to obtain help with the problems in this packet.

Prerequisite Objectives: The following are a list of objectives you are expected to know and will not be taught but can be necessary to solve problems or explain fundamental concepts in chemistry.

1. I can convert between SI units (L → mL)
2. I can, given the formula of a compound, calculate any compounds molar mass.
3. I can apply the rules of significant figures to round answers to appropriate number of digits.
4. I can apply the formula for percent error to a set of data
5. I can find the percent composition of a compound
6. I can balance a chemical equation
7. I can determine the number of protons, neutrons, and electrons in an isotope
8. I can determine the charge of an ion from its location on the periodic table
9. I can use the periodic table to determine if a compound is ionic or covalent
10. I can recall the common diatomic molecules and know when to apply them (Br, I, N, Cl, H, O, F all should be written as H_2, O_2, etc.)
11. I can recall the formula and name of a polyatomic ion from a list (see below) of common polyatomic ions
12. I can recall the names and formulas of the six strong acids (see below)
13. I can use Avogadro's number, 6.02×10^{23}, to convert between particles and moles
14. I can use dimensional analysis, aka conversion factors, to convert between units (especially grams → mol)

Unit 0: Chemistry Fundamentals Objectives (Subject to Change)

1. I can write the formula or name ionic, hydrated ionic compounds, and covalent compounds.
2. I can write the formula or name binary and oxyacids.
3. I can determine the atomic mass of an element given a list of isotopes and their abundances or mass spectrometer data.
4. I can calculate the empirical formula of a compound given percent by mass, or given masses of all elements in the compound
5. I can calculate the percent yield of a reaction given experimental data
6. I can determine the molecular formula of a compound from its empirical formula and its molar mass
7. I can evaluate hydrate analysis data to determine the formula of a hydrate.
8. I can evaluate combustion analysis data to determine the formula of a hydrocarbon.
9. I can use stoichiometric calculations to determine the following: amount of product produced, the limiting and excess reactant, amount of excess reactant remaining

Polyatomic Ion List

Name	Formula	Name	Formula
Ammonium	NH_4^+	Iodate	IO_3^-
Hydromium	H_3O^+	Periodate	IO_4^-
Bromate	BrO_3^-	Permanganate	MnO_4^-
Carbonate	CO_3^{2-}	Nitrate	NO_3^-
Hypochlorite	ClO^- or OCl^-	Nitrite	NO_2^-
Chlorite	ClO_2^-	Oxalate	$C_2O_4^{2-}$
Chlorate	ClO_3^-	Peroxide	O_2^{2-}
Perchlorate	ClO_4^-	Phosphate	PO_4^{3-}
Chromate	CrO_4^{2-}	Phosphite	PO_3^{3-}
Cyanide	CN^-	Sulfate	SO_4^{2-}
Acetate	$C_2H_3O_2^-$ or CH_3COO^-	Sulfite	SO_3^{2-}
Hydrogen Sulfate or Bisulfate	HSO_4^-	Hydroxide	OH^-
Hydrogen Carbonate	HCO_3^-	Dichromate	$Cr_2O_7^{2-}$

Strong Acids

Name	Formula	Name	Formula
Hydrobromic acid	HBr	Perchloric acid	$HClO_4$
Hydroiodic acid	HI	Nitric acid	HNO_3
Hydrochloric acid	HCl	Sulfuric acid	H_2SO_4

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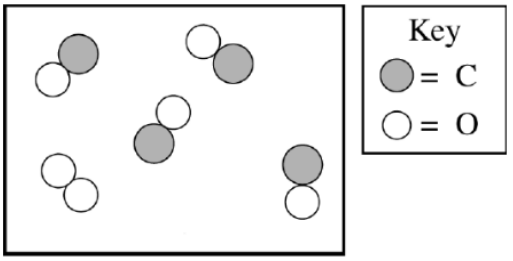
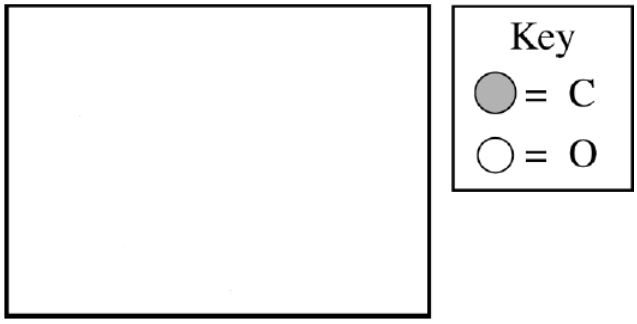
Problems

1. A mixture of CO(g) and O_2(g) are combined in a container as shown at right and will react to form CO_2(g).



a) Write the balanced chemical equation described above.

b) In the box at right, draw the particle level representation that accurately depicts the container after the reaction has gone to completion.



c) Calculate the percent by mass of carbon in CO. Record your answer to three significant figures.

Propane (C_3H_8) is a common fuel used in cooking and heating. When propane is combusted in a low oxygen environment, incomplete combustion will occur, and the products will be carbon monoxide gas and water.

d) Write the balanced chemical equation described above.

e) What mass of oxygen reacts during the incomplete combustion of 18.0 g of propane?

f) The combustion products are analyzed and the percent carbon in the oxide of carbon is found to be 27.3%. Determine the empirical formula of this compound.

2. Solid ammonium carbonate decomposes upon heating, producing ammonia (NH_3) gas, water vapor, and carbon dioxide gas.

a) Write a balanced chemical equation for this reaction.

b) How many grams of ammonia will be produced after 17.05 grams of ammonium carbonate are completely decomposed.

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c) A 0.050 mol sample of ammonium carbonate is placed in a sealed rigid container pictured to the right. The ammonium carbonate is heated until the reaction described in a) is completed. Does the mass of the container increase, decrease, or remain the same? Justify your answer.

3. A student performs an experiment to produce a zinc salt of unknown composition, $Zn_xCl_y(aq)$, and determine its empirical formula. The student places a sample of $Zn(s)$ in a beaker containing $HCl(aq)$, as represented by the following equation.

$$x\,Zn(s) + y\,HCl(aq) \rightarrow Zn_xCl_y(aq) + \frac{y}{2}H_2(g)$$

The reaction produces hydrogen gas and $Zn_xCl_y(aq)$ as seen in Figure 1. After the reaction is complete (Figure 2), the $Zn_xCl_y(aq)$ is then heated to remove the water leaving $Zn_xCl_y(s)$. The data for the experiment are given in the following table.

Mass of empty beaker	68.543 g
Mass of beaker and $Zn(s)$	69.018 g
Mass of Beaker and Zn_xCl_y after 1st heating	70.513 g
Mass of Beaker and Zn_xCl_y after 2nd heating	70.130 g
Mass of Beaker and Zn_xCl_y after 3rd heating	69.616 g

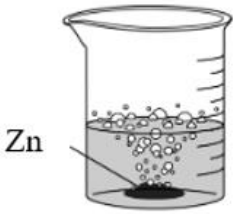

Figure 1


Figure 2

a) Calculate the mass of $Zn(s)$ that reacted rounding your answer to the correct number of significant figures.

b) Based on figures 1 and 2, determine the limiting reactant in this reaction. Justify your answer.

c) Calculate the number of moles of Zn in the sample of Zn_xCl_y remaining in the beaker.

d) The student determines that 0.0145 mol of HCl were used in the experiment. Use the data to determine the
i) empirical formula of the $Zn_xCl_y(s)$.

ii) the theoretical yield, in grams, of the $Zn_xCl_y(s)$.

e) Use the data in the table and your answer to part d part ii) to calculate the percent yield.

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f) The student hypothesizes that the percent yield is too high because too much hydrochloric acid was added to the beaker and zinc. Do you agree or disagree with the students' claim? Explain your reasoning.

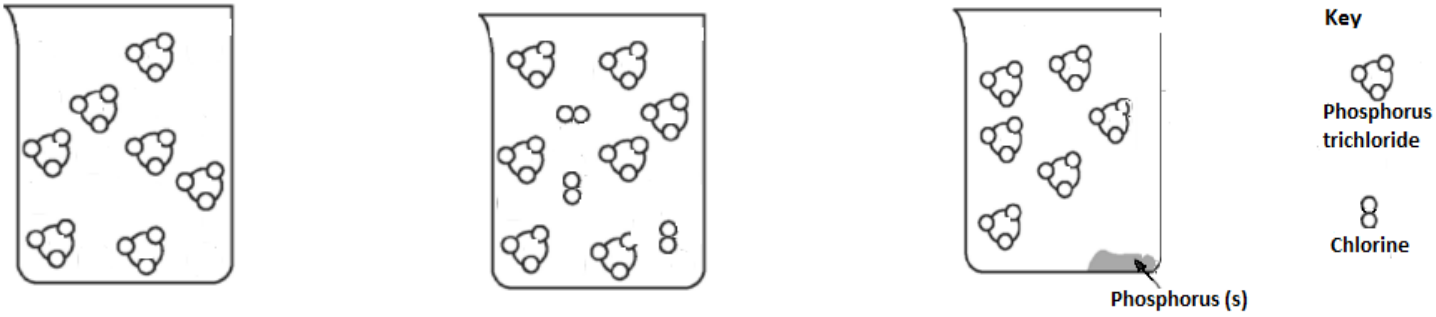
4. Solid phosphorus exists as P_4, a covalent compound. The solid phosphorus will react with chlorine gas to produce phosphorus trichloride gas.

a) Write the balanced chemical equation for the reaction described above, be sure to include state symbols.

b) If 3.79 g of phosphorus reacts with 4.19 g of chlorine, what is the limiting reactant?

c) Determine the mass of the excess reactant remaining after the reaction has gone to completion.

d) The following representations of the reaction mixture after the reaction are provided below.



i) Circle the diagram above that best represents the reaction mixture after the reaction.

ii) Explain your reasoning.

5. A hydrocarbon, C_xH_y where x and y are unknown, is combusted. After the combustion reaction is complete 19.8 g of CO_2 gas and 6.08 g of liquid water are collected.

a) Determine the moles of carbon in the hydrocarbon.

b) Determine the moles of hydrogen in the hydrocarbon.

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c) Determine the empirical formula.

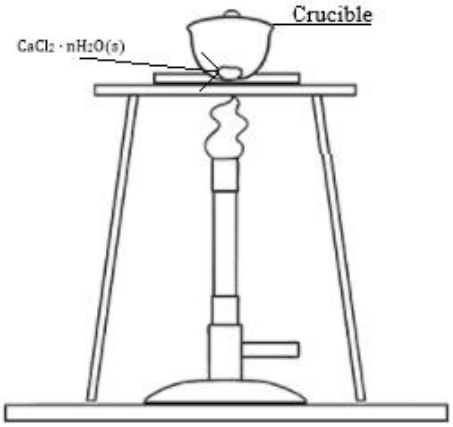
d) The molar mass of the hydrocarbon is found to be 54 g/mol. What is the molecular formula for the compound?

6. Use the data from this experiment to answer the following questions regarding the hydrate $CaCl_2 \cdot nH_2O$

Hydrated calcium chloride is heated in a crucible. The following reaction occurs during heating.

$$CaCl_2 \cdot nH_2O(s) \rightarrow CaCl_2(s) + nH_2O(g)$$

Mass of Empty Crucible	18.435g
Mass of Crucible and Sample	23.951g
Mass of sample and crucible after 1st heating	22.780g
Mass of sample and crucible after 2nd heating	22.601g
Mass of sample and crucible after 3rd heating	22.601g



a) Explain how you could conclude the hydrate had been heated a sufficient number of times.

b) Calculate the number of moles of water lost during heating

c) Determine the mass of anhydrous calcium chloride remaining in the crucible after heating.

d) Determine the formula and name of the original hydrated compound.

e) If some solid spatters out of the crucible during the heating process, what effect would this have on your calculated moles of water lost? Explain.

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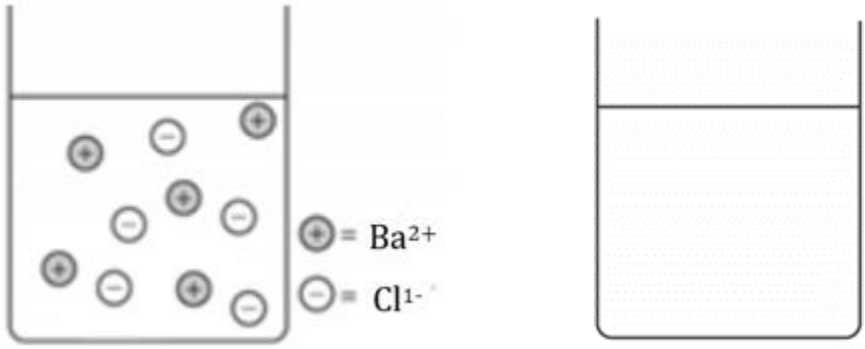
7. The value of x in $Fe(NH_4)_2(SO_4)_2 \bullet xH_2O$ can be found by determining amount of solid $BaSO_4$ produced.

$$Fe(NH_4)_2(SO_4)_2\ (aq) + 2BaCl_2\ (aq) \rightarrow 2BaSO_4\ (s) + FeCl_2\ (aq) + 2NH_4Cl\ (aq)$$

(a) A student draws a particle representation of the $BaCl_2$ before the reaction. Describe one error with the drawing and use the blank beaker to the right to draw a correct representation of the particles.



The following data table was collected to determine the mass of the solid $BaSO_4$ collected.

Mass of $Fe(NH_4)_2(SO_4)_2 \bullet xH_2O$	1.959 g
Mass of thoroughly dried filter paper	1.462 g
Mass of filter paper + solid	3.792 g

(b) Calculate the mass of solid $BaSO_4$ collected in grams.

(c) Using your answer from part (b) determine the amount, in moles, $BaSO_4$ collected

(d) Determine the mass of $Fe(NH_4)_2(SO_4)_2$ which reacted.

(e) Calculate the mass of water in $Fe(NH_4)_2(SO_4)_2 \bullet xH_2O$.

(f) Determine the formula for the hydrated $Fe(NH_4)_2(SO_4)_2 \bullet xH_2O$. Justify your answer with calculations.