AP Chemistry – Summer Assignment

This assignment is due on the first day of school. You must show all your work in all problems.

AP Chemistry is a science course that will demand an exceptional knowledge of algebra-based mathematics, trigonometry, and geometry. In addition, we will be working constantly with elements and compounds, and you must be able to write names and formulas for a wide variety of substances comfortably. There are several purposes to this summer assignment. First, it reviews significant topics you covered in your first chemistry course. These are topics I expect you to master in the first couple weeks of school, and starting over the summer prepares you for that goal. Second, you must familiarize yourself with the fundamental knowledge used daily in class.

Google Classroom:
Join the summer assignment Google Classroom using the code *lwp3say*. I will post some reference videos and course materials for you to review and recommended due dates as guidelines to help divide the assignment. You can also send me questions, and I will reply when I am able.

Things to know about AP Chemistry:

1. Ignore your grade. You will do well if you focus on the content, do your work on time, and ask questions as often as needed.
2. Conceptual knowledge is critical for success. We will cover concept after concept, and to truly do well in the class, you need to be ready to apply that knowledge in different ways, as the question being asked will always be different from what you expect.
    a. This means you need to be involved in the course and study regularly. If you do so, you can build upon your knowledge and more deeply understand the concepts. Throughout the course, you will continue to use topics covered at the beginning of the year.
3. Outside resources are your friend. Assigned readings and videos are to help, and you need to do them. Take notes while reading or watching videos to review later. Study the diagrams, graphs, and equations as well.
    a. Taking effective notes is the key to success in college. Every course and every teacher are different, so find a method that works best for you, but take notes!
    b. Find your own resources! The internet is full of information, and you can find dozens of people explaining the same topic. If you find something beneficial, send it to me, and I can share it with the rest of the class.
4. Do not spend an exceptionally long time on one problem. The AP test and the class exams are timed. If you get stuck on a problem, skip it. Often, future problems provide hints or reminders on how to solve your problem.
5. Work together as a class. Help each other out, bounce ideas off each other, and problem-solve together. Find a study group and share quizlets and videos. Use class time effectively. Socializing with friends may be fun, but you will have more work later.
6. Do not cram. This is not a memory-based course. You will need to be able to combine multiple topics to solve one problem. Keeping up with the material and constantly using it helps keep everything fresh and easy to recall. Learn how to solve a problem, not just memorize the steps from one example.

This course differs from the chemistry course you have already taken in several ways.

1. You must be able to find charges and write formulas of common simple ions and various polyatomic ions on demand. Unlike regular chemistry, AP chemistry students are expected to memorize the formulas of many more polyatomic ions. You are also expected to know the names and formulas of common acids and bases. Proficiency in recognizing transition metals and proper use of Roman numerals are also expected.

2. You must be proficient in using prefixes in the names of binary covalent compounds. You also need to memorize the formulas of the seven diatomic elements for use in writing chemical equations and be able to write formulas of some common covalent compounds.

3. The AP periodic table is different from the one used in regular chemistry. It has no element names (only symbols, atomic numbers, and atomic masses), no period number information, and no family names. You are expected to know element names, symbols, and their relative positions in the table to explain trends.

4. You are expected to be able to differentiate between different types of chemical reactions, predict expected products, and be able to balance chemical equations.

Memorization Checklist:
While the course focuses on skills and applications, some things must be memorized. Having the following memorized before the start of class will make the entire year smoother and save precious time on exams. These items are described in the following pages.

- ☐ Main group and common transition element symbols, especially those that do not match the element name
- ☐ Liquid and gaseous elements
- ☐ Diatomic and polyatomic elements
- ☐ Polyatomic ions
- ☐ Main group ion charges, including silver and zinc
- ☐ Molecular naming prefixes
- ☐ Metric prefixes
- ☐ Units of measurements and symbols

You do NOT need to memorize the following:

- The periodic table (atomic numbers, molar mass, etc.), but you should be able to find any element within seconds
- Transition and p-block metal ions (except silver and zinc)
- Solubility rules
- Activity series

Common Elements

Since the AP periodic table does not include names, only symbols of elements, you should have common element names memorized. Pay special attention to similar symbols/names and symbols that do not match the name. Phases are included for those elements that are not solid at room temperature.

Al	Aluminum
Ar	Argon (g)
As	Arsenic
B	Boron
Ba	Barium
Be	Beryllium
Bi	Bismuth
Br	Bromine* (l)
C	Carbon
Cd	Cadmium
Ca	Calcium
Cl	Chlorine* (g)
Co	Cobalt
Cr	Chromium
Cs	Cesium
F	Fluorine* (g)
Fr	Francium
Ga	Gallium
Ge	Germanium
H	Hydrogen* (g)
He	Helium (g)
I	Iodine*
In	Indium
Ir	Iridium
Kr	Krypton (g)
Li	Lithium
Mg	Magnesium
Mn	Manganese
N	Nitrogen* (g)
Ne	Neon (g)
Ni	Nickel
O	Oxygen* (g)
Os	Osmium
P	Phosphorus**
Pd	Palladium
Pt	Platinum
Pu	Plutonium
Ra	Radium
Rb	Rubidium
Rn	Radon (g)
S	Sulfur**
Se	Selenium
Si	Silicon
Sr	Strontium
Th	Thorium
Ti	Titanium
U	Uranium
Xe	Xenon (g)
Zn	Zinc

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Ag	Silver
Au	Gold
Cu	Copper
Fe	Iron
Hg	Mercury (l)
K	Potassium
Na	Sodium
Pb	Lead
Sb	Antimony
Sn	Tin
W	Tungsten

(l) = Liquid
(g) = Gas
* = Diatomic
** = Polyatomic elements (P_4, S_8)

Monatomic and Polyatomic Ions

You will need to be able to write formulas and names for ionic compounds. I suggest making flashcards to study and memorize these.

COMMON POLYATOMIC IONS					
-1 charge		**-2 charge**		**-3 charge**	
Formula	Name	Formula	Name	Formula	Name
$C_2H_3O_2^-$	Acetate*	SO_3^{2-}	Sulfite	PO_4^{3-}	Phosphate
HCO_3^-	Hydrogen carbonate (bicarbonate)	SO_4^{2-}	Sulfate	PO_3^{3-}	Phosphite
		O_2^{2-}	Peroxide		
NO_2^-	Nitrite	CO_3^{2-}	Carbonate		
NO_3^-	Nitrate			**+1 charge**	
CN^-	Cyanide			Formula	Name
OH^-	Hydroxide			NH_4^+	Ammonium
MnO_4^-	Permanganate			H_3O^+	Hydronium**
ClO^-	Hypochlorite				
ClO_2^-	Chlorite			**The Hydronium ion tends not to be used in compounds	
ClO_3^-	Chlorate				
ClO_4^-	Perchlorate	*The formula for the acetate ion can also be written as $CH_3CO_2^-$ or as CH_3COO^-			

FORMULAS AND NAMES OF COMMON METAL IONS WITH MORE THAN ONE IONIC CHARGE	
Formula	Name
Cu^{1+}	Copper (I)
Cu^{2+}	Copper (II)
Fe^{2+}	Iron (II)
Fe^{3+}	Iron (III)
Hg_2^{2+}	Mercury (I)*
Hg^{2+}	Mercury (II)
Pb^{2+}	Lead (II)
Pb^{4+}	Lead (IV)
Sn^{2+}	Tin (II)
Sn^{4+}	Tin (IV)
Cr^{2+}	Chromium (II)
Cr^{3+}	Chromium (III)
Mn^{2+}	Manganese (II)
Mn^{3+}	Manganese (III)
Co^{2+}	Cobalt (II)
Co^{3+}	Cobalt (III)
Ag^+	Silver
Zn^{2+}	Zinc

Tips for Memorizing Ions

Monatomic Ions: From the periodic table

Cations:
These ions are broken into two groups:

1. Main group metals:
    - Charges determined from location on the periodic table
    - Ions keep the element name, just add "ion" (sodium ion, calcium ion)

    a. All group 1 elements lose 1 electron to form an ion with a 1+ charge
    b. All group 2 elements lose 2 electrons to form an ion with a 2+ charge
    c. All group 13 metals lose 3 electrons to form an ion with a 3+ charge

2. Transition (and other) metals:
    - These elements cannot be predicted based on a pattern in the table. Many of these also form more than one type of ion, so their charge is denoted by a roman numeral in parentheses immediately after the name of the element (e.g. Iron (III) = Fe^{3+})

    a. Silver and zinc have only one possible charge, so do not use Roman numerals since there is no discrepancy. Silver is always $Ag^{+,}$ and zinc is always Zn^{2+}.
    b. Mercury (I) is a diatomic ion that always appears as Hg_2^{2+}, while Mercury (II) remains as Hg^{2+}.

Anions:
- These ions belong to non-metals
- Ions get the "-ide" suffix on the element name (chlor*ide* ion, ox*ide* ion, phosph*ide* ion)

a. All group 17 elements (halogens) gain 1 electron to form a 1- charge
b. All group 16 nonmetals gain 2 electrons to form a 2- charge
c. All group 15 nonmetals gain 3 electrons to form an ion with a 3- charge

Polyatomic Ions: Tips to Memorize

1. Memorize the "-ate" ions (sulf*ate*, nitr*ate*, etc.)
2. The suffix "-ite" means the ion has the same charge but one less oxygen (sulf*ate* = SO_4^{2-}, sulf*ite* = SO_3^{2-})
3. The prefix "hypo-" means "under" or "too little. "Hypo-" is added to "-ite" ions, indicating one additional less oxygen (chlor*ite* = ClO_2^-, *hypo*chlorite = ClO^-).
4. The prefix "per-" comes from "hyper" meaning "above" or "too much." "Per-" is added to "-ate" ions indicating one additional oxygen (chlor*ate* = ClO_3^-, *per*chlorate = ClO_4^-).
5. The prefix "bi-" usually means "two" and in some antiquated way, it applies here, but that is left over from an old naming system. Instead, think of "bi-" meaning "add hydrogen." At the same time, the charge is reduced by one since the added hydrogen has a 1+ charge. (carbonate = CO_3^{2-}, *bi*carbonate = HCO_3^-)

Naming Molecules and Compounds

There are two ways to name compounds based on what type of compound they are.

1. Ionic Compounds: Combine the name of cation and anion. The cation is always listed first.
    - Main group metals use just their element name
    - Transition metals use Roman numerals to indicate charge (Iron (III) oxide)
    - Hydrogen and ammonium are non-metal cations (H^+, NH_4^+)
    - Monatomic anions use the "-ide" suffix and polyatomic anions use the name listed

2. Covalent compounds: Covalent bonding with <u>non-metals</u> only
    - Prefixes used to specify subscript
    - Elements usually listed by increasing electronegativity
    - The first element keeps the element name, and the second element uses the "ide-" suffix
    - <u>NO</u> "mono-" prefix on the first element, only second

Mono-	1
Di-	2
Tri-	3
Tetra-	4
Penta-	5
Hexa-	6
Hepta-	7
Octa-	8
Nona-	9
Deca-	10

Solubility and Activity Series

Knowledge of the solubility rules and activity series is necessary to predict whether a reaction will occur during double and single replacement reactions. These do not need to be memorized.

Ion	**Solubility**
Group 1 (including H)	All soluble.
NH_4^+	All soluble.
NO_3^-, ClO_3^-, ClO_4^-, $C_2H_3O_2^-$	All soluble.
Br^-, I^-, Cl^-	Soluble except Ag^+, Hg^{2+}, and Pb^{2+}.
SO_4^{-2}	Soluble except Ca^{2+}, Ba^{2+}, Sr^{2+}, Hg^{2+}, Pb^{2+}, and Ag^+.
CO_3^{-2}, SO_3^-, CrO_4^{2-}, PO_4^{3-}	Insoluble except for alkali metals (Group 1) and NH_4^+.
PO_4^{-3}	Insoluble except for alkali metals (Group 1) and NH_4^+.
OH^-, S^{2-}	Insoluble except for alkali metals (Group 1), NH_4^+, Ca^{2+}, Ba^{2+}, and Sr^{2+}.

Activity Series

Most Reactive

Lithium	Li	Fluorine	F
Potassium	K	Chlorine	Cl
Barium	Ba	Bromine	Br
Strontium	Sr	Iodine	I
Calcium	Ca		
Sodium	Na		
Magnesium	Mg		
Aluminum	Al		
Manganese	Mn		
Zinc	Zn		
Iron	Fe		
Cobalt	Co		
Nickel	Ni		
Tin	Sn		
Lead	Pb		
Hydrogen	H		
Copper	Cu		
Silver	Ag		
Mercury	Hg		
Gold	Au		

Least Reactive

Significant Figures

Always use the correct number of significant figures in your answers, whether in scientific or regular notation.

Significant Figures Rules:

Bold&underline = significant figure
~~Strikethrough~~ = not significant

1. Non-zero digits are always significant Eg. **322.7**
2. Zeroes between non-zero numbers are significant. Eg. 3**0**2.**0**7
3. Zeroes at the beginning of a number are never significant. Eg. ~~0.00~~32
4. Zeroes at the end of a number are significant IF there is a decimal point.
   Eg. 32**0**. is significant, but 32~~0~~ is not. Also, 0.0032**00** or 32**0**.**0** are significant.

Addition/Subtraction Rule:
The answer is rounded to the value place of the number whose last sig fig is in the highest value place.

35.4**8** + 2.**4** = 37.88, which would round to 37.**9**
The last digit of the 1st number (8) is in the 100th place, while the last digit of the 2nd number (4) is in the 10th place. Since 10th place is the highest place value, we rounded to the 10th place.

4,3**3**0 – 210.**5** = 4,119.5, which would round to 4,1**2**0
The last digit of the 1st number (3) is in the 10's place while the last digit of the 2nd number (5) is in the 10th place. Since the 10's place is the higher place value, we round to the 10's place.

Multiplication/Division Rule:
The answer is rounded to have the same number of significant figures as the value with the fewest significant figures.

20.82 * 0.0**42** = 0.87444, which would round to 0.**87**
The first number has four total sig figs, while the second number only has two total sig figs. Since the least number of sig figs is two, we round to the first two significant digits.

7,890. / **8.6486** = 912.28638, which would round to **912.3**
The first number has four total sig figs (since there is a decimal), while the 2nd number has five total sig figs. Since the least number of sig figs is four, we round to the first four significant digits.

Metric Measurements, Units, and Conversions

You should be comfortable using and converting the following metric prefixes. Proper symbols for units, variables, prefixes, etc., are essential, as the wrong symbol could change the entire meaning. These symbols are CaSe SeNsItIvE. Capital and lowercase letters mean different things.

Complete the following table:

Metric Prefix	Symbol	Power
Tera-		
Giga-		
Mega-		
Kilo-	k	10^3
Base Unit	-----	10^0
Centi-		
Milli-		
Micro-		
Nano-		
Pico-	p	10^{-12}

Measurement	Symbol	Unit [Unit symbol]
Length	L	meter [m]
Volume	*V*	liter [L] cubic centimeter [cm^3]
Pressure	*P*	atmosphere [atm] millimeters of mercury [mm Hg] Torr [torr]
Temperature	*T*	degrees Celsius [°C] Kelvin [K]
Mass	*m*	gram [g]
Amount	*n*	mole [mol]
Molar Mass	***M***	grams per mole [g/mol]
Time	*t*	second [s]
Energy	*E*	joule [J]
Heat	*q*	joule [J]
Electric Current	*I*	amperes [A]
Charge	*q*	coulomb [C]

Significant Figures, Metric Conversions, and Scientific Notation

Round each of the following numbers to four significant figures. Write the answer in decimal form AND scientific notation.

1. 300.235800
2. 456,500
3. 5,799.823
4. 0.00658022

Complete the following calculations. Round all answers to the correct number of sig figs.

5. 1.24056 + 75.80
6. 37.05 – 75
7. 890,000 * 112.3
8. 78,132 / 2.50

Convert the following units. Solve each problem using dimensional analysis. Show all your work. Every number must have a unit, and the answer must be expressed with proper significant figures.

9. Convert 4,200 mg to kg

$$4,200mg \times \frac{10^{-3}g}{1mg} \times \frac{1kg}{10^{3}g} = 0.0042kg$$

10. 50.0 m to mm
11. 25 cL to kL
12. 0.00332 Mg to kg
13. 457.3 nm to m
14. 39.2 m/s to miles per hour

Review Problems

1. Fill in the following table. Assume each row represents a <u>neutral atom.</u>

   - Nuclear notation: $^{Mass\ Number}_{Atomic\ Number}Element^{Charge}$

     Ex: $^{138}_{92}U$

   - Mass number = protons + neutrons
   - Atomic number = protons
   - Electrons = Protons **For <u>neutral</u> atoms only.
     **Electrons do <u>NOT</u> equal atomic number. Electrons equal protons, and protons equal atomic number

Nuclear Notation	Protons	Neutrons	Electrons	Mass Number
$^{38}_{19}K$				
	25	30		
		64	48	
			56	137
	82			207

2. Describe the location of the following elements on the periodic table, and list two element examples.
   a. Alkaline earth metals
   b. Halogens
   c. Alkali metals
   d. Noble gasses
   e. Metalloids
   f. Rare earth metals
   g. Transition metals
   h. Non-metals

3. Write the formula of the common ion derived from each of the following atoms:
   a. Li
   b. S
   c. I
   d. N
   e. Al
   f. Cs
   g. Mg
   h. Xe
   i. Br

4. Give the name for each of the following ionic compounds:
   a. AlF_3
   b. $Fe(OH)_2$
   c. $Cu(NO_3)_2$
   d. $Ba(ClO_4)_2$
   e. Li_3PO_4
   f. Hg_2S
   g. $Ca(C_2H_3O_2)_2$
   h. $(NH_4)_2SO_4$

5. Write the chemical formula for each of the following compounds:
    a. Copper (I) oxide
    b. Potassium peroxide
    c. Aluminum hydroxide
    d. Ammonium sulfite
    e. Silver carbonate
    f. Mercury (I) bromide
    g. Iron (III) chlorite
    h. Lead (II) nitrate

6. Fill in the blanks in the following table:

Cation	**Anion**	**Formula**	**Name**
			Magnesium bicarbonate
		$SrCl_2$	
Fe^{3+}	NO_2^-		
			Manganese (II) chlorate
		$SnBr_4$	
Co^{2+}	PO_4^{3-}		
Hg_2^{2+}	I^-		
		$CuCO_3$	
			Lithium nitride
Al^{3+}	S^{2-}		

7. Give the name or chemical formula, as appropriate, for each of the following acids:
    a. $HBrO_3$
    b. HBr
    c. H_3PO_4
    d. Hypochlorous acid
    e. Chloric acid
    f. Sulfuric acid

8. Give the name or chemical formula, as appropriate, for each of the following molecular compounds:
    a. Dinitrogen tetroxide
    b. SF_6
    c. IF_3
    d. XeO_3
    e. Dihydrogen monosulfide
    f. Tetraphosphorous hexasulfide

9. Give the name or chemical formula, as appropriate, for the following. Types of compounds are mixed. Make sure you can determine how to name each when the type is not specified.
    a. Sodium hypochlorite
    b. $Cr_2(CO_3)_3$
    c. CO
    d. Iron (III) oxide
    e. Nitrogen Dioxide
    f. K_2CrO_4

10. Determine the molar mass of each of the following compounds.
    a. N_2O_3
    b. $Ca(NO_3)_2$
    c. Iron (II) carbonate
    d. Disilicon hexabromide

11. Balance the following equations:
    a. $NaH_2PO_4 \rightarrow NaPO_3 + H_2O$

    b. $Ca(OH)_2 + CO_2 \rightarrow Ca(HCO_3)_2$

    c. $SrBr_2 + (NH_4)_2CO_3 \rightarrow SrCO_3 + NH_4Br$

    d. $Mn_2O_3 + Al \rightarrow Al_2O_3 + Mn$

    e. $S + N_2O \rightarrow SO_2 + N_2$

    f. $N_2 + H_2 \rightarrow NH_3$

    g. $AgNO_3 + FeCl_3 \rightarrow Fe(NO_3)_3 + AgCl$

    h. $Fe_2(SO_4)_3 + KOH \rightarrow K_2SO_4 + Fe(OH)_3$

    i. $Al_2(SO_4)_3 + KOH \rightarrow Al(OH)_3 + K_2SO_4$

    j. $C_7H_{16} + O_2 \rightarrow CO_2 + H_2O$

For each of the following problems, show your work and circle your final answer with proper units. Remember that the first step to any stoichiometry problem is to <u>balance your equation</u>!

12. How many atoms are present in 3.14 g of copper?

13. How many moles of cobalt atoms are there in 6.50×10^9 cobalt atoms?

14. How many moles of oxygen are necessary to react completely with 4 mol of propane (C_3H_8)?
    $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

15. The fermentation of glucose, $C_6H_{12}O_6$, produces ethyl alcohol, C_2H_5OH, and carbon dioxide as shown here:
    $C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$

    a. How many moles of CO_2 are produced when 0.300 mol of $C_6H_{12}O_6$ fully reacts?

b. How many grams of glucose are needed to form 2.00 g of ethyl alcohol?

c. How many molecules of CO_2 form when 2.00 g of C_2H_5OH are produced?

16. Nitrogen gas and hydrogen gas react to produce ammonia (NH_3).
    a. Write a balanced chemical equation for the synthesis reaction.

    b. What volume of hydrogen gas is necessary to react completely with 5.0 L of nitrogen gas to produce ammonia at STP?

    c. What volume of ammonia is produced in this reaction?

17. The fizz produced when an Alka-Seltzer tablet is dissolved in water is due to the reaction between sodium bicarbonate and citric acid ($H_3C_6H_5O_7$)

$$3\ NaHCO_3 + H_3C_6H_5O_7 \rightarrow 3\ CO_2 + 3\ H_2O + Na_3C_6H_5O_7$$

    In an experiment, 2.50 g of sodium bicarbonate and 5.00 g of citric acid are allowed to react.
    a. Which reactant is the limiting reagent? You must show work to support your answer.

    b. How many grams of carbon dioxide are formed? What is the volume of this gas (in liters) at STP?

    c. What is the mass of the limiting reagent left when the reaction is complete?

    d. What is the mass of the excess reagent left after the reaction is complete?

18. Calculate the percent yield for the reaction below if 75.0 g of phosphorus reacts with excess chlorine gas and produces 111.0 g of phosphorus trichloride during the lab.

$P_4 + 6\ Cl_2 \rightarrow 4\ PCl_3$

19. Calculate the molarity of each of the following solutions:
    a. 29.0 g of ethanol (C_2H_5OH) in 545 mL of solution

    b. 15.4 g of sucrose ($C_{12}H_{22}O_{11}$) in 74.0 mL of solution

20. Using the activity series, predict the outcomes of the single replacement reactions below. Then, balance the equations. Use NR for no reaction.

    a. $Cu + HCl \rightarrow$

    b. $I_2 + NaBr \rightarrow$

    c. $Mg + CuSO_4 \rightarrow$

    d. $Cl_2 + KBr \rightarrow$

    e. $K + Mg(NO_3)_2 \rightarrow$

21. Characterize the following compounds as soluble or insoluble in water:

a. $Ca_3(PO_4)_2$	d. K_2S	g. $Hg(NO_3)_2$
b. $Mn(OH)_2$	e. $CaCO_3$	h. $HgSO_4$
c. $AgClO_3$	f. $ZnSO_4$	i. NH_4ClO_4