AP chemistry summer assignment 2025-2026

Dear AP Chemistry Student,

AP Chemistry is a very challenging but rewarding course and will require a significant amount of focus and dedication from you during the upcoming school year. You will perform a minimum of 16 laboratory activities which you will document in a lab journal that is updated over the course of the entire year. In addition, you will explore content that is equivalent to a first college semester chemistry course that dives deeper into the complexities of the discipline and various phenomena in our world and beyond. The course requires a level of precision and familiarity with certain core concepts from previous chemistry courses that we will not have time to explicitly cover in the course (given the amount of content and labs that we have to cover in time to prepare you for the AP exam in May) which is the purpose of this summer work.

Two of the crucial skills required to be successful in this course will be time management and pacing. It is very easy to become bogged down by the course load which can lead to feeling overwhelmed especially because for many of you this is only one of many AP courses on your roster this upcoming year. It is important, therefore, to learn to pace yourself and break up the work you have to accomplish into manageable chunks. This summer assignment is the first practice you may have applying those skills. ***IT IS NOT RECOMMENDED TO ATTEMP TO COMPLETE THE SUMMER ASSIGNMENT AT ONE TIME***. Chunk the assignment into 3 or 4 parts and work to complete each piece one at a time. The goal should be to complete the summer assignment in its entirety prior to or in time to begin the upcoming school year (after the Labor Day weekend).

I will check emails periodically throughout the summer (but by no means on a regular basis) and so you are encouraged to use other available resources, if need be/as necessary, to help you complete the assignment. There will be a period of review where I will go over specific topics or questions at the beginning of the school year prior to your assessment on this content.

There will be an assessment on the summer assignment content within the first 2 weeks of school. This will be the only major assessment that will deviate from the AP test format that I will be using throughout the rest of the course. More details will be provided in the first few days of school PRIOR to your assessment.

I look forward to seeing you in September and not only instructing you but also supporting and guiding you through this challenging experience. It is my promise to you that I will be there for you every step of the way and that you will grow as a student by the time you complete the course.

Sincerely,

Mr. Kuppler
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AP Chemistry/Chemistry Teacher
Winslow Township High School

Memorize: Element names and symbols of common elements & phases

Al	aluminum
Sb	antimony
Ar	argon
As	arsenic
Ba	barium
Be	beryllium
B	boron
Br	bromine
Cd	cadmium
Ca	calcium
C	carbon
Cs	cesium
Cl	chlorine
Cr	chromium
Co	cobalt
Cu	copper
F	fluorine
Fr	francium
Ge	germanium
Au	gold
He	helium
H	hydrogen
I	iodine
Fe	iron
Kr	krypton
Pb	lead
Li	lithium
Mg	magnesium
Mn	manganese
Hg	mercury
Ne	neon
Ni	nickel
N	nitrogen
O	oxygen
Pd	palladium
P	phosphorous
Pt	platinum
Pu	plutonium
K	potassium
Ra	radium
Rn	radon
Rb	rubidium
Se	selenium
Si	silicon
Ag	silver
Na	sodium
Sr	strontium
S	sulfur
Te	tellurium
Th	thorium
Sn	tin
W	tungsten
U	uranium
Xe	xenon
Zn	zinc

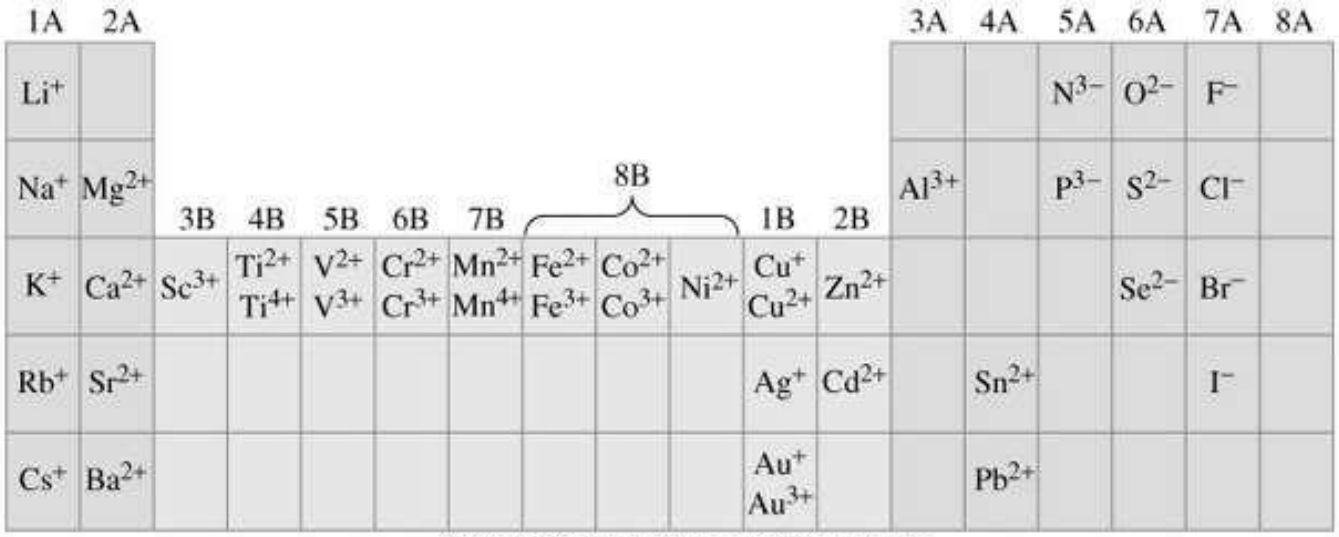
- All metals are solid except for mercury which is a liquid.

- All metalloids are solids.

- Nonmetals: carbon, phosphorus, sulfur, & selenium are solids; bromine is a liquid; and the rest are gases.

- Elements with Subscripts: Br_2, I_2, N_2, Cl_2, H_2, O_2, F_2, P_4, S_8

Common Monatomic Ions



Metals with Multiple Oxidation States

Element	Symbol	Oxidation #		Old System	New System
Iron	Fe	+2		Ferrous	Iron (II) (Green)
		+3		Ferric	Iron (III) (Yellow)
Copper	Cu	+1		Cuprous	Copper (I) (green)
		+2		Cupric	Copper (II) (blue)
Mercury	Hg_2	+2		Mercurous	Mercury (I)
	Hg	+2		Mercuric	Mercury (II)
Lead	Pb	+2		Plumbous	Lead (II)
		+4		Plumbic	Lead (IV)
Tin	Sn	+2		Stannous	Tin (II)
		+4		Stannic	Tin (IV)
Nickel	Ni	+2	(Green)		
		+3			

Polyatomic Ions

$H_2PO_4^-$	dihydrogen phosphate
$C_2H_3O_2^-$	acetate
HSO_3^-	hydrogen sulfite (bisulfite)
HSO_4^-	hydrogen sulfate (bisulfate)
HCO_3^-	hydrogen carbonate (bicarbonate)
NO_2^-	nitrite
NO_3^-	nitrate
CN^-	cyanide
SCN^-	thiocyanate
OH^-	hydroxide
MnO_4^-	permanganate (Purple)
ClO^-	hypochlorite
ClO_2^-	chlorite
ClO_3^-	chlorate
ClO_4^-	perchlorate
BrO^-	hypobromite
BrO_2^-	bromite
BrO_3^-	bromate
BrO_4^-	perbromate
IO^-	hypoiodite
IO_2^-	iodite
IO_3^-	iodate
IO_4^-	periodate
HPO_4^{2-}	hydrogen phosphate
$C_2O_4^{2-}$	oxalate
$S_2O_3^{2-}$	thiosulfate
SO_3^{2-}	sulfite
SO_4^{2-}	sulfate
CO_3^{2-}	carbonate
CrO_4^{2-}	chromate (Yellow)
$Cr_2O_7^{2-}$	dichromate (Orange)
SiO_3^{2-}	silicate
O_2^{2-}	peroxide
PO_3^{3-}	phosphite
PO_4^{3-}	phosphate
BO_3^{3-}	borate
NH_4^+	ammonium
H_3O^+	Hydronium

SUMMARY OF STRONG AND WEAK ELECTROLYTES

RULE	EXCEPTIONS
1. Most acids are weak electrolytes	Common strong acids (strong electrolytes) are HCl, HBr, HI, HNO_3, H_2SO_4, $HClO_3$, $HClO_4$ and HIO_4
2. Most bases are weak electrolytes	Strong base hydroxides (strong electrolytes) are those of Li, Na, K, Rb, Ca, Sr, and Ba.
3. Most soluble salts are strong electrolytes.	Important weakly ionized salts are $HgCl_2$, $Hg(CN)_2$, $CdCl_2$, $CdBr_2$, CdI_2, and $Pb(C_2H_3O_2)_2$.

Other Important Things to Remember

Gases That Form: (The gases are in Bold)

- ➔ H_2CO_3 ➔ **CO_2** + H_2O
- ➔ H_2SO_3 ➔ **SO_2** + H_2O
- ➔ 2 HNO_2 ➔ **NO** + **NO_2** + H_2O
- ➔ NH_4OH ➔ **NH_3** + H_2O
- ➔ **H_2S**
- ➔ **HCN**

Ammonium Hydroxide (NH_4OH = $NH_{3(aq)}$)
Production of NH_3 is a Gas and a Weak Base

Driving Forces in Double Replacement Reactions:

1) Insoluble Solid (Precipitate)
2) Weak Electrolyte (H_2O or Weak Acid)
3) Gas Formation

AP Chemistry: Physical & Chemical Changes, Matter, & Energy

1. Label each situation as either a physical or chemical change:

    a. Corrosion of aluminum metal by hydrochloric acid

    b. Melting wax

    c. Pulverizing an aspirin tablet

    d. Digesting a Three Musketeers® bar

    e. Explosion of nitroglycerin

    f. A burning match

    g. Metal warming up, due to the burning match

    h. Water vapor condensing on the metal

    i. The metal oxidizes, becoming dull and brittle

    j. Salt being dissolved by water

2. For each process describe, state whether the material being discussed (in **bold**) is a mixture or a compound, and state whether the change is physical of chemical.

    a. An **orange liquid** is distilled (boiled to separate components with different boiling points), resulting in the collection of a red solid and a yellow liquid.

    b. A **colorless, crystalline solid** is decomposed, leaving a pale yellow-green gas and a soft, shiny metal.

    c. A **cup of tea** becomes sweeter as sugar is added to it.

AP Chemistry: Uncertainty in Measurement & Calculations

1. Exact numbers

Counted numbers and definitions do not involve any measurement and are considered as exact numbers:

Definitions:
1 week = 7 days
1 mile = 5,280 feet
1 yard = 3 feet

Counted:
5 players on the basketball court
23 students in a room
25 pennies used by a class in an experiment
5 rocks

2. Measured numbers:

All *measured numbers* have some degree of uncertainty.

When recording measurements, **record only the significant figures**. Record measurements to include one decimal estimate beyond the smallest increment on the measuring device.

Examples (consider a measuring instrument like a ruler):

- If smallest increment = 1 m, then record measurement to 0.1 m (i.e. 3.1 m)
- If smallest increment = 0.1 m, then record measurement to 0.01 m (i.e. 5.67 m)
- If smallest increment = 0.01 m, then record measurement to 0.001 m (i.e. 12.675 m)

Unless otherwise stated the uncertainty in the last significant figure (the uncertain or *estimated digit*) is assumed to be ±1 unit. Modern digital instruments and many types of volumetric glassware will state the level of uncertainty.

3. Rules for counting significant figures.

a. Non-zero numbers: Non-zero numbers are always significant
b. Zeros:
   i. Leading zeros that come before the first non-zero number are *never* significant
   ii. Captive zeros (sandwich zeros) that fall between two non-zero digits are *always* significant.
   iii. Ending zeros that appear after the last non-zero digits are significant only when a decimal point appears somewhere in the number

Examples:

Number	0.005	5005	5005.00	500.	0.0050
Sig Figs	1	4	6	3	2

4. **Scientific notation:** Significant figures are recorded in the mantissa (number $1 \leq x \leq 10$)

Examples:

Number	3.0×10^3	5.998×10^5	6.00000×10^{-23}	0.5×10^4
Sig Figs	2	4	6	1

5. **Rules for using significant figures in calculations**
   a. *Multiplication, division, powers, and roots: "Least Sig Fig Rule"*
      1. The result should be reported to the same number of significant figures as the measured number having the *least number of significant figures.*
      2. Only consider the number of significant figures in each of the *measured numbers* (not constants).

Example 1:

2.3 x 5.78; Calculator returns 13.294

2.3 has 2 sig figs

5.78 has 3 sig figs

2.3 x 5.78 = 13 (the answers must be rounded to show 2 sig figs)

Example 2:

$$\frac{1.67 \times 10^5 \times 0.00045}{2 \times 10^{-23}} = calculator\ returns\ 2.505000000 \times 10^{24}$$

1.67 x 10^5 has 3 sig figs

0.00045 has 2 sig figs

2 x 10^{-23} has 1 sig fig

$$\frac{1.67 \times 10^5 \times 0.00045}{2 \times 10^{-23}} = 3 \times 10^{24}\ (rounded\ to\ 1\ sig\ fig)$$

Example 3:

$$\sqrt{2.3} = calculator\ returns\ 1.516575089$$

2.3 has 2 sig figs

$$\sqrt{2.3} = 1.5\ (round\ answer\ to\ 2\ sig\ figs)$$

AP Chemistry: Sig Fig Practice Problems

How many significant figures are in the following numbers:

1. _____ 1, 245 m
2. _____ 0.030 m
3. _____ 10,000 m
4. _____ 1.340×10^{23} m
5. _____ 3.02003×10^{14} m
6. _____ 0.0000001 m
7. _____ 1,000. m
8. _____ 0.10000010 m

9. Convert the following numbers into standard scientific notation:

   a. 96.3×10^{4} g _____
   b. 0.05×10^{23} s _____
   c. 123×10^{-7} m _____

For problems 10-15 perform the following calculations and record your answer with correct significant figures AND units

10. 0.6030 s + 0.82 s = _____

11. 4.1 m + 0.3789 m – 153.22 m = _____

12. 3.1567×10^{2} g + 9.212×10^{4} g – 4.677×10^{6} g = _____

13. $\frac{0.307\ g}{(1.0 \times 10^{-3})\ ml} =$ _____

14. $\frac{1.26 \times 10^{-3} kg}{(3.2\ m + 10\ m + 8.9\ m)(4.3 \times 10^{-6}\ s)} =$ _____

15. $\sqrt[3]{5.33 \times 10^{5}\ m} =$ _____

AP Chemistry: Dimensional Analysis

1. If you have 470 milligram of table salt, which has a chemical formula of NaCl, how many liters of NaCl solution can I make if I want the solution to be 0.90% NaCl? (9 grams of salt per 1000 grams of solution).

   The density of the NaCl solution is 1.0 g solution/mL solution.

2. I have a bar of gold that is 7.0 in x 4.0 in x 3.0 in. The density of gold is 19.3 g/cm^3. The price of gold has been $1,945.94 per ounce. How much is my gold bar worth?

3. If the recommended daily allowance (RDA) for vitamin C is 60 mg per day and there are 70 mg of vitamin C per 100 g of orange, how many 3 oz. oranges would you have to eat each week to meet this requirement?

4. Owls generally maintain territories of 3 acres. How many owls could live in a large wooded area of 20 hectares? (1 hectare = 1 sq. dekameter = 100 m^2 = 2.47 acres)

AP Chemistry: The Mole

For each problem below, write the equation and show your work. Always use/show complete units and box in your final answer.

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? (1000 mg = 1g)

    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?

2. Calculate the following amounts:

    a. How many moles of chloride ions are in 0.0750 g of magnesium chloride?

    b. What is the mass, in grams, of 3.50×10^{-3} mol of aluminum sulfate?

    c. What is the mass, in grams, of 1.75×10^{20} molecules of caffeine, $C_8H_{10}N_4O_2$?

    d. What is the molar mass of cholesterol if 0.00105 mol weigh 0.406 g?

AP Chemistry: Chemical Equations & Calculations

For each problem below, write the equation and show your work. Always use complete units and box in your final answer.

1. Why is it essential to use balanced chemical equation in solving stoichiometry problems?
2. The fermentation of glucose, $C_6H_{12}O_6$, produces ethyl alcohol, C_2H_5OH and CO_2 as shown here:

$$C_6H_{12}O_{6\,(aq)} \rightarrow 2\ C_2H_5OH_{\,(aq)} + 2\ CO_{2\,(g)}$$

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

   b. How many grams of $C_6H_{12}O_6$ are need to form 2.00 g of C_2H_5OH?

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

3. Automotive air bags inflate when sodium azide, NaN_3, rapidly decomposes to its component elements:

$$2\ NaN_{3\,(s)} \rightarrow Na_{\,(s)} + 3\ N_{2\,(g)}$$

   a. How many moles of N_2 are produced by the decomposition of 1.50 moles of NaN_3?

   b. How many grams of NaN_3 are required to form 5.00 g of nitrogen gas?

   c. How many grams of NaN_3 are required to produce 10.0 L of nitrogen gas if the gas has a density of 1.25 g/L?

AP Chemistry: Limiting Reactants & Theoretical Yield

For each problem below, write the equation and show your work. Always use complete units and box in your final answer.

1. A manufacturer of bicycles has 50 wheels, 30 frames, and 24 seats.

    a. How many bicycles can be manufactured using these parts?

    b. How many of each part are left over?

    c. Which part is like a limiting reagent in that it limits the production of bicycles?

2. The fizz produced when an Alka-Seltzer tablet is dissolved in water is due to the reaction between sodium bicarbonate, $NaHCO_3$, and citric acid, $H_3C_6H_5O_7$.

    $3\ NaHCO_{3\ (aq)} + H_3C_6H_5O_{7\ (aq)} \rightarrow 3\ CO_{2\ (g)} + 3\ H_2O_{\ (l)} + Na_3C_6H_5O_{7\ (aq)}$

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

    a. Which reactant is the limiting reactant? You must show work to support your answer.

    b. How many grams of carbon dioxide form?

    c. Describe how you would determine the amount of the other two products formed.

    d. How much of the excess reactant remains after the reaction is complete?

AP Chemistry: Balancing Equations Practice Problems

Balance each of the equations below by filling in the appropriate coefficients:

1) _____ $Al(NO_3)_3$ + _____ $(NH_4)_3PO_4$ → _____ $AlPO_4$ + _____ NH_4NO_3

2) _____ AgF + _____ $CaCl_2$ → _____ $AgCl$ + _____ CaF_2

3) _____ $ZnBr_2$ + _____ $Pb(NO_2)_2$ → _____ $Zn(NO_2)_2$ + _____ $PbBr_2$

4) _____ $C_2H_4O_2$ + _____ O_2 → _____ CO_2 + _____ H_2O

5) _____ Ca + _____ CuF_2 → _____ CaF_2 + _____ Cu

6) _____ H_2SO_4 + _____ $B(OH)_3$ → _____ $B_2(SO_4)_3$ + _____ H_2O

7) _____ S_8 + _____ O_2 → _____ SO_2

8) _____ H_2O_2 → _____ O_2 + _____ H_2O

9) _____ K + _____ F_2 → _____ KF

10) _____ $AgNO_3$ + _____ Ga → _____ Ag + _____ $Ga(NO_3)_3$

11) _____ N_2 + _____ H_2 → _____ NH_3

12) _____ $NaCl$ + _____ H_2SO_4 → _____ $NaHSO_4$ + _____ HCl

13) _____ $KMnO_4$ → _____ K_2MnO_4 + _____ MnO_2 + _____ O_2

14) _____ Fe + _____ $AgNO_3$ → _____ $Fe(NO_3)_2$ + _____ Ag

15) _____ Li_2SO_4 + _____ K_3PO_4 → _____ Li_3PO_4 + _____ K_2SO_4

AP Chemistry: Free-Response Question

1. Answer the following questions relating to gravimetric analysis

In the first of two experiments, a student is assigned the task of determing the number of moles of water in one mole of $MgCl_2 \cdot n\ H_2O$. The student collects the data shown in the following table.

Mass of empty container	22.347 g
Initial mass of sample and container	25.825 g
Mass of sample and container after first heating	23.982 g
Mass of sample and container after second heating	23.976 g
Mass of sample and container after third heating	23.977 g

(a) Explain why the student can correctly conclude that the hydrate was heated a sufficient number of times in the experiment.

(b) Use the data above to:

(i) Calculate the total number of moles of water lost when the same was heated

(ii) Determine the formula of the hydrated compound

(c) A different student heats the hydrate in an uncovered crucible, and some of the solid spatters out of the crucible. This spattering will have what effect on the calculated mass of the water lost by the hydrate? Justify your answer.

In the second experiment, a student is given 2.94 g of a mixture containing anhydrous $MgCl_2$ and KNO_3. To determine percentage by mass of $MgCl_2$ in the mixture, the students uses excess $AgNO_{3\,(aq)}$ to precipitate the chloride ion as $AgCl_{(s)}$.

(d) Starting with the 2.94 g sample of the mixture dissolved in water, briefly describe the steps necessary to quantitatively determine the mass of the AgCl precipitate.

(e) The student determines the mass of the AgCl precipitate to be 5.48 g. On the basis of this information, calculate each of the following:

(i) The number of moles of $MgCl_2$ in the original mixture

(ii) The percent by mass of $MgCl_2$ in the original mixture