June 17, 2021

Dear AP Chemistry student,

I welcome each of you as the new crop of AP Chemistry students. Chemistry is a great subject but it takes a lot of hard work and dedication to excel in this class. You'll be seeing all the interesting topics you encountered in your first year of Chemistry, but we'll move at a faster pace and do a lot more problem solving. (If you're the type who likes to keep your notes over the years, find your old binder and you can use some of those notes as background material.) The key to doing well in the course is keeping up with the assignments, doing optional problem sets, reading the textbook, watching the assigned videos and asking questions in class as soon as difficulties arise.

I've already checked the calendar and our AP exam is again in the first full week in May. With that in mind, it's imperative that we get started a little earlier than in September. To facilitate this you will find the Summer Assignment on the Syosset Website which will take you through a wide variety of topics from your first year of Chemistry.   By completing the assignment we can focus on some of the more challenging introductory topics. I am expecting you to know how to name and write formulas as soon as you come into class.

The assignment isn't extremely long so you can still have a great summer. (If you choose to do the assignment early in the summer – just remember to look it over before we meet in September.) ***You must memorize the polyatomic ions and solubility rules!*** (Hint: memorize what is always soluble and hopefully that leaves the other things as insoluble.) We'll have a quiz on this material in the first week of school. If you have any questions while working on the summer assignment you can email me: krogers@syossetschools.org and you can also reference the online textbook for help: [here](#)

I'm looking forward to meeting you all. Have a terrific summer!

Sincerely,

Mr. Rogers

AP CHEMISTRY
SUMMER ASSIGNMENT

AP Chemistry is a rigorous science course which incorporates all the topics studied in your first year chemistry class, plus more advanced problems solving in extended areas. The summer assignment is to be a review of three topics you previously studied. It is hoped that you will come prepared with this knowledge so that we can move onto more challenging aspects of the AP course. The worksheets are to be done over the summer and handed in the first day of school. In addition, this material will be tested the first week of school.

The Summer Assignment will take you through a wide variety of topics from your first year of Chemistry which will act as our foundation for our learning of the year. The goal is that when we show up to school in September we are ready to hit the ground running and able to get right to the main curriculum.

AP chemistry covers a lot of concepts at a fast pace. We need to get started right away and not waste time going over things you already know. This assignment is meant to be a review. We will spend the first few weeks of the year going into some of the assigned chapters in more depth and so, if you have some questions while you are doing the summer assignment, you will have a chance to ask. However, if you have any pertinent questions you are free to reach out to me via email: krogers@syossetschools.org or you can utilize the online version of our textbook, which can be found here.

On the next page you will find the polyatomic ions and solubility rules which need to be memorized for not only the AP Exam but more importantly for the day to day operations in our class. The pages thereafter feature the summer assignment questions themselves.

Selected Polyatomic Ions

NH_4+	ammonium	NO_2^-	nitrite
$C_2H_3O_2^-$	acetate	NO_3^-	nitrate
$CH_3COO-\}$		O_2^{2-}	peroxide
CN^-	cyanide	$OH-$	hydroxide
CO_3^{2-}	carbonate	PO_4^{3-}	phosphate
HCO_3^-	hydrogen carbonate	PO_3^{3-}	phosphite
$C_2O_4^{2-}$	oxalate	MnO_4^-	permanganate
ClO^-	hypochlorite	SCN^-	thiocyanate
ClO_2^-	chlorite	SO_3^{2-}	sulfite
ClO_3^-	chlorate	SO_4^{2-}	sulfate
ClO_4^-	perchlorate	HSO_4^-	hydrogen sulfate
CrO_4^{2-}	chromate	$S_2O_3^{2-}$	thiosulfate
$Cr_2O_7^{2-}$	dichromate		

SOLUBILITY RULES
Soluble:
- All Nitrates (NO_3^{-1}), Acetates ($C_2H_3O_2^{-1}$), Ammonium (NH_4^{+1}), and Group 1 (IA) salts
- All Chlorides (Cl^{-1}), Bromides (Br^{-1}), and Iodides (I^{-1}), except Silver, Mercury(I) and Lead(II)
- All Fluorides (F^{-1}) except Group 2 (IIA), Lead(II), and Iron(III)
- All Sulfates (SO_4^{-2}) except Calcium, Strontium, Barium(to remember think CBS), Mercury, Lead(II), and Silver

Insoluble (0.10 *M* or greater):
- All Carbonates (CO_3^{-2}) and Phosphates (PO_4^{-3}) except Group 1 (IA) and Ammonium
- All Hydroxides (OH^{-1}) except Group 1 (IA),Strontium, Barium, and Ammonium (Calcium hydroxide is slightly soluble)
- All Sulfides (S^{-2}) except Group 1 (IA),2 (IIA), and Ammonium
- All Oxides (O^{-2}) except Group 1 (IA)

Complete the following list of chemistry problems. They cover concepts you learned in first year chemistry. If you get stuck, feel free to read through the appropriate section of your textbook. Show all work on this copy.

1. Give an example of a homogeneous mixture and a heterogeneous mixture.

2. Do the following statements describe chemical or physical properties?
    a. Oxygen gas supports combustion.

    b. Fertilizers help to increase agricultural production.

    c. Water boils below 100°C on top of a mountain.

    d. Lead is denser than aluminum.

    e. Uranium is a radioactive element.

3. Does each of the following describe a physical change or a chemical change?
    a. The helium gas inside a balloon tends to leak out after a few hours.

    b. A flashlight beam slowly gets dimmer and finally goes out.

    c. Frozen orange juice is reconstituted by adding water to it.

    d. The growth of plants depends on the sun's energy in a process called photosynthesis.

    e. A spoonful of table salt dissolves in a bowl of soup.

4. Give the names of the elements represented by the chemical symbols:
    a. Li   h. Pt

    b. F   i. Mg

    c. P   j. U

    d. Cu   k. Al

    e. As   l. Si

    f. Zn   m. Ne

    g. Cl

5. Give the chemical symbols for the following elements:
   a. potassium

   b. tin

   c. chromium

   d. boron

   e. barium

   f. plutonium

   g. sulfur

   h. argon

   i. mercury

6. Classify each of the following substances as an element or compound:
   a. hydrogen

   b. water

   c. gold

   d. sugar

7. Classify each of the following as an element, compound, homogeneous mixture, or heterogeneous mixture:
   a. seawater

   b. helium gas

   c. sodium chloride (table salt)

   d. a bottle of soft drink

   e. milk shake

   f. air in a bottle

   g. concrete

8. Name the SI base units that are important in chemistry. Give the SI units for expressing the following:
    a. length

    b. volume

    c. mass

    d. time

    e. energy

    f. temperature

9. Write the numbers represented by the following prefixes:
    a. mega

    b. kilo

    c. deci

    d. centi

    e. milli

    f. micro

    g. nano

    h. pico

10. What units do chemists usually use for liquids and solids? For gas density? Explain the differences.

11. Bromine is a reddish-brown liquid. Calculate the density of bromine (in g/mL) if 586 g of the substance occupies 188 mL.

12. a. Normally the human body can endure a temperature of 105°F for only short periods of time without permanent damage to the brain or other vital organs. What is this temperature in °C?

b. Ethylene glycol is a liquid organic compound that is used as an antifreeze in car radiators. It freezes at -11.5°C. Calculate the freezing point temperature in degrees Fahrenheit.

c. The temperature on the surface of the sun is about 6300°C. What is this temperature in degrees Fahrenheit?

d. The ignition temperature of paper is 451°F. What is the temperature in degrees Celsius?

13. Convert the following temperatures to Kelvin:
    a. 113°C, the melting point of sulfur

    b. 37°C, the normal body temperature

    c. 357°C, the boiling point of mercury

14. Convert the following temperature to degrees Celsius:
    a. 77 K, the boiling point of liquid nitrogen

    b. 4.2 K, the boiling point of liquid helium

    c. 601 K, the melting point of lead

15. What is the number of significant figures in each of the following measurements?
    a. 4867 mi
    b. 56 mL
    c. 60,104 ton
    d. 2900 g
    e. 40.2 g/cm^3

16. Carry out the following calculations as if they were calculations of experimental results, and express each answer in the correct units with the correct number of significant figures.
    a. 5.6792 m + 0.6 m + 4.33 m

    b. 3.70 g – 2.9133 g

    c. 4.51 cm x 3.6666 cm

17. Carry out the following conversions (you must use conversion factors):
    a. 22.6 m to dm

    b. 25.4 mg to kg

    c. 556 mL to L

    d. 10.6 kg/m^3 to g/cm^3

18. The average speed of helium at 25°C is 1255 m/s. Convert this speed to miles per hour (mph) using conversion factors.

19. Describe the contributions of the following scientists to our knowledge of atomic structure:
    a. JJ Thomson

    b. RA Millikan

    c. Ernest Rutherford

    d. James Chadwick

20. Describe the experimental basis for believing that the nucleus occupies a very small fraction of the volume of the atom.

21. Indicate the number of protons, neutrons, and electrons in each of the following species:

    a. $^{15}_{7}N$

    b. $^{33}_{16}S$

    c. $^{63}_{29}Cu$

    d. $^{84}_{38}Sr$

    e. $^{130}_{56}Ba$

    f. $^{186}_{74}W$

    g. $^{202}_{80}Hg$
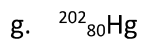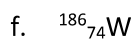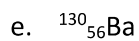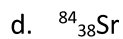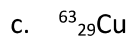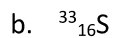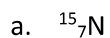
22. Define, with two examples, the following terms:

    a.   alkali metals

    b.   alkaline earth metals

    c.   halogens

    d.   noble gases

23. Elements whose name ends with –ium are usually metals. Sodium is one example. Identify a nonmetal whose name ends with –ium.

24. Explain why the chemical formula HCl can represent two different chemical systems.

25. Name the following compounds:
    a. KClO

    b. Ag_2CO_3

    c. HNO_2

    d. $KMnO_4$

    e. $CsClO_3$

    f. KNH_4SO_4

    g. FeO

    h. Fe_2O_3

    i. $TiCl_4$

    j. NaH

    k. Li_3N

    l. Na_2O

    m. Na_2O_2

26. Write the formulas for the following compounds:
    a. rubidium nitrite

    b. potassium sulfide

    c. sodium hydrogen sulfide

    d. magnesium phosphate

    e. calcium hydrogen phosphate

    f. potassium dihydrogen phosphate

    g. iodine heptafluoride

    h. ammonium sulfate

    i. silver perchlorate

    j. boron trichloride

27. Write the formulas for the following compounds:
   a. copper (I) cyanide

   b. strontium chlorite

   c. perbromic acid

   d. hydroiodic acid

   e. disodium ammonium phosphate

   f. lead (II) carbonate

   g. tin (II) fluoride

   h. tetraphosphorous decasulfide

   i. mercury (II) oxide

   j. mercury (I) iodide

   k. selenium hexafluoride
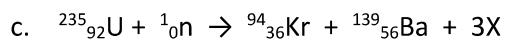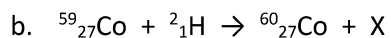

28. Write the formula of the common ion derived from each of the following:
   a. Li

   b. S

   c. I

   d. N

   e. Al

   f. Cs

   g. Mg

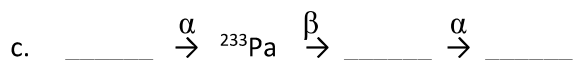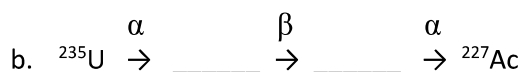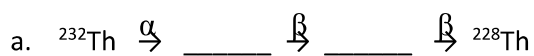29. Fill in the blanks in the following table:

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^-		
		Cu_2CO_3	
			Lithium nitride
Al^{3+}	S^{2-}		

30. Complete the following nuclear equations and identify X in each case:
   a. $^{26}_{12}Mg + ^{1}_{1}p \rightarrow ^{4}_{2}\alpha + X$

   b. $^{59}_{27}Co + ^{2}_{1}H \rightarrow ^{60}_{27}Co + X$

   c. $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{94}_{36}Kr + ^{139}_{56}Ba + 3X$

   d. $^{53}_{24}Cr + ^{4}_{2}\alpha \rightarrow ^{1}_{0}n + X$

   e. $^{20}_{8}O \rightarrow ^{20}_{9}F + X$
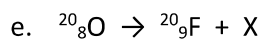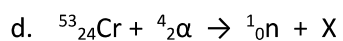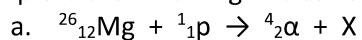
31. Fill in the blanks in the following radioactive decay series:

   a. $^{232}Th \overset{\alpha}{\rightarrow}$ _____ $\overset{\beta}{\rightarrow}$ _____ $\overset{\beta}{\rightarrow}$ ^{228}Th

   b. $^{235}U \overset{\alpha}{\rightarrow}$ _____ $\overset{\beta}{\rightarrow}$ _____ $\overset{\alpha}{\rightarrow}$ ^{227}Ac

   c. _____ $\overset{\alpha}{\rightarrow}$ $^{233}Pa \overset{\beta}{\rightarrow}$ _____ $\overset{\alpha}{\rightarrow}$ _____

32. How many moles of cobalt (Co) atoms are there in 6.00×10^9 cobalt atoms?

33. How many moles of calcium (Ca) atoms are in 77.4 g of calcium?

34. How many atoms are present in 3.14 g of copper (Cu)?

35. Calculate the molar mass of each of the following substances:
    a. NO_2

    b. SO_3

    c. C_6H_6

    d. NaI

    e. K_2SO_4

    f. $Ca_3(PO_4)_2$

36. How many molecules of ethane (C_2H_6) are present in 0.334 g of C_2H_6?

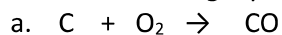37. What are the empirical formulas of the compounds with the following compositions?
   a. 40.1% C, 6.6% H, 53.3% O

    b. 18.4% C, 21.5% N, 60.1% K

38. The anticaking agent added to Morton salt is calcium silicate, $CaSiO_3$. This compound can absorb up to 2.5 times its mass of water and still remain a free flowing powder. Calculate the percent composition of $CaSiO_3$

39. The empirical formula of a compound is CH. If the molar mass of this compound is about 78 g, what is the molecular formula?

40. Balance the following equations:
    a. $C + O_2 \rightarrow CO$

    b. $CO + O_2 \rightarrow CO_2$

    c. $H_2 + Br_2 \rightarrow HBr$

    d. $K + H_2O \rightarrow KOH + H_2$

    e. $Mg + O_2 \rightarrow MgO$

    f. $O_3 \rightarrow O_2$
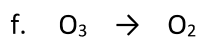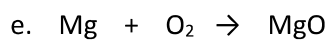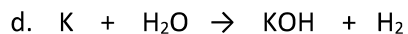
41. Ammonia is a principal nitrogen fertilizer. It is prepared by the reaction between nitrogen and hydrogen.

$$3 H_{2\ (g)} + N_{2\ (g)} \rightarrow 2 NH_{3\ (g)}$$
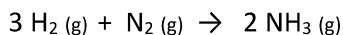
In a particular reaction, 6.0 moles of NH_3 were produced.   How many moles of H_2 and how many moles of N_2 were reacted to produce this amount of NH_3?

42. When baking soda (sodium bicarbonate or sodium hydrogen carbonate, $NaHCO_3$) is heated, it releases carbon dioxide gas, which is responsible for the rising of dough in cookies, rolls and donuts.
   a. Write the balanced equation for the decomposition of the compound (one of the products is Na_2CO_3).

    b. Calculate the mass of $NaHCO_3$ required to produce 20.5 g of CO_2.

43. When potassium cyanide (KCN) reacts with acids, a deadly poisonous gas, hydrogen cyanide, HCN, is produced. Here is the equation:

$$KCN_{(aq)} + HCl_{(aq)} \rightarrow KCl_{(aq)} + HCN_{(g)}$$
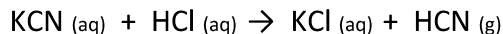
If a sample of 0.140 g of KCN is treated with excess HCl, calculate the amount of HCN formed, in grams.

44. Fermentation is a complex chemical process of wine making in which glucose is converted into ethanol and carbon dioxide:

$$C_6H_{12}O_6 \rightarrow 2\ C_2H_5OH + 2\ CO_2$$
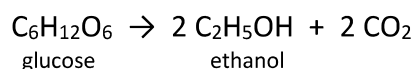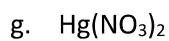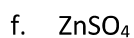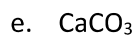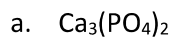
glucose   ethanol

Starting with 500.4 g of glucose, what is the maximum amount of ethanol in grams and in liters that can be obtained by the process? (Density of ethanol is 0.789 g/mL)

45. Nitric oxide (NO) reacts with oxygen to form nitrogen dioxide (NO_2), a dark brown gas.

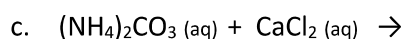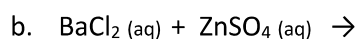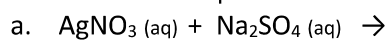$$2\ NO_{(g)} + O_{2\ (g)} \rightarrow 2\ NO_{2\ (g)}$$
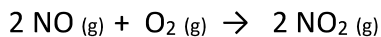
In one experiment, 0.886 mole of NO is mixed with 0.503 mole of O_2. Calculate which of these two reactants is the limiting reactant. Also calculate the number of moles of NO_2 produced.

46. Characterize the following compounds as soluble or insoluble in water:
    a. $Ca_3(PO_4)_2$

    b. $Mn(OH)_2$

    c. $AgClO_3$

    d. K_2S

    e. $CaCO_3$

    f. $ZnSO_4$

    g. $Hg(NO_3)_2$

    h. $HgSO_4$

    i. NH_4ClO_4

47. Write the net ionic equations for the following reactions:
    a. $AgNO_{3\ (aq)} + Na_2SO_{4\ (aq)} \rightarrow$

    b. $BaCl_{2\ (aq)} + ZnSO_{4\ (aq)} \rightarrow$

    c. $(NH_4)_2CO_{3\ (aq)} + CaCl_{2\ (aq)} \rightarrow$

48. Give Arrhenius's and Bronsted's definitions of an acid and a base. Why are Bronsted's definitions more useful in describing acid-base properties?

49. Identify each of the following species as a Bronsted acid, base, or both:
    a. HI

    b. CH_3COO^-

    c. $H_2PO_4^-$

    d. HSO_4^-

    e. NH_4^+

    f. ClO_2^-

50. Predict the outcomes of the reactions represented by the following equations by using the activity series, and balance the equations:
    a. $Cu_{(s)} + HCl_{(aq)} \rightarrow$

    b. $I_2{}_{(s)} + NaBr_{(aq)} \rightarrow$

    c. $Mg_{(s)} + CuSO_4{}_{(aq)} \rightarrow$

    d. $Cl_2{}_{(g)} + KBr_{(aq)} \rightarrow$

51. How many moles of $MgCl_2$ are present in 60.0 mL of 0.100 M $MgCl_2$ solution?

52. How many grams of KOH are present in 35.0 mL of a 5.50 M solution?

53. 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.

    c. 9.00 g of sodium chloride (NaCl) in 86.4 mL of solution.

54. A sample of nitrogen gas kept in a container of volume 2.3 L and a temperature of 32°C exerts a pressure of 4.7 atm. Calculate the number of moles of gas present. (Note: The AP curriculum tends to present pressures in atm rather than kPa. As a result, the value for R will be 0.0821 L·atm/mol·K instead of 8.31 L·kPa/mol·K)

55. Given that 6.9 moles of carbon monoxide gas are present in a container with volume 30.4 L, what is the pressure of the gas (in atm) if the temperature is 62°C?

56. Methane, the principal component of natural gas, is used for heating and cooking. The combustion process is:

$$CH_4 \text{ (g)} + 2\ O_2 \text{ (g)} \rightarrow CO_2 \text{ (g)} + 2\ H_2O \text{ (g)}$$
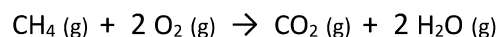
If 15.0 moles of CH_4 are reacted, what is the volume of CO_2 in liters produced at 23.0°C and 0.985 atm?