GREETINGS JUNIORS!

Welcome to your first year at the Governor's School! I look forward to meeting everyone when the new school year begins. In order to prepare everyone for what will be a rigorous college level chemistry curriculum, I have prepared a summer assignment that will review basic chemistry concepts that many of you have probably learned during the previous school year. You will not need a textbook for any of these problems. With the plethora of online tutorials, YouTube videos, and other resources readily available at your home or local library, I am confident that you will be able to complete this assignment and prepare for the upcoming school year.

You will find that much of the material in this assignment is already familiar to you. In the event that you encounter something that is unfamiliar to you, do not fret! We will be going over everything (and then some) throughout the school year. That being said, please bring your completed summer assignment with you on **THE FIRST DAY OF CLASS**. It will be important for everyone to not only come to that first day prepared and ready to work, but to also maintain that academic edge throughout the school year. While I do hold review sessions, spending extensive time devoted to remediation is not an option. We will be following a fast paced college curriculum, and it is also my goal to help everyone be 100% prepared for the AP Chemistry exam in early May.

This summer assignment will not be graded, but I do reserve the right to give you a quiz (which **will** be graded) after reviewing the assignment in class. Just saying.

In addition to your summer assignment, please begin brainstorming possible ideas for your research project in mentorship. If you have any questions as to whether select research project topics are allowed in a basic chemistry laboratory, please do not hesitate to email me about it. We will discuss the mentorship project at the start of the school year.

Finally, I highly recommend that you spread out your work on the summer assignment. Email me if you need help. I do check my work email over the summer break, so I will respond to your messages whenever I can. Please do not procrastinate and attempt to finish the entire assignment during the final week of your summer vacation. In order to be successful in chemistry as well as the AP exam, you will need to give yourself time to process and understand the material.

I hope you are looking forward as much as I am to an exciting year of chemistry. You are all exceptional students, and with motivation and diligence, you should find your time at the Governor's School a rewarding experience.

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Junior Summer Assignment

The following assignment is to be completed on lined paper and submitted on the first day of school. <u>YOU MUST SHOW WORK FOR ALL PROBLEMS</u>. Questions cover topics from general chemistry to basic Mole concepts. Certain topics will be reviewed during regular school year.

1. Write the most common guidelines to determine significant figures (digits) with an example?

2. Use factor labeling method to convert the following:
    a. 515 m = ___ miles.
    b. 200 in = ____ meters
    c. 325 days = _____ seconds.
    d. 20 gallons = _____ ml

3. Classify each of the following as units of mass, volume, length, density, energy, or pressure.
    a. mg   b. mL   c. cm^3 d. mm
    e. kg/m^3 f. kJ   g. atm   h. cal

4. Some laboratory experiments are performed at 55°C. Express this temperature in:
    a. °F
    b. K

5. A cylinder rod formed from silicon is 21.3 cm long and has a mass of 5.00 kg. The density of silicon is 2.33 g/cm^3. What is the diameter of the cylinder? (the volume of cylinder is given by $\pi r^2 h$, where r is the radius and h is the length)

6. How many significant figures are in each of the following?
    a. 1.92 mm   b. 0.030100 kJ   c. 6.022 x10^{23} atoms
    d. 460.00 L   e. 0.00036 cm^3 f. 100
    g.   1001   h. 0.001   i. 0.0101

7. Record the following in correct scientific notation:
    a. 350,000,000 cal
    b. 0.0000721 mol
    c. 0.0000000809 Å
    d. 765,400,000,000 atoms

8. Calculate the following to the correct number of significant figures.
    a. 1.27 g / 5.296 cm^3
    b. 12.235 g / 1.01 L
    c. 12.2 g + 0.38 g
    d. 17.3 g + 2.785 g
    e. 2.1 x 3.21
    f. 17.6 + 2.838 + 2.3 + 110.77

9. Give the chemical symbols for the following elements:

a. Carbon   b. sulfur   c. Titanium   d. Nitrogen

e. Helium   f. Krypton   g. Fluorine   h. Scandium

i. Arsenic

10. Write the name for each of the elements symbols:

a. Na   b. Au   c. Ag   d. Sn

e. Fe   f. Hg   g. K

11. Label each of the following as either a physical process or a chemical process.
   a. Corrosion of aluminum metal.
   b. Melting of ice.
   c. Pulverizing an aspirin.
   d. Digesting a candy bar.
   e. Explosion of nitroglycerin.
   f. Milk turning sour.
   g. Burning of paper.
   h. Forming of frost on a cold night.
   i. Bleaching of hair with hydrogen peroxide.
   j. A copper wire is hammered flat.

12. Calculate the mass of O_2 produced if 3.450 g potassium chlorate is completely decomposed by heating in presence of a catalyst (Manganese dioxide).

13. Write the formula of the following compounds.

a. Calcium sulfate.   b. Ammonium Phosphate   c. Lithium Nitrite

d. potassium perchlorate.   e. Barium Oxide   f. Zinc sulfide

g. Sodium Perbromate   i. Calcium Iodide   j. Aluminum Carbonate

14. Convert 6.75 atm to:
   a. mm Hg
   b. pascals

15. Define the words: atomic number, atomic mass, mass number, molecular formula, structural formula, empirical formula, isotopes, cation, anion, and metalloid.

16. White gold is an alloy that typically contains 45.0% by mass gold and the remainder is platinum. If 154 g of gold are available, how many grams of platinum are required to combine with the gold to form this alloy?

17. What is the empirical formula of a compound that contains 53.73% Fe and 46.27% of S ?

18. Determine the number of molecules present in 4.56 mol of nitrogen (N_2).

19. List the following as diatomic molecule, molecular compound, ionic compound or element.

a. F_2 b. Cl_2 c. C   d. NaCl   e. KF

f. CO_2 g. H_2 h. Ag   i. Rust (Fe_2O_3)   j. MgO

k. O_2 l. I_2 m.CO   n. K_2CO_3

20. What is the difference between:

a. Chlorine and Chloride?

b. Sodium atom and sodium ion?

21. Calculate the mass in grams of each of the following:

a. 6.02×10^{23} atoms of Mg.

b. 3.01×10^{23} Formula units of $CaCl_2$.

c. 12.4×10^{15} atoms of neon.

22. In an experiment, a student gently heated a hydrated copper compound to remove the water of hydration. The following data was recorded:

- *Mass of crucible, cover, and contents before heating*   *23.4 g*
- *Mass of empty crucible and cover*   *18.82 g*
- *Mass of crucible, cover, and contents after heating to constant mass*   *20.94 g*

Calculate the experimental percent of water in the compound.

23. How do you distinguish:

a. An element from a compound.

b. An element from a mixture.

c. A true solution from a heterogeneous mixture.

24. An extensive property is one that depends on the amount of the sample. Which of the following properties are extensive?

a. volume   b. density   c. temperature

d. energy   e. melting point.   f. pressure

25. Define Acid, base and salt? Give some examples of each.

26. What mass of copper is required to replace silver from 4.00g of silver nitrate dissolved in water?

$$Cu(s) + AgNO_3 \rightarrow Cu(NO_3)_2 + Ag$$

27. Write the chemical formulas for the following compounds:

a. Calcium Carbonate   b. Ammonium Phosphate   c. Sodium Chloride

d. Sodium Oxide   e. Calcium Sulfate   f. Sodium Nitrite

g. Magnesium Acetate   h. Potassium cyanide   i. Zinc(II) Nitrate

j. Iron(III) Phosphate   k. Nickel (II) Fluoride

28. Define   a. Law of conservation of mass.   b. Law of multiple proportion.

29. Mercury has an atomic mass of 200.59 amu. Calculate the following values:
    a. Mass of 3.0×10^{10} atoms
    b. Number of atoms in one nanogram of Mercury

30. Calculate the molar masses (g/mol) of:
    a. Ammonia (NH_3)   b. Baking soda ($NaHCO_3$)   c. Osmium Metal (Os)

31. Convert the following to moles:
    a. 3.86 grams of Carbon dioxide
    b. 6.0×10^5g of Hydrazine (N_2H_4), a rocket propellant.

32. The molecular formula of morphine, a pain-killing narcotic, is $C_{17}H_{19}NO_3$.
    a. What is the molar mass?
    b. What fraction of atoms in morphine is accounted for by carbon?
    c. Which element contributes least to the molar mass?

33. Complete the list of ionic compounds with the correct name or formula.
    a. Cupric Hydroxide
    b. Strontium Chromate
    c. Ammonium Per chlorate
    d. $NaHCO_3$
    e. $Fe_2(CO_3)_3$
    f. Sodium Hydroxide.
    g. Potassium Chloride.

34. The hormone, thyroxine is secreted by the thyroid gland, and has the formula: $C_{15}H_{17}NO_4I_4$. How many milligrams of Iodine can be extracted from 15.0 Grams of thyroxine?

35. Determine the formula weight for the following:
    a. N_2O_5 b. $CuSO_4$ c. $Ca(HCO_3)_2$ d. $CaSO_4$

36. Calculate the percentage by mass of the following compounds:
    a. SO_3 b. CH_3COOCH_3 c. Ammonium Nitrate.

37. Vanillin, a flavoring agent, is made up of carbon, hydrogen, and Oxygen atoms. When a sample of Vanillin weighing 2.500g burns in Oxygen, 5.79 g of carbon dioxide and 1.18 g of water are obtained. What is the empirical formula of Vanillin?

38. What is the molecular formula of each of the following compounds?
    a. Empirical formula CH_2, molar mass = 84g/mol
    b. Empirical formula NH_2Cl, molar mass = 51.5 g/mol

39. Determine the empirical and molecular formula of each of the following substances:
    a. Ibufuren, a headache remedy contains 75.6 % C, 8.80 % H , and 15.5 % O by mass and has a molar mass about 206 g/mol.
    b. Epinerphine(adrenaline) a hormone secreted into the bloodstream in times of danger or stress contains 59% C, 7.1% H, 26.2% O, and 7.7% N by mass, its MW is about 180 amu.

40. Write balanced chemical equations for the reactions of sodium with the following nonmetals to form ionic solids.
    a. Nitrogen   b. Oxygen   c. Sulfur   d. Bromine

41. Write a balanced equation for the following:
    a. Reaction of boron trifluoride gas with water to give liquid hydrogen fluoride and solid boric acid,(H_3BO_3).
    b. Reaction of magnesium oxide with Iron to form Iron (III) Oxide and Magnesium.
    c. The decomposition of dinitrogen oxide gas to its elements.
    d. The reaction of calcium carbide solid with water to form calcium hydroxide and acetylene (C_2H_2) gas.
    e. Ethane burns in air (Oxygen).
    f. Hydrogen reacts with oxygen to from Water.
    g. Nitrogen gas reacts with Hydrogen to form Ammonia.
    h. Hydrogen reacts with Iodine gas to form Hydrogen Iodide.
    i. Sodium reacts with Iodine gas to form Sodium Iodide.
    j. Sodium Oxide reacts with water to form sodium hydroxide and hydrogen.
    k. Carbon dioxide combines with water to form carbonic acid.
    l. Magnesium and nitrogen gas combine to form magnesium nitride.

42. Define the following terms: limiting reagent, theoretical yield, and actual yield.

43. Sodium hydroxide reacts with carbon dioxide as follows:

$$2\ NaOH(s)\ +\ CO_2\ (g)\ \rightarrow Na_2CO_3\ (s)\ +\ H_2O(l)$$
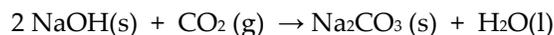
    a. Which reagent is the limiting reactant when 1.85 mol of sodium hydroxide and 1.00 mol carbon dioxide are allowed to react? How many moles of sodium carbonate can be produced? How many moles of the excess reactant remain after the completion of the reaction?

44. When benzene (C_6H_6) reacts with bromine (Br_2) bromobenzene (C_6H_5Br) is obtained:
$$C_6H_6\ +\ Br_2\ \rightarrow\ C_6H_5Br\ +\ \ HBr$$

    a. What is the theoretical yield of bromobenzene in this reaction when 30.0g of benzene reacts with 65.0 g of bromine?
    b. If the actual yield of bromobenzene was 56.7 g what was the percentage yield?

45. Chlorine and Fluorine react to form gaseous chlorine trifluoride. You start with 1.75 mol of chlorine and 3.68 mol of fluorine.
    a. Write the balanced equation for the reaction.
    b. What is the limiting reagent?

46. To prevent a condition called the "bends", deep sea divers breathe a mixture containing, in mole percent, 10.0% O2, 10.0% N2 , and 80.0% He.
    a. Calculate the molar mass of this mixture.
    b. What is the ratio of the density of this gas to that of pure Oxygen?

47. When Hydrogen sulfide gas, H_2S, reacts with oxygen, Sulfur dioxide gas and steam are produced.
    a. Write the balanced chemical equation for this reaction.
    b. How many liters of sulfur dioxide would be produced from 4.0 l of Oxygen? Assume 100% yield and that all gases are measured at the same temperature and pressure.

48. Name the following:

a. CO_2	b. P_4S_{10}	c. NI_3	d. PCl_5
e. CCl_4	f. SF_6	g. CH_4	h. C_2H_6
i. C_3H_8			

49. Which of the following statements are always true? Never true? Not always true?
    a. A compound with the molecular formula C_6H_6 has the same simplest formula.
    b. The mass percent of copper in CuO is less than in Cu_2O.
    c. The limiting reactant is the one present in the smallest number of grams.
    d. Since $C_3H_6O_3$ and $C_6H_{12}O_6$ reduce to the same formula, they represent the same compound.

50. A sample of carbon dioxide gas, CO2 (g), occupies a volume of 5.75 L at 0.890 atm. If the temperature and the number of moles remain constant, calculate the volume when the pressure
    a. increased to 1.25 atm
    b. decrease to 0.350 atm

51. On a warm day, an amusement park balloon is filled with 47.8 g He. The temperature is $33°C$ and the pressure in the balloon is 2.25 atm. Calculate the volume of the balloon.

52. What is an Activity series of metal? How does it help us in studying properties of elements.

53. Define the terms: Exothermic, endothermic reactions?

54. What is a solute and solvent?
    a. Define Molarity, Molality.

55. Identify each of the following as being most like an observation, a law, or a theory.
    a. All coastal areas experience two high tides and two low tides each day.
    b. The tides in Earth's oceans are caused mainly by the gravitational attraction of the moon.
    c. Yesterday, high tide in San Francisco Bay occurred at 2.43 a.m. and 3.07 P.m.
    d. Tides are higher at the full moon and ne moon than at other times of the month.

56. Calculate the molarity of a solution that contains 0.0345 mol NH_4Cl in exactly 400 ml of solution?

57. Calculate the molarity of a solution that contains 20.0grams of sodium hydroxide in 200ml?

58. How many grams of solute are present in 50.0 ml of 0.360 M sodium chloride?

59. DDT, an insecticide harmful to fish, birds, and humans, is produced by the following reaction:

$$2C_6H_5Cl \quad + \quad C_2HOCl_3 \quad \rightarrow \quad C_{14}H_9Cl_5 \quad + H_2O$$
Chloro benzene   *Choral*   *DDT*

If 1142 g of chlorobenzene is reacted with 485 g of chloral, answer the following questions:
    a. What mass of DDT is formed?
    b. Which reactant is limiting? Which is in excess?
    c. What mass of excess reactant is left over?
    d. If the actual yield of DDT is 200.0 g, what is the percent yield?

Write formulas for the following

I have provided you with the following monoatomic cations and anions as well as polyatomic ions. In addition to knowing the charges of these species, I would like you to make flash cards with the name, symbol, and charge (when applicable) of these compounds that you will use throughout the school year.

Common monoatomic ions

Name (Ion)	Symbol (Ion)	Name (Ion)	Symbol (Ion)
Sodium		Potassium	
Cesium		Beryllium	
Calcium		Strontium	
Barium		Gallium	
Aluminum		Nitrogen	
Arsenic		Bismuth	
Oxygen		Fluorine	
Chlorine		Bromine	
Iodine			

Common ions of transition elements

Ion name	Ion	Ion name	Ion
Chromium(III)		Nickel(II) or nickel	
Manganese(II)		Copper(II) or Cupric	
Iron(II) or Ferrous		Zinc	
Iron(III) or Ferric		Silver	
Cobalt(II)		Cadmium	
Mercury(II) or Mercuric			

Common Polyatomic Ions

Name	Formula	Name	Formula
Acetate		Ammonium	
Carbonate		Chlorate	
Chlorite		Chromate	
Cyanide		Dichromate	
Dihydrogen Phosphate		Dihydrogen Phosphate	
Hydrogen Carbonate		Hydrogen Sulfate	
Hydrogen Sulfite		Hypochlorite	
Hydroxide		Nitrate	
Nitrite		Oxalate	
Perchlorate		Permanganate	
Peroxide		Phosphate	
Sulfate		Sulfite	
Thiosulfate			

Common Acids

Common Acids	Formula	Common Acids	Formula
Hydrochloric acid		Phosphoric acid	
Perchloric acid		Carbonic acid	
Nitrous acid		Sulfuric acid	
Nitric acid		Hypochlorous acid	
Chlorous acid		Chloric acid	