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 focuses on the mathematical skills that are essential for success in a college-level general chemistry course. You will not need a textbook for any of these problems. With resources readily available at your home, local library, and the internet, I am confident that you will be able to complete this assignment and prepare for the upcoming school year.

Additionally, you will need the following supplies for chemistry class:

- A scientific calculator (please familiarize yourself with the calculator you will be bringing to class)
- Pens/pencils
- Paper
- A binder to keep notes and other class handouts in

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. 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.

I highly encourage you to take your time with this summer assignment and to complete small portions of the assignment each day or week instead of waiting until the final week of your summer break. Various concepts in chemistry can take some time to process and understand, so you will do much better working on small portions of the assignment on a regular basis. Additionally, I have included some tables with essential information on it. I recommend that you print and fill out (when applicable) and either laminate the tables (or place them inside sheeet protectors) so that you can refer to them throughout the school year.

Have a great summer, and I look forward to meeting everyone in Fall!

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Junior Summer Assignment

Work on the following problems as a review/refresher activity of concepts that have been covered in previous chemistry classes. Show your work on separate sheets of paper. You may use any resources you have, including study guides, textbooks, and the internet. As you go through the questions, make sure to write down the question(s) and/or topics that you found challenging. We will be covering all of the concepts and more throughout the school year as well as important calculations and problem-solving strategies.

Topic 1: Chemistry Theory and Concepts

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

2. 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.

3. 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.

4. How do you distinguish:
   a. An element from a compound.
   b. An element from a mixture.
   c. A true solution from a heterogeneous mixture.

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

6. 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

7. 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.

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

9. Define the terms: Exothermic, endothermic reactions?

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

Topic 2: Significant Figures, Scientific Notations, and Dimensional Analysis

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

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

13. 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

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

15. 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)

16. How many significant figures are in each of the following?
    a. 1.92 mm b. 0.030100 kJ c. 6.022×10^{23} atoms
    d. 460.00 L e. 0.00036 cm^3 f. 100
    g. 1001 h. 0.001 i. 0.0101

17. 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

18. 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

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

Topic 3. Chemical Nomenclature and Classification

20. 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

21. Write the name for each of the elements symbols:
    a. Na b. Au c. Ag d. Sn
    e. Fe f. Hg g. K

22. What is the difference between:
    a. Chlorine and Chloride?
    b. Sodium atom and sodium ion?

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

24. 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

25. 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

26. 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).

27. 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

28. 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

29. 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	

Topic 4. Chemical Equations, Unit Conversions, and Formula Determination

30. 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

31. 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.

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

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

34. 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.

35. 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

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

37. 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.

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

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

40. 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?

41. 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?

42. 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

Topic 5. Stoichiometry and Fun with Moles

43. 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?

44. 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.

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

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

46. 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?

47. 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.

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

49. 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?

50. 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?

51. 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?

52. To prevent a condition called the "bends", deep sea divers breathe a mixture containing, in mole percent, 10.0% O_2, 10.0% N_2 , 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?

53. 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.

54. A sample of carbon dioxide gas, CO_2 (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

55. 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.

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:

$$2C_6H_5Cl + C_2HOCl_3 \rightarrow C_{14}H_9Cl_5 + H_2O$$

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. Print out and keep this table as reference 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	

Solubility Rules

Key: Soluble = dissolves in water = (aq) Insoluble = forms a precipitate or solid in water = (s)			
Anion (negative)	**Plus**	**Cation (positive)**	**Soluble or Insoluble**
Any negative ion	+	Li^{2+}, Na^{2+}, K^{+}, Rb^{+}, Cs^{+}, or NH_4^{+}	Soluble (aq)
NO_3^{-}	+	Any positive ion	Soluble (aq)
$C_2H_3O_2^{-}$	+	Any positive ion	Soluble (aq)
HCO_3^{-}	+	Any positive ion	Soluble (aq)
ClO_3^{-}	+	Any positive ion	Soluble (aq)
ClO_4^{-}	+	Any positive ion	Soluble (aq)
Cl^{-} Br^{-} I^{-}	+	Ag^{+}, Pb^{2+}, Hg^{2+}	Insoluble (s)
	+	Any other positive ion	Soluble (aq)
F^{-}	+	Mg^{2+}, Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}	Insoluble (s)
	+	Any other positive ion	Soluble (aq)
SO_4^{2-}	+	Ca^{2+}, Sr^{2+}, Ba^{2+}, Pb^{2+}, Hg^{2+}, Ag^{+}	Insoluble (s)
	+	Any other positive ion	Soluble (aq)
CO_3^{2-} S^{2-} $Cr_2O_7^{2-}$ PO_4^{3-}	+	Li^{2+}, Na^{2+}, K^{+}, Rb^{+}, Cs^{+}, or NH_4^{+}	Soluble (aq)
	+	Any other positive ion	Insoluble (s)
OH^{-}	+	Li^{2+}, Na^{2+}, K^{+}, Rb^{+}, Cs^{+}, or NH_4^{+}	Soluble (aq)
	+	Ba2+, Sr^{2+}, Ca^{2+}	Marginally Soluble
	+	Any other positive ion	Insoluble (s)
CrO_4^{2-}	+	Li^{2+}, Na^{2+}, K^{+}, Rb^{+}, Cs^{+}, NH_4^{+}, Ca^{2+}, Mg^{2+}	Soluble (aq)
	+	Any other positive ion	Insoluble (s)

Simple Rules for the Solubility of Salts in Water

1. Most nitrate (NO_3^-), acetates ($C_2H_3O_2^-$), chlorates (ClO_3^-), and perchlorates (ClO_4^-) salts are soluble.
2. Most salts containing the alkali metal ions (Group 1 ions) (Li^+, Na^+, K^+, Cs^+, Rb^+), and the ammonium ion (NH_4^+) are soluble.
3. Most chloride, bromide, and iodide salts are insoluble. Notable exceptions are salts containing the ions, Ag^+, Pb^{2+}, and Hg^{2+}.

Metric System Prefixes

Prefix	**Symbol**	**Meaning**	**Example**
Giga-	G	1,000,000,000	1,000,000,000 m = 1 Gm
Mega–	M	1,000,000	1,000,000 m = 1Mm
Kilo-	k	1,000	1000 m = 1 km
Hecto-	h	100	100 m = 1 hm
Deka	D or da	10	10 m = 1 Dm
Base Unit (g, L, m)			1 m = 1 m
Deci-	d	0.1	10 dm = 1 m
Centi-	c	0.01	100 cm = 1 m
Milli-	m	0.001	1000 mm = 1 m
Micro-	μ	0.000001	1,000,000 μm = 1 m
Nano-	n	0.000000001	1,000,000,000 nm = 1 m
Pico	p	0.000000000001	1,000,000,000,000 pm = 1 m