IB Chemistry HL Year 1 Summer Assignment

The purpose of this summer assignment is to ensure you remember key information and skills from Chemistry I, and to help you refresh things you may have forgotten, so you will not be behind at the beginning of the school year. When we start IB Chem in August we do not review Chem I, we pick up where we left off. Without this assignment you'll be quite lost.

Complete the following assignment on separate paper, preferably in a bound notebook or composition book. Additionally, you are to complete this assignment in the order it has been assigned. If you complete the assignment at the pace I have laid out for you, it should not be too time consuming, it should serve its purpose well, and we should all be ready for a great new school year. If you do not, you will be completely overwhelmed by this assignment and unprepared for the coming school year. The course will be taught with the expectation that you have mastery and fluency with the fundamentals included in this assignment. If you need additional information beyond what I have provided for you in the boxes, your Chemistry I notes or internet resources should prove useful.

Additionally, you will have a quiz over elements, ions, and compounds EVERY week. Your first quiz will be over elements 1-54; you must know element names with the correct spelling and the corresponding chemical symbol. Start reviewing your monatomic and polyatomic ions so you know them.

Step 1: Join the class Remind (IB Chemistry HL 2022-2024):
@ibchembell or text the code to 81010

Step 2: Revive whatever shreds of self-discipline you're clinging to. This summer assignment is self-paced. If you decide to start it in late July you're not going to be a happy camper…

There are eleven weeks of summer.

There are eleven weeks of assignments in this massive, annoying, at times quite daunting packet.

This assignment is due on the first day of school- half day or full- whenever I see you first. Late summer assignments are not accepted.

Week One

Review of significant figures, scientific notation, metric conversions, density, & nomenclature:

Significant figures

- Count all numbers as significant except for leading and trailing zeros –placeholders
- Addition and subtraction: Keep the same number of places before or after the decimal as the number with the fewest places before or after the decimal.
- Multiplication and division: The answer should have the same number of significant figures as the number with the fewest total significant figures.

Scientific notation

- Move the decimal until you obtain a number equal to or greater than one and less than ten.
- Count how many places you moved the decimal in order to obtain your exponent. If you moved the decimal to the left, the exponent is positive; if you moved to the right, the exponent is negative.
    - Ex.: $105000 = 1.05 \times 10^5$, $0.0032 = 3.2 \times 10^{-3}$
- Addition and subtraction: Since decimal places must line up, exponents have to be the same. Add or subtract the numbers; exponents do not change.
- Multiplication: Multiply the numbers, and add the exponents.
- Division: Divide the numbers, and subtract the exponents.

Metric conversions & Dimensional analysis

- Review metric units and prefixes
    - Metric Prefixes

Prefix	Example conversion
Mega- (M)	1 Mg = 10^6 g
kilo- (k)	1 kJ = 10^3 J
hecto- (h)	1 hm = 100 m
deca- (da)	1 dag = 10 g
BASE	
deci- (d)	10 dm = 1m
centi- (c)	100 cs = 1 s
milli- (m)	10^3 mg = 1 g
micro- (µ)	10^6 µg = 1 g
nano- (n)	10^9 nm = 1 m
pico- (p)	10^{12} pg = 1 g

    - **1 dm^3 = 1 L; 1 cm^3 = 1 mL** *** IB uses dm^3 and cm^3 NOT L and mL*
- Use dimensional analysis/"train tracks" to convert units. Remember to line up conversion factors so the units you are trying to get rid of divide out and you are left with the desired units.
    - If units are squared or cubed, the entire conversion factor must be squared or cubed, i.e. 1 dm^3 = (10 cm)^3 = 1000 cm^3.

Density

- Density = mass/volume

- *Units (IB): g cm^{-3} (read as grams per centimeters cubed--same as g/ml) or g dm^{-3} (same as g/l)*

Nomenclature

- Ionic: a metal and a nonmetal or a polyatomic ion and a counterion
  Remember, charges must balance out to an overall charge of zero.
  - o Name the cation first, then the anion.
  - o For metals that
    - only have one possible charge, simply name the metal
    - have more than one possible charge, the charge must be indicated
      - o Write the name of the metal followed by roman numerals in parentheses to indicate the charge (stock system),
        i.e. iron (III)—Fe^{3+} vs. iron (II)—Fe^{2+}
  - o For nonmetals (second element), change the ending to -ide

- Covalent: 2 nonmetals or a metalloid and a nonmetal
  - o Name the elements in the order in which they appear.
  - o Do not change the name of the first element; change the ending of the second element to –ide.
  - o Add prefixes to each element to indicate the number of atoms of that element. (Omit the "mono" prefix on the first element.)

- Acids: Compounds beginning with hydrogen
  - o Binary acids: hydrogen + one other element
    - Add the prefix "hydro-" and change the ending of the element to "-ic"
  - o Oxyacids: hydrogen + a polyatomic ion containing oxygen
    - Do not add a prefix
    - If the polyatomic ion ends in –ite, change the ending to –ous.
    - If the polyatomic ion ends in –ate, change the ending to –ic.

1. How many significant figures does each of the numbers contain?

a. 0.0278 meter

b. 1.3 centimeter

c. 1.00 foot

d. 8021 yards

e. 7.98 x10^{-3} pounds

2. Round the following numbers to three significant figures.

a. 4325 b. 6.873 x 10^3 c. 0.17354

3. Make the following conversions:

a. 65 kg to grams

b. 750 micrograms to grams

c. 0.25 nanometers to cm

d. 23.8 milligrams to kg

4. Express the following numbers in scientific notation with the indicated number of significant figures:

a. 0.0000098765 (5 sig. figs) b. 10,000 (2 sig. figs)

5. Express the following as ordinary numbers (standard notation):

a. 7.51 x 10^{-7} **b. 5.43 x 10^{0}**

6. Perform the indicated operations and round your answers to the proper number of significant figures. Assume that all answers were obtained from measurements.

a. $(2.11 \times 10^{-3}) + (1.54 \times 10^{-3})$

b. $(1.54 \times 10^{-3}) + (2.11 \times 10^{-2})$

c. $(4.56 + 18.7)/(1.23 \times 10^{2})$

d. $(1.23 \times 10^{-2})(4.56 + 1.87)$

7. **How many cubic meters (m^3) are there in 1.773×10^5 cubic decimeters (dm^3)?**

8. The density of silver is 10.5 g/cm^3. What volume of silver metal will have a mass of exactly 2500.0 grams?

9. **What is the mass of 215 dm^3 of hydrogen sulfide gas if the density of hydrogen sulfide is 1.54 g dm^{-3} (g/dm^3)?**

10. 28.5 grams of iron shot is added to a graduated cylinder containing 45.5 cm^3 of water. The water level rises to the 49.1 cm^3 mark. From this information, calculate the density of iron.

11. **A rectangular block of copper metal weighs 1896 grams. The dimensions of the block are 8.4 cm by 5.5 cm by 4.6 cm. From this data, what is the density of copper?**

12. The helium gas stored inside a large weather balloon weighs 13.558 grams. What is the volume of this balloon if the density of helium is 0.1786 g dm^{-3}?

13. **Write the name of the following compounds:**
    - **a. KF**
    - **b. $CaSO_4$**
    - **c. HCl**
    - **d. $SbCl_3$**
    - **e. As_4O_{10}**
    - **f. NH_4Cl**
    - **g. NH_4NO_3**
    - **h. IF_5**
    - **i. $NaHCO_3$**
    - **j. $Ba(OH)_2$**
    - **k. $FeCl_3$**
    - **l. HF**
    - **m. $PbSO_4$**
    - **n. KrF_2**
    - **o. NaCl**
    - **p. P_2O_5**

14. Write the formula for the following compounds:
    - a. ammonium sulfide
    - b. cupric bromide
    - c. aluminum sulfate
    - d. potassium nitrite
    - e. ferrous carbonate
    - f. lead (II) phosphate
    - g. diphosphorus pentoxide
    - h. cupric hydroxide
    - i. calcium fluoride
    - j. tin (II) nitrate
    - k. silver cyanide
    - l. ammonium sulfite
    - m. zinc sulfate
    - n. antimony (III) chloride
    - o. silver sulfide
    - p. magnesium hydroxide
    - q. ammonium carbonate
    - r. nickel (II) acetat

Week Two

Review of atomic structure & chemical reactions:

Atomic structure:

- An atom is made up of protons and neutrons (both found in the nucleus) and electrons (found in the orbitals surrounding the nucleus).
- The atomic number of an element is equal to the number of protons.
- The mass number (different from the average atomic mass) is the sum of the protons and neutrons.
- A charge written in the upper right corner indicates that electrons have been lost or gained.

Isotopic Symbol	Proton	Neutron	Electron	Mass #	Charge	Cation or Anion
$^{19}_{9}F^{-1}$	9	10	10	19	-1	A
$^{24}_{12}Mg^{+2}$	12	12	10	24	+2	C
$^{32}_{16}S^{-2}$	16	16	18	32	-2	A
$^{59}_{28}Ni^{+2}$	28	31	26	59	+2	C

Chemical reactions:

- Remember to add coefficients to balance all equations.
- Do not forget the seven diatomic elements.
- Review the five reaction types: synthesis, decomposition, single replacement, double replacement, and combustion: How to classify them and predict products

15. Express the following numbers with the indicated number of significant figures.

a. 1000 (2 sig figs) b. 43,927 (3 sig figs) c. 0.000286 (3 sig figs)

16. How many cubic meters (m^3) are there in 4312 cubic centimeters (cm^3)?

17. A cylindrical glass tube of length 27.75 cm and the radius 2.00 cm is filled with argon gas. The empty tube weighs 188.25 grams and the tube filled with argon weighs 188.87 grams. Use the data to calculate the density of argon gas. (Volume of a cylinder = $\pi r^2 h$.)

18. Complete the following table

Element/Ion	Atomic Number	Mass Number	# Protons	# Neutrons	# Electrons
^{1}H					
$^{1}H^{+1}$					
^{12}C					
$^{7}Li^{+}$					
$^{35}Cl^{-1}$					
^{39}K					
$^{24}Mg^{+2}$					

19. **Write a balanced equation and indicate the reaction type (single or double replacement, decomposition, or composition/synthesis) for each of the following:**
    a. **Aluminum nitrate (aq) + sodium hydroxide (aq) → aluminum hydroxide (s) + sodium nitrate (aq)**
    b. **Potassium chlorate (s) → potassium chloride (s) + oxygen (g)**
    c. **Phosphoric acid (aq) + magnesium hydroxide (aq) → magnesium phosphate (s) + water (l)**
    d. **Ammonium nitrite (s) → nitrogen (g) + water (l)**
    e. **Iron (s) + silver acetate (aq) → iron (II) acetate (aq) + silver (s)**
    f. **Ammonium sulfide (aq) + iron (II) nitrate (aq) → ammonium nitrate (aq) + iron (II) sulfide (s)**

20. Write the name of the following compounds:
    a. $KMnO_4$
    b. NiI_2
    c. Cu_2CO_3
    d. $AgClO_4$
    e. $Mg(NO_3)_2$
    f. $FeCrO_4$
    g. Hg_2O_2

21. **Write a balanced equation and indicate the reaction type (single or double replacement, decomposition, or composition/synthesis) for each of the following:**
    a. **Calcium hydroxide (aq) + nitric acid (aq) →**
    b. **Zinc chloride (aq) + ammonium sulfide (aq) →**
    c. **Silver acetate (aq) + potassium chromate (aq) →**

Week Three

Review of stoichiometry: **BALANCE. LABEL. TRAIN TRACK.**

Line up conversion factors using dimensional analysis.

- grams ↔ moles, same substance: use molar mass
- particles ↔ moles, same substance: Avogadro's number (6.022×10^{23} particles = 1 mol)
- volume of a gas ↔ moles, at STP: use standard molar volume (22.42 L = 1 mol)
- volume of a solution ↔ moles: use molarity (Molarity = moles of solute/ liter of solution)
- moles one substance ↔ moles another substance: use mole ratio (coefficients in eqn)

Limiting reactant problems: when you have more than one given, solve for all to determine the limiting reactant and the amount of product formed.

22. Determine the moles of barium bromate that can be prepared from 7.000 moles of each $HBrO_3$ and $Ba(OH)_2$ given this balanced equation:

$$2\ HBrO_3 + Ba(OH)_2 \rightarrow Ba(BrO_3)_2 + 2\ H_2O$$

23. How many molecules of ammonia would be produced if 13.4 grams of nitrogen gas reacted at STP?

$$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3\ (g)$$

24. $6\ NaOH + 2\ Al \rightarrow 2\ Na_3AlO_3 + 3\ H_2$

a. **What mass of Na_3AlO_3 can be formed from 165.0 grams of sodium hydroxide?**
b. **How many moles of NaOH are required to produce 3.0 grams of hydrogen?**
c.

25. $4\ FeCr_2O_7 + 8\ K_2CO_3 + O_2 \rightarrow 2\ Fe_2O_3 + 8\ K_2CrO_4 + 8\ CO_2$

How many grams of iron (II) dichromate are required to produce 44.0 grams of carbon dioxide?

26. What volume of oxygen gas will be required to produce 23.7 grams of mercury (I) oxide at STP?

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

27. If 20.0 grams of KOH react with 15.0 grams of $(NH_4)_2SO_4$, calculate the moles of K_2SO_4 produced. Identify the limiting reactant.

$$2\ KOH + (NH_4)_2SO_4 \rightarrow 2\ H_2O + 2\ NH_3 + K_2SO_4$$

28. What reactant is limiting if 3000 cm^3 of Cl_2 at STP reacts with a solution containing 25.0 grams of NaBr? $Cl_2 + 2\ NaBr \rightarrow Br_2 + 2\ NaCl$

29. Write the formula for the following compound:

a. Ammonium phosphate
b. Iron (II) chlorite
c. Potassium sulfide
d. Tin (II) bromide
e. Lithium chromate
f. Sulfurous acid
g. Zinc bisulfite
h. Sodium sulfite
i.

30. Write the names of the following compounds:

a. **Hg_2SO_4**
b. **KH**
c. **$Co_2(SO_3)_3$**
d. **N_2O_3**
e. **N_2O**
f. **$Fe(NO_3)_2$**
g. **$Sn_3(PO_4)_2$**
h. **H_2O_2**

31. Write a balanced equation and indicate the reaction type (single or double replacement, decomposition, or composition/synthesis) for each of the following:

a. Sulfuric acid (aq) + potassium hydroxide (aq) →
b. Mercury (II) sulfate (aq) + ammonium nitrate (aq) →
c. Zinc (s) + sulfuric acid (aq) →

Week Four

Review of Periodic Table & electron configuration:
Review the Periodic Table, trends, and electron configuration.
Orbital Notation ("Electron in a box")
Remember how to use your Periodic Table to determine electron configuration.
- o Period tells you the main energy level being filled
- o "Block" tells you the energy sublevel being filled
- o Column within the block tells you the number of electrons in that sublevel.

Shorthand electron configuration (Noble Gas configuration)
1) Step one, go up one row and all the way over to the Noble Gas (Group 18). Write the element symbol in square brackets [ ]
2) Start at the next element (Beginning of the row the element is in) and write the remainder of the electron configuration.
   Example for iron: [Ar] $4s^2$ $3d^6$

32. a. What name is given to the elements in a vertical column on the periodic table?
b. What name is given to the elements in a horizontal row on the periodic table?

33. a. What is the most active metal?
b. What is the most active nonmetal?
c. What are the least reactive elements on the Periodic Table?

34. What is the significance of the zig zag line running diagonally down and to the right near the right side of the periodic table?

35. What is electron affinity?

36. What element has the lowest ionization energy?

37. How many electrons are in the valence shell of:
a. the Halogens?
b. the Oxygen family?
c. the alkali metals?
d. the boron family?
e. the neon gases?
f. the alkaline earth metals?
g. the carbon family?
h. the nitrogen family?

38. a. Why do atomic radii decrease from left to right within a period?
b. Why do they decrease down a group?

39. Arrange each of the following in order of increasing atomic radii:
a. the alkaline earth metals
b. the main group elements in the third period
c. C, Si, Sn, Pb

40. Arrange the following in order of decreasing radius: Br, I, Se, Li.

41. Why does ionization energy increase from left to right across a period?

42. Arrange the members of each of the following sets of elements in order of increasing first ionization energy:
a. the alkali metals
b. the halogens
c. the elements in the second period
d. Br, Cl, B, Ga, Cs, and H

43. Write the electron configuration (long way) for:

a. palladium. **b. sulfur** **c. francium**

44. Write the orbital notation (boxes) for:

a. scandium b. magnesium c. cadmium

45. Write the electron configuration using the Noble Gas core method (shorthand) for

a. radium. **b. lead** **c. californium**

46. Make the following conversions:

a. 9.57×10^{-8} mm to nm
b. 2.00 L to mL
c. 35.38 mL to L
d. 5000 cm^3 to mL

47. Find the mass of 250.0 cm^3 of benzene. The density of benzene is 0.90 g cm^{-3}.

48. Write a balanced equation and indicate the reaction type (single or double replacement, decomposition, or composition/synthesis) for each of the following:

a. barium carbonate (s) + hydrochloric acid (aq) →
b. chlorine (g) + magnesium iodide (aq) →
c. aluminum sulfate (aq) + calcium phosphate (s) →
d. iron (s) + hydrochloric acid (aq) →

49. If 81.00 g of H_2O is formed during this reaction, what mass of BaO was used?

$BaO + H_2SO4 \rightarrow BaSO_4 + H_2O$

Week Five

Review of percent composition, empirical formulas, and molecular formulas:
****NEW if you were not in Honors Chemistry 1*
Percent composition:

1. Calculate the mass of the entire compound (molar mass).
2. Calculate the mass that the element/component contributes to the compound.
3. Divide the mass due to the element/component by the molar mass and multiply by 100.

Empirical formula: (simplest whole number ratio of atoms in a compound)

1. Percent to mass: If percent composition is given, assume a 100g sample and change percent sign to grams.
2. Mass to moles: Convert the mass of each element to moles, using molar mass.
3. Divide by small: Divide all answers from step 2 by the smallest mole number from step 2.
4. Multiply 'til whole: If any of the answers from step 3 are not whole numbers, multiply all answers from step 3 by the same number to achieve whole numbers.

Molecular formula: (true formula)

1. Determine the empirical formula.
2. Calculate the mass of the empirical formula.
3. Divide the molar mass of the compound by the mass of the empirical formula to find the ratio between the molecular formula and the empirical formula.
4. Multiply all the atoms (subscripts) by this ratio to find the molecular formula.

50. Calculate the percentage composition of iron (III) oxide

51. Calculate the percentage of nitrogen in $(NH_4)_2SO_3$

52. Determine the percentage of sodium in sodium sulfate.

53. Chromium exists in four different oxide compounds. From the following data, determine the empirical formula for a compound containing 0.765 grams Cr and 0.235 grams O.

54. Citric acid, an organic acid found in lemons and other fruits, contains 37.5% carbon, 58.3% oxygen, and 4.20% hydrogen. What is the empirical formula of citric acid? What is the molecular formula if it has a molecular mass of 192 amu?

55. Perform the indicated operations and round off your answers to the proper number of significant figures. Assume that all numbers were obtained from measurements.

a. 18.56 + 1.233 b. 1.234 x 0.247 c. 4.3/8.87

56. Make the following conversions:

a. 3.5 L to cm^3
c. 2.0043×10^{-5} km to m
b. 105 m to km
d. 1.549 µm to km

57. Write the electron configuration (long way) for yttrium.

58. Write the orbital notation (boxes) for zinc.

59. Write the electron configuration using the Noble Gas core method for mendelevium.

60. A rubber balloon weighing 144.85 grams is filed with carbon dioxide gas and reweighed. The weight of the balloon plus gas is 153.77 grams. The volume of the balloon filled with carbon dioxide is 4.55 dm^3. What is the density of carbon dioxide?

61. Calculate the density of sulfuric acid if 35.4 mL of the acid has a mass of 65.14 grams.

62. Write the formulas for the following compounds:

a. silver oxide
b. mercury (II) perchlorate
c. oxygen difluoride
d. acetic acid
e. barium hypobromite
k. ammonium hydroxide
f. cobalt (II) iodide
g. chromium (II) bicarbonate
h. hydrochloric acid
i. aluminum bisulfite
j. cobalt (III) sulfate

63. Write the name of the following compounds:

a. N_2O_5
b. $SnCrO_4$
c. Al_2O_3
d. $CuCO_3$
e. ClO_2
f. CuS
g. MgI_2
h. NaCN
i. **Hg_3N_2**

64. Write a balanced equation and indicate the reaction type (single or double replacement, decomposition, or composition/synthesis) for each of the following:

a. cobalt (III) hydroxide (aq) + nitric acid (aq) →
b. bromine (l) + sodium iodide (aq) →
c. ammonium sulfate (aq) + calcium hydroxide (aq) →

65. $CaCl_2 + 2\ AgNO_3 \rightarrow 2\ AgCl + Ca(NO_3)_2$
How many grams of AgCl would be produced from 78.00 grams of $CaCl_2$?

Week Six

Review of gases:
Remember temperature must be in Kelvin anytime you are working with gases.
At STP (100 kPa and 273 K) 1 mol of a gas has a volume of 22.7 dm^3.
[*These numbers are slightly different from the ones you used in Chemistry 1.]*
Remember, at constant pressure and temperature conditions, equal volumes of gases contain equal moles, so coefficients in a balanced chemical equation can be used as volume ratios for gases.
Combined gas law -- Use for changing conditions of a single gas.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Ideal gas law -- Use when mass or moles of a gas are referred to, and you are not at STP.

$PV = nRT$ $\qquad$ $R = 8.3145\ \frac{kPa\ dm3}{mol\ K}$

Dalton's law -- For a mixture of gases, the total pressure is equal to the sum of partial pressures of the individual gases.
$P_{total} = P_1 + P_2 + P_3 \ldots$

66. A rigid container holds a gas at a pressure of 56kPa at –100.°C. What will the pressure be when the temperature is increased to 200.°C?

67. What is the volume at STP of a sample of carbon dioxide that has a volume of 75.0 cm^3 at 30.0°C and 98kPa?

68. What is the volume of a sample of oxygen gas that has a mass of 50.0 grams and is under a pressure of 122kPa at 27.0°C?

69. If 20.0 dm^3 of methane, CH_4, react with 200.0 dm^3 of oxygen, calculate the mass of carbon dioxide produced at STP.

$$CH_4\ (g) + 2\ O_2\ (g) \rightarrow CO_2\ (g) + 2\ H_2O\ (l)$$

70. If 20.0 grams of KOH react with 15.0 grams of $(NH_4)_2SO_4$, calculate the following:

$$2\ KOH + (NH_4)_2SO_4 \rightarrow 2\ H_2O + 2\ NH_3 + K_2SO_4$$

a. the mass of NH_3 produced
b. the cm^3 of NH_3 produced at STP

71. Determine the total pressure of a gas mixture that contains CO, Ne, and He if the partial pressures of the gases are P_{CO} = 1.53 atm, P_{Ne} = 0.82 atm, and P_{He} = 0.34 atm.

72. Ammonia is produced by the reaction of nitrogen and hydrogen according to this balanced equation:

$$N_2\ (g) + 3\ H_2\ (g) \rightarrow 2\ NH_3\ (g)$$

What volume of ammonia would be produced if 13.4 grams of hydrogen gas reacted at STP?

73. Calculate the density of helium in g/ dm^3 if a balloon with a capacity of 5.00 dm^3 holds 0.890 grams.

74. Write the formulas for the following compounds:
a. nitrogen triiodide
b. calcium perchlorate
c. iron (II) chromate
d. iron (III) carbonate
e. ammonia
f. nitric acid

75. Write the name of the following compounds:

a. NaOH **d. P_3H_5** **g. CsF**

b. NI_3 **e. UF_6** **h. CO**

c. ClF_3 **f. Cl_2O_3** i. **Cu_2S**

76. Write the electron configuration using the Noble Gas shorthand for gold.

77. Write a balanced equation and indicate the reaction type (single or double replacement, decomposition, or composition/synthesis) for each of the following:

a. Ammonium nitrite (s) → nitrogen (g) + water (l)

b. Ammonia (g) + oxygen (g) → nitrogen (II) oxide (g) + water (l)

c. Magnesium hydroxide (aq) + phosphoric acid (aq) → magnesium phosphate (s) + water (l)

78. Calcium dihydrogen phosphate is an important fertilizer. What is the percent phosphorus in $Ca(H_2PO_4)_2$?

79. Two compounds are analyzed and found to contain:

a. 0.89 grams K, 1.18 grams Cr, and 1.27 grams O

b. 1.03 grams K, 0.69 grams Cr, and 0.84 grams O

Determine the empirical formulas for these two compounds.

<u>Week Seven</u>

Review of solution concentration:
Molarity (M):
Molarity = moles of solute/total volume of solution
Units: mol dm^{-3} (read as moles per decimeters cubed, same as mol/L = M)
Percent by mass:
% by mass = mass of solute/**total** mass of solution

80. What is the molarity of 5.00 grams of NaOH in 750.0 cm^3 of solution?

81. How many grams of Na_2CO_3 are required to make 100.0 mL of a 2.0 M solution?

82. What is the concentration of a solution with 5.30 grams of Na_2CO_3 dissolved in 400.0 g of water?

83. What is the percent by mass of 125.0 grams of H_2SO_4 dissolved in 500.0 cm^3 of water? (The density of water is 1.00 g/cm^3)

84. Calculate the empirical formula of the compound which has the following percentage compositions: 21.8 % Mg, 27.9% P, and 50.3% O

85. Perform the indicated operations and round off your answers to the proper number of significant figures. Assume that all numbers were obtained from measurements.
- **a. $(1.54 \times 10^3) + (2.11 \times 10^3)$**
- **b. $(4.56 + 8.7)/(1.23 \times 10^{-2})$**

86. Make the following conversions:
- a. 7.8825×10^5 mm to cm
- b. 5.79×10^{-7} m to nm
- c. 0.0031 km to m
- d. 5,240 cm^3 to dm^3

87. A flask built to hold exactly 2.5000 L is filled with nitrogen. The mass of the nitrogen in the flask at standard conditions is 0.1250 grams. What is the density of the nitrogen?

88. Write the formulas for the following compounds:
- a. Phosphorus pentabromide
- b. Iron (III) bicarbonate
- c. Silver sulfide
- d. Potassium iodide
- e. Lead (IV) chlorite
- f. Mercury (I) chromate
- g. Potassium dichromate

89. Write the name of the following compounds:
- **a. BrO_3 (not an ion)**
- **b. Sb_2O_5**
- **c. LiH**
- **d. SF_6**
- **e. SnI_4**
- **f. K_2O**
- **g. H_2SO_4**

90. Write a balanced equation and indicate the reaction type (single or double replacement, decomposition, or composition/synthesis) for each of the following:
- a. Magnesium (s) + oxygen (g) → magnesium oxide (s)
- b. Ammonium phosphate (aq) + barium hydroxide (aq) →

91. An essential amino acid which cannot be made (synthesized) by the body and must be obtained in the diet is methionine. What is the percentage of carbon, nitrogen, and sulfur in this amino acid if the formula of methionine is $CH_3SCH_2CH_2CHNH_2COOH$?

92. Write the electron configuration (long way) for barium.

93. Write the orbital notation (boxes) for selenium.

94. Write the electron configuration using the shorthand configuration (Noble Gas notation) for protactinium.

95. Given the following balanced equation $4\ Hg\ (l) + O_2\ (g) \rightarrow 2\ Hg_2O\ (s)$
How many grams of oxygen will be required to react with 67.3 grams of Hg?

96. Arrange the members of each of the following sets of elements in order of increasing electron affinities:

a. the alkali metals
b. the elements in the second period
c. Li, K, C, F, and Cl

97. Arrange the following elements in order of increasing electron affinities: P, S, Cl, and I .

98. Nitrogen gas in a steel cylinder is under a pressure of 1520 kPa at 27°C. What will be the pressure in the tank if the tank is left in the sun and the temperature rises to 55°C?

99. If 20.0 dm^3 of methane, CH_4, (measured at STP) reacts with excess oxygen in a combustion reaction, calculate the mass of water produced.

Week Eight

Review Drawing Covalent Lewis Dot Structures

1. Find total number of valence electrons
2. Arrange atoms – singleton atom is usually in the middle.
   *** *If carbon is present, it ALWAYS goes in the middle. Hydrogen is NEVER in the middle (only forms 1 bond).*

0. Form covalent bonds between atoms (1 bond = 2 electrons).
0. Arrange remaining electrons to give each atom a full valence shell (8 electrons=octet).

Exceptions:
*** H is full with 2 electrons. Be is stable with 4 electrons. B is stable with 6 electrons.

0. If there aren't enough electrons to give all atoms a full valence shell, form double or triple bonds.

100. Draw Lewis dot structures for the following molecules:

a. BF_3 **c. NH_3** **e. CH_3Cl**
b. SO_3 **d. H_2O** **f. C_2H_6**

101. How many significant figures does each of the numbers contain?

a. 0.2003 ton c. 1×10^{12} atoms
b. 4.69×10^4 tons d. 1.73×10^{24} atoms

102. Mercury metal is poured into a graduated cylinder that holds exactly 22.5 cm^3. The mercury used to fill the cylinder weighs 306.0 grams. From this information, calculate the density of the mercury in g cm^{-3} (g/cm^3)

103. Write the names for the following compounds:

a. $KHCO_3$ c. HgO e. PBr_5 g. Cl_2O i. NO
b. $SbCl_5$ d. PCl_3 f. IF_7 h. CCl_4

104. Write a balanced equation and indicate the reaction type (single or double replacement, decomposition, or composition/synthesis) for each of the following:

a. Calcium oxide (s) + diphosphorus pentoxide (s) → calcium phosphate (s)
b. Sodium carbonate (aq) + sulfuric acid (aq) → sodium sulfate (aq) + carbon dioxide (g) + water (l)
c. Iron (II) sulfide (s) + hydrochoric acid (aq) →

105. The sugar substitute sodium benzosulfimide (sodium saccharin) has a sweetness of about 500 times that of regular sugar. Calculate the percentage of sodium and carbon in the sweetener if its formula is $C_7H_4O_3SNNa$.

106. SnO_2 is reduced by carbon according to this reaction: $SnO_2 + C \rightarrow Sn + CO_2$.

a. What volume of CO_2 are produced if 300.0 grams of tin are produced at STP?
b. How many grams of SnO_2 are required to produce 1800.0 grams of tin?

107. If 20.0 grams of hydrogen gas react with 15.0 grams of nitrogen, which gas is the limiting reactant? How many dm^3 of ammonia will be produced? Assume the reaction takes place at STP.

108. Determine the number of mass of solute to prepare these solutions:

a. 2.00 dm^3 of a 0.50 mol dm^{-3} $Cu(NO_3)_2$ solution.
b. 16.00 mL of a 0.415 M $Pb(NO_3)_2$ solution.

109. Sea water contains roughly 28.0 grams of NaCl per liter. What is the molarity of sodium chloride in seawater?

110. White lead contains 80.1% lead, 16.5% oxygen, 3.10% carbon, and 0.260% hydrogen. What is the formula of this compound?

111. Compare the elements Na, B, Al, and C with regard to the following properties:

- **a. Which has the largest atomic radius?**
- **b. Which has the largest electron affinity?**
- **c. Place the elements in order of increasing ionization energy.**

112. Which has the largest ionization energy: N, P, or As? Why?

113. A mass of air occupies a volume of 5.7 dm^3 at a pressure of 53 kPa. What is the new pressure if the same mass of air at the same temperature is transferred to a 2.0 dm^3 container?

114. What is the mass of ethyl alcohol that exactly fills a 200.0 cm^3 container? The density of ethyl alcohol is 0.789 g/cm^3.

Week Nine

115. Draw Lewis dot structures for the following molecules:

g. BeF_2 h. SO_2 i. NCl_3 j. H_2S

116. Write the electron configuration (long way) for silicon.

117. Write the orbital notation (boxes) for nitrogen.

118. Write the electron configuration using the Noble Gas shorthand for arsenic.

119. A sample of seawater has a mass of 159 grams and has a volume of 156 cm^3. What is its density?

120. Write the names of the following compounds:

a. XeF_4	**d. H_3BO_3**	**g. NaBr**	**j. Hg_2O**
b. CaH_2	**e. I_2O_5**	**h. $Li_2Cr_2O_4$**	**k. $Ca(C_2H_3O_2)_2$**
c. As_4O_6	**f. PbO**	**i. SO_3**	**l. $Al(OH)_3$**

121. Write the formulas for the following:

a. Calcium sulfide	e. Sulfuric acid	i. Perchloric acid
b. Zinc permanganate	f. Aluminum oxide	j. Iron (II) phosphate
c. Hydrobromic acid	g. Cobalt (II) bisulfate	k. Lead (II) oxide
d. Hydrogen cyanide	h. Barium carbonate	l. Cobaltic chlorate

122. Calculate the percentage composition of the following:

a. HgO **b. Na_2S**

123. For the reaction $2\ KMnO_4 + H_2SO_4 \longrightarrow K_2SO_4 + Mn_2O_7 + H_2O$,
how many moles of Mn_2O_7 can be formed from 196.0 grams of $KMnO_4$?

124. KOH with a mass of 50.0 grams is neutralized by 20.0 grams of sulfuric acid. The products are potassium sulfate and water. Calculate the amount in moles of potassium sulfate produced.

125. What is the temperature of the gas inside a 750 cm^3 balloon filled with 0.300 grams of H_2 gas? The pressure of the balloon is 110 kPa.

126. How many grams of water vapor will be produced when 1.18 grams of oxygen react completely with hydrogen to form water?

127. What mass in grams of KCl is needed to make 2.50 dm^3 of a 0.50 mol dm^{-3} KCl solution?

128. What is the molarity of a solution containing 12.0 grams of NaOH in 250.0 mL of solution?

129. Which has the larger radius, Br or Br^-? Why?

130. Arrange the members of each of the following sets of elements in order of increasing electronegativities:

a. S, Na, Mg, Cl

b. P, N, Sb, Bi

c. Se, Ba, F, Si, Sc

131. A sample of a compound is analyzed and found to contain 0.89g K, 1.18g Cr, and 1.27g O. Determine the empirical formula for this compound.

Week Ten

132. A piece of property is found to be 499 decimeters long. What is the value of this length in centimeters?

133. Calculate the number of kilometers in 105 meters.

134. Write the formulas for the following:

- **a. Mercury (II) fluoride**
- **b. Potassium permanganate**
- **c. Barium hydroxide**
- **d. Calcium carbonate**
- **e. Barium phosphate**
- **f. Carbonic acid**
- **g. Phosphorus pentafluoride**
- **h. Silver oxide**
- **i. Lead (II) chlorite**
- **j. Copper (I) chromate**
- **k. Calcium perchlorate**
- **l. Acetic acid**

135. Write the names of the following compounds:

- a. $CuSO_4$
- b. $Cr(OH)_3$
- c. $HClO$
- d. $HClO_2$
- e. $HClO_3$
- f. $HClO_4$
- g. $Al(MnO_4)_3$

136. Write the electron configuration using the Noble Gas shorthand for antimony.

137. Write a balanced equation and indicate the reaction type (single or double replacement, decomposition, or synthesis/composition) for each of the following:

- a. aluminum acetate (aq) + sodium hydroxide (aq) $\rightarrow$ aluminum hydroxide (s) + sodium acetate (aq)
- b. Bromine (l) + calcium iodide (aq) $\rightarrow$ calcium bromide (aq) + iodine (s)
- c. Calcium hydroxide(aq) + phosphoric acid(aq) $\rightarrow$ calcium phosphate(s) + water(l)

138. A zinc sample, which has a mass of 40.0 grams, reacts with 20.0 grams of pure HCl. Zinc chloride and hydrogen gas are produced. Calculate the moles of $ZnCl_2$ produced.

139. A volume of 3.0 L of air is warmed from 50°C to 100°C. What is the new volume if the pressure remains constant?

140. A sample of gas occupies a volume of 80 mL at a pressure of 0.50 atm and a temperature of 0°C. What will the new volume be at a pressure of 1.50 atm and a temperature of 50°C?

141. If 20.0 dm^3 of methane, CH_4, react with 200.0 dm^3 of air, calculate the dm^3 of carbon dioxide gas produced.

$$CH_4\ (g) + 2\ O_2\ (g) \rightarrow CO_2\ (g) + 2\ H_2O\ (l)$$

142. How many grams of silver iodide can be produced from 52.38 grams of iodine and unlimited silver? $I_2\ (s) + 2\ Ag\ (s) \rightarrow 2\ AgI$

143. Ammonia is produced by the reaction of nitrogen and hydrogen according to this balanced equation:

$$N_2\ (g) + 3\ H_2\ (g) \rightarrow 2\ NH_3\ (g)$$

What mass of ammonia would be produced if 13.4 grams of nitrogen gas reacted?

144. Determine the final volume of a solution in which 8.97 grams of $(NH_4)_2CO_3$ is dissolved to make a 0.250 M solution

Week Eleven

145. Draw Lewis dot structures for the following molecules:

k. CO l. SF_2 m. HCN n. O_2

146. Complete the following table

Element/Ion	Atomic Number	Mass Number	# Protons	# Neutrons	# Electrons
$^{74}As^{-3}$					
^{108}Ag					
$^{108}Ag^{+1}$					
$^{33}S^{-2}$					
^{238}U					

147. Make the following conversions:

a. 2.77 kg to mg
b. 0.0290 cm to nanometers
c. 4560 microliters to decaliters
d. 1.08 kg to µg

148. A block of lead has dimensions of 4.5 cm by 5.2 cm by 6.0 cm. The block has a mass of 1587 g. From this information, calculate the density of lead.

149. Express the following exponentials as ordinary numbers:

a. 7.23×10^4 b. 8.193×10^2 c. 1.98×10^{-3}

150. Chromium exists in different oxide compounds. From the following data, determine the empirical formula of a compound containing 5.60 grams Cr and 2.62 grams O

151. Write the formulas for the following compounds:

a. Aluminum sulfate
b. Hydrobromic acid
c. Mercury (I) hypochlorite
d. Chromium (III) chloride
e. Phosphoric acid
f. Lithium permanganate
g. Magnesium bicarbonate
h. Tin (II) phosphate
i. Nitric acid
j. Zinc chloride
k. Tin (IV) carbonate

152. Write the name of the following compounds:

a. $Al(OH)_3$
b. Li_2HPO_4
c. $Ca(NO_3)_2$
d. $Ni(ClO_4)_2$
e. $Mn(NO_3)_2$
f. $Al(C_2H_3O_2)_3$
g. $Al_2(SO_4)_3$
h. $(NH_4)_3PO_4$

153. Write the electron configuration (long way) for krypton.

154. Write a balanced equation and indicate the reaction type (single or double replacement, decomposition, or synthesis/composition) for each of the following:

a. Potassium carbonate (aq) + barium chloride (aq) → potassium chloride (aq) + barium carbonate (aq)

b. Cadmium phosphate (s) + ammonium sulfide (aq) → cadmium sulfide (s) + ammonium phosphate (aq)

155. The volume of a sample of water is found to be 86.3 cm^3. What is the volume of the sample in dm^3?

156. Determine the moles of Na_2S that can be prepared by the reaction of 0.2240 moles of sodium with 0.1320 moles of sulfur. Which reactant in the limiting reactant?

$$16\ Na + S_8 \rightarrow 8\ Na_2S$$

157. If 46.2 grams of sulfur trioxide gas decompose into oxygen and sulfur dioxide, how many liters of oxygen gas will be produced at STP?

158. Which has the largest atomic radius: S, Se, or Cl? Why?

159. A volume of 20.0 L of O_2 is warmed from –30.0°C to 85.0°C. What is the new volume, if the pressure is kept constant?

160. What mass NaCl would be required to make 100.0 cm^3 of a 0.20 mol cm^{-3} NaCl solution?

161. What mass of H_2SO_4 would be needed to make 750.0 mL of a 2.00 M solution?

162. One compound of chromium contains 57.9% chlorine and a second compound contains 67.3% chlorine. What are the empirical formulas of these two chromium chloride compounds?

163. Explain the experiments and the contributions of the following to the development of the model of the atom:

a) Thomson
b) Millikan
c) Rutherford
d) Chadwick