Name: _____ Section: _____

Workshop 1 – Math Review

Algebra is an essential skill in solving scientific problems. The following problems review the type of math you will need to use in this course.

1. Given the following equation: $\mathbf{y = 3x^2 + 7}$

   a) Show your work using algebra (symbols only) to solve for x:

   b) If y = 100, solve for x by entering into your re-arranged equation:

   Write your numerical answer from the calculator: _____

2. a) Given the equation: $M_1V_1 = M_2V_2$, solve for M_2 (hint: rearrange the symbols)

   b) If $M_1 = 0.100$, $V_1 = 5$, and $V_2 = 250$, then what is the numerical value of M_2?

   M_2 = _____

Name: _____ Section: _____

3. For the equation $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$, use algebra to solve for T_2:

Ask yourself: Did you *actually* solve for T_2 or is your answer in terms of T_2^{-1}?

Check your math: If $V_1 = 950{,}000$, $V_2 = 115{,}600$, $P_1 = 0.980$, $T_1 = 298$, $P_2 = 0.905$, what does $T_2 = ?$

T_2 = _____

4. Use Power Rules to solve for the following (without a calculator!):

a) $\frac{10^8}{10^2} =$ (a) _____

b) $(10^4)(10^3) =$ (b) _____

c) $(10^1)(10^{-2}) =$ (c) _____

5. a) Write 10^{-7} as a fraction.

b) Write 10^{-2} as a decimal.

6. Average the following numbers:

3.75 4.23 4.95 3.80 4.41 4.72 _____

Name: _____ Section: _____

Workshop 2 – Scientific Notation and Scientific Calculators

1. Write each of the following numbers in proper scientific notation:

   (a) 587 (a) _____

   (b) 0.0077 (b) _____

   (c) 9,200 (c) _____

   (d) 406.0 (d) _____

   (e) 13,800,000 (e) _____

   (f) 0.0004 (f) _____

2. For each of these problems, complete the answer with a 10 raised to the proper power. Note that each answer is expressed to the correct number of significant figures.

   (a) $(1.73 \times 10^3)(2.0 \times 10^3) =$ (a) $3.5 \times$ _____

   (b) $\dfrac{6.477 \times 10^5}{3.62 \times 10^3} =$ (b) $1.79 \times$ _____

   (c) $(5.7 \times 10^3)(2.6 \times 10^5) =$ (c) $1.5 \times$ _____

   (d) $\dfrac{2.75 \times 10^{-6}}{2.3 \times 10^3} =$ (d) $1.2 \times$ _____

   (e) $\dfrac{5.80 \times 10^4}{9.53 \times 10^7} =$ (e) $6.09 \times$ _____

3. Solve each of the following problems, expressing each answer to the proper number of significant figures. Use scientific notation.

   (a) $(7.55 \times 10^2)(2.83 \times 10^8) =$ (a) _____

   (b) $\dfrac{(6.51 \times 10^{-2})(7.07 \times 10^{-5})}{2.92 \times 10^3} =$ (b) _____

Name: _____ Section: _____

Scientific Calculator

4. Write down the Brand and series number of your Scientific Calculator.
   Example: Texas Instruments TI-30XIIS

   Find at least one other student with the same brand and version of calculator (you may consider working with them for the remainder of this assignment).

5. Enter Avogadro's Number (6.022×10^{23}) into your calculator. Write down the sequence of buttons you used to enter a number in scientific notation on your calculator:

6. The diameter of a penny is 0.01905 meters. Convert this number into scientific notation and then enter into your calculator. Write below what button(s) would allow you to convert the number back to "standard" notation on your calculator.

7. Use this number for all the questions in this problem: $\mathbf{10^{-3}}$

   Write it as a fraction _____

   Write it as a decimal _____

   Enter into your scientific calculator. Which button(s) did you use to input?

Name: _____ Section: _____

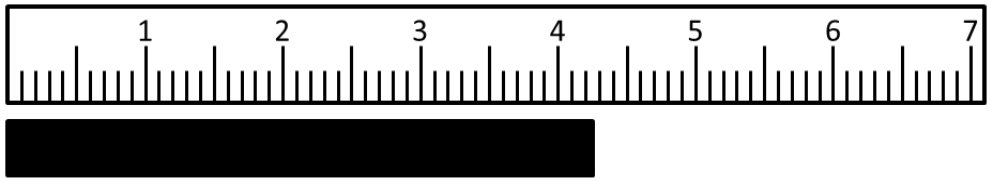
Workshop 3 – Significant Figures

Show calculation setups and answers for all problems below.

1. Using the ruler shown on the page, what is the length of the dark rectangle to the correct number of significant figures?

_____ cm

2. How many significant figures are in each of the following numbers?



(a) 8.57 _____ (b) 9.3 _____ (c) 6.20 _____ (d) 74,000 _____

(e) 0.058 _____ (f) 0.0085 _____ (g) 0.0790 _____ (h) 0.4020 _____

3. How many significant figures should be in the answer to each of the following calculations? (You may need to solve the math to answer the question, but your final answer is the number of significant figures, NOT the numerical answer to the problem.)

(a) 16.20
+ 0.87

(a) _____

(b) 46.837
–9.5

(b) _____

(c) 23.3×1.73

(c) _____

(d) 3.1×6.4215

(d) _____

(e) $\dfrac{0.4273}{0.1853}$

(e) _____

(f) $\dfrac{4.73 \times 8.31 \times 337}{834 \times 357}$

(f) _____

Name: _____ Section: _____

Workshop 4 – Dimensional Analysis

Show your calculation setup for the following problems. Make certain to express the appropriate units and round-off your answers to the proper number of significant figures.

1. Convert 25 ^{o}F to degrees Celsius. _____

2. Convert –75 ^{o}C to degrees Fahrenheit. _____

3. A ruler is 48.0 in. long. How long is this in centimeters? _____

4. A bowling ball weights 15.3 lbs. Calculate its mass in grams. _____

5. 125 mL of water are contained in a beaker. Convert this to quarts. _____

6. A baseball bat is 95.9 cm long. How long is this in:

   (a) Millimeters? _____

   (b) Feet? _____

7. An object has a mass of 35.8 g and a volume of 40.5 cm^3. Calculate the density of the object in g/mL.

   _____

Name: _____ Section: _____

8. A rubber stopper weighing 65.4 g is immersed into a graduated cylinder filled with 30.0 mL of liquid. The liquid level then rises to 48.8 mL. Calculate the density of the stopper.

_____

9. If the density of the liquid in Problem 8 is 0.785 g/mL, calculate the mass of the liquid in the graduated cylinder.

_____

10. A flask contains 365 mL of water. The density of water is 1.00 g/mL. Calculate:

    (a) The mass of the water in grams. _____

    (b) The volume of the water in liters. _____

11. The density of CCl_4 is 1.57 g/mL. Calculate the volume of 135 g of CCl_4.

_____

12. What is the density (g/mL) of a rectangular block of wood if it measures 4.0 cm thick, 120 mm long, and 0.57 in wide and has a mass of 0.0620 kg? Will the block sink or float in water?

_____

Circle one: sink or float

Name: _____ Section: _____

Workshop 5 – Nomenclature

Hint: The names and formulas of a variety of polyatomic ions (including ones that your instructor many not have previously given) can be found in the appendix of this lab manual.

A. Provide a chemical name for the following formulas:

1. NaBr _____
2. $MgBr_2$ _____
3. H_2O _____
4. $Ca(NO_3)_2$ _____
5. $Fe(NO_3)_2$ _____
6. Na_2SO_4 _____
7. SO_3 _____
8. $(NH_4)_3PO_4$ _____
9. $Fe_3(PO_4)_2$ _____
10. Cu_2CO_3 _____
11. Na_2O _____
12. KOH _____
13. $Mg(OH)_2$ _____

Name: _____ Section: _____

B. Provide a formula for the following names:

1. Sodium fluoride _____
2. Calcium iodide _____
3. Sodium phosphate _____
4. Barium phosphate _____
5. Chromium(III) nitrate _____
6. Gold(I) carbonate _____
7. Potassium hydrogen carbonate _____
8. Nickel(I) bicarbonate _____
9. Cobalt(II) acetate _____
10. Ammonium hydrogen sulfate _____
11. Calcium oxide _____
12. Barium hydroxide _____
13. Copper(II) chloride _____

Name: _____ Section: _____

C. Harder Set! Provide a chemical name for the following formulas:

1. Na_2S _____
2. $Ca(C_2H_3O_2)_2$ _____
3. $Fe(NO_2)_2$ _____
4. $MgSO_3$ _____
5. $NaHSO_3$ _____
6. Na_2CrO_4 _____
7. $Na_2Cr_2O_7$ _____
8. CCl_4 _____
9. $KClO_3$ _____
10. $Ca(ClO)_2$ _____
11. HNO_3 _____
12. $HBr_{(aq)}$ _____
13. HBr _____

Name: _____ Section: _____

D. Harder! Provide a formula for the following names:

1. Sodium permanganate _____
2. Beryllium chromate _____
3. Sodium sulfite _____
4. Calcium hydrogen phosphate _____
5. Chromium(III) chlorate _____
6. Sodium perchlorate _____
7. Sulfur pentachloride _____
8. Chlorine trioxide _____
9. Cobalt(III) cyanide _____
10. Potassium permanganate _____
11. Potassium carbonate _____
12. Hydrochloric acid _____
13. Phosphoric acid _____

Name: _____ Section: _____

E. Still harder set! Provide a chemical name for the following formulas:

1. $HClO_{4(aq)}$ _____
2. Na_2O_2 _____
3. $HI_{(aq)}$ _____
4. $HC_2H_3O_{2(aq)}$ _____
5. NaH _____
6. $TiCl_4$ _____
7. $Cu(MnO_4)_2$ _____
8. NH_4HSO_3 _____
9. $MgSO_4 \cdot 5H_2O$ _____
10. $Ca(ClO_3)_2$ _____
11. $H_2Cr_2O_{7(aq)}$ _____
12. $H_2CO_{3(aq)}$ _____
13. CO_2 _____

Name: _____ Section: _____

F. Still harder! Provide a formula for the following names:

1. Hydrogen peroxide _____
2. Arsenic trichloride _____
3. Potassium chromate _____
4. Chromic acid _____
5. Potassium hypochlorite dihydrate _____
6. Carbon disulfide _____
7. Ammonia _____
8. Iron(III) dichromate _____
9. Chloric acid _____
10. Copper(II) permanganate _____
11. Sodium hydrogen phosphate _____
12. Magnesium sulfide _____
13. Methane _____

Name: _____ Section: _____

Workshop 6 – Writing and Balancing Equations

Balance the following reactions. If given words, write the formulas and balance reactions in the space below the words. Remember which elements are diatomic. Include phases.

1. $Al(s) + O_2(g) \rightarrow Al_2O_3(s)$

2. $Fe(ClO_3)_3(s) \rightarrow FeCl_3(s) + O_2(g)$

3. $Ag(s) + HI(aq) \rightarrow AgI(s) + H_2(g)$

4. $H_2O(l) + N_2O_5(g) \rightarrow HNO_3(aq)$

5. $NH_3(g) + O_2(g) \rightarrow NO_2(g) + H_2O(l)$

6. $C_3H_8(l) + O_2(g) \rightarrow CO_2(g) + H_2O(l)$

7. Aqueous sodium hydroxide and sulfuric acid react to form aqueous sodium sulfate and liquid water

8. Methane gas (CH_4) and oxygen gas react to form carbon dioxide gas and water.

9. Solid calcium oxide and water create aqueous calcium hydroxide.

10. Solid sodium bicarbonate decomposes when heated to form solid sodium carbonate, carbon dioxide gas and liquid water.

11. Aqueous potassium sulfide and lead(II) nitrate react to produce solid lead(II) sulfide and aqueous potassium nitrate.

12. Aqueous acetic acid and potassium sulfite react to form aqueous potassium acetate, water and sulfur dioxide gas.

Name: _____ Section: _____

Predict products and Balance the following reactions. If no reaction takes place, write NR for no reaction. Include phases.

13. Combustion reactions: *nonmetals* + O_2 → *nonmetal oxides* (CO_2, H_2O)
    a) $C_7H_{16}(s) + O_2(g) \rightarrow$
    b) $C_6H_6(l) + O_2(g) \rightarrow$
    c) $C_4H_{10}O(l) + O_2(g) \rightarrow$
    d) $C_7H_6O_2(s) + O_2(g) \rightarrow$

14. Double displacement reactions: $AB + CD \rightarrow AD + CB$
    a) $AlCl_3(aq) + Pb(NO_3)_2(aq) \rightarrow$
    b) $HC_2H_3O_2(aq) + Ba(OH)_2(aq) \rightarrow$
    c) $K_2CrO_4(aq) + SnF_4(aq) \rightarrow$
    d) $Ca(HCO_3)_2(aq) + HBr(aq) \rightarrow$

15. Mixed reactions: Classify, Predict products, and Balance. Write the formulas and balance reactions in the space below the words. Identify all types of reactions for each in the margin.
    a) $HCl(aq) + Sr(OH)_2(aq) \rightarrow$
    b) $AlCl_3(aq) + NaNO_3(aq) \rightarrow$
    c) $C_2H_4(g) + O_2(g) \rightarrow$
    d) $HNO_3(aq) + Li_2SO_3(aq) \rightarrow$

16. Word reactions: Write formulas and balance the reactions.
    a) Crude gunpowders often contain a mixture of potassium nitrate (KNO_3) and charcoal (solid carbon). When heated until a reaction occurs, a solid residue of potassium carbonate (K_2CO_3) is produced. The explosive force of the gunpowder comes from the fact that two gases are also produced, carbon monoxide and nitrogen, which increase in volume with great force and speed.

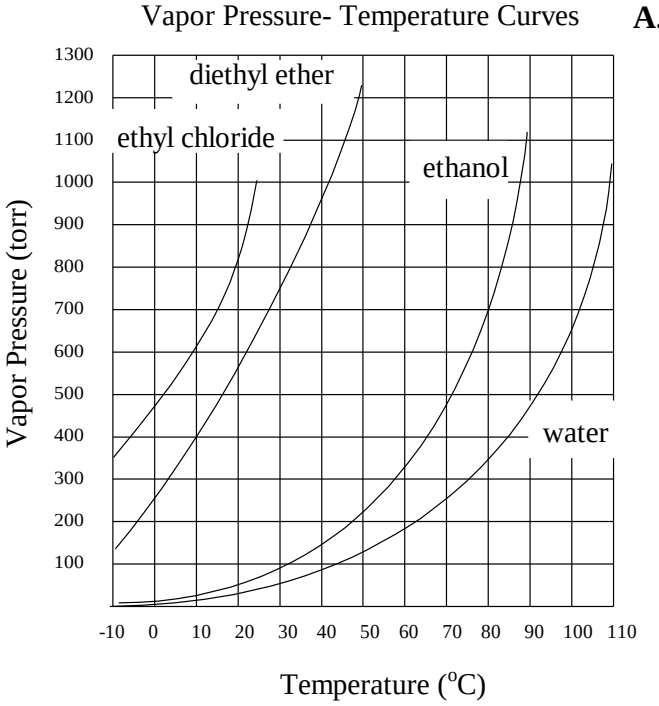
    b) A method of preparing pure iron involves heating iron(III) oxide and carbon monoxide together; they react to produce solid iron and carbon dioxide gas.

    c) The following reaction takes place in termites as they digest wood. Solid glucose, $C_6H_{12}O_6$, and liquid water react to produce aqueous acetic acid ($HC_2H_3O_2$), carbon dioxide, and hydrogen gas. Write a balanced chemical equation for the reaction including phases. (There are several correct answers possible, try to come up with more than one.)

Name: _____ Section: _____

Workshop 7 – Graphical Representation of Data

Answer the following questions by plotting and interpreting the data respectively.



A. Reading a Graph

From the figure at the left, read values for the following:

1. The vapor pressure of water at 70 ºC.

   _____

2. The temperature at which diethyl ether has a vapor pressure of 600 torr.

   _____

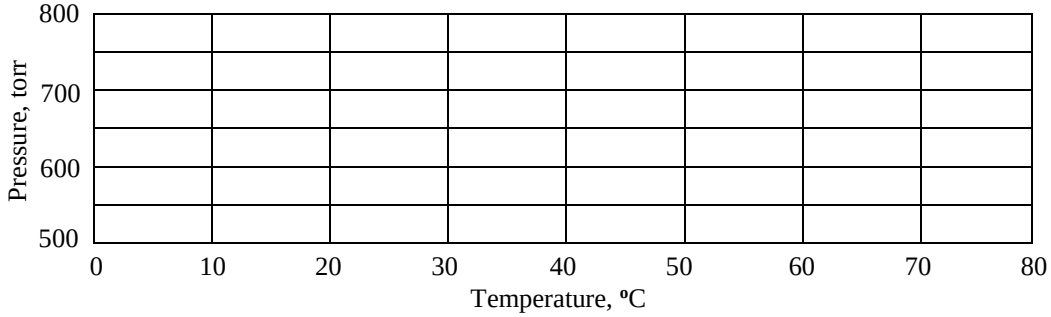
3. The temperature at which ethyl chloride has the same pressure ethanol has at 80 ºC.

   _____

B. Plotting Graphs

1. Plot the following pressure-temperature data for a gas on the graph. Draw the best possible straight line through the data.

Temperature, °C:	0	20	40	60	80
Pressure, torr:	550	605	665	720	775



2. Solve for the slope of the graph above. Slope is defined as rise/run ($\Delta y/\Delta x$).

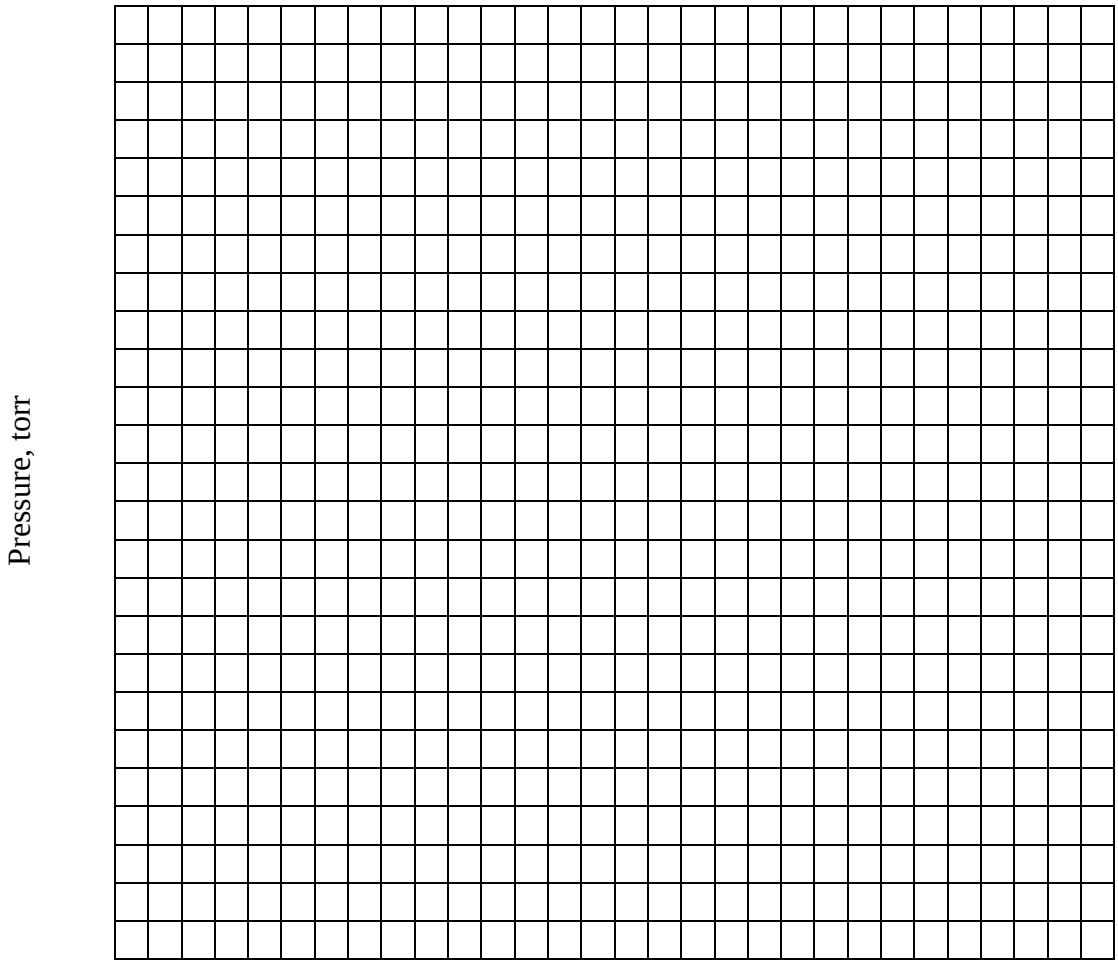
Slope = _____ (include units)

Name: _____ Section: _____

3. (a) Study the data given below; (b) determine suitable scales for pressure and for volume and mark these scales on the graph; (c) plot the eight points on the graph; and (d) draw the best possible CURVE through these points.

Pressure-Volume data for a gas

Volume, mL	107	76.4	55.7	45.6	35.2	29.7	24.3	20.1
Pressure, torr	25	35	48	60	76	90	110	133



Read from your graph:

(a) The pressure at 100 mL _____

(b) The volume at 70 torr _____

Name: _____ Section: _____

Workshop 8 – Quantum Mechanics

Show calculation setups and answers for all problems below.

1. An FM radio station has a frequency of 88.9 MHz (1 MHz = 10^6 Hz). Determine the wavelength (in nm).

_____

2. Violet light has a wavelength of about 410 nm. What is its frequency (in Hz)?

_____

3. An advertising sign gives off red light and green light.

   A. Which light has the higher energy? Briefly explain below.

_____

   B. One of the colors has a wavelength of 680 nm, and the other has a wavelength of 500 nm. Identify which color has which wavelength. Explain your identifications below.

Red = _____

Green = _____

   C. Which light has the higher frequency? Briefly explain below.

_____

4. Write the symbols for three cations and three anions *isoelectronic* with neon:

_____ _____ _____ _____ _____ _____

Name: _____ Section: _____

5. Write complete and abbreviated electron configurations for each of the following atoms/ions:

   A. S
   Complete: _____

   Abbreviated: _____

   B. Nb
   Complete: _____

   Abbreviated: _____

   C. Sb^{+}
   Complete: _____

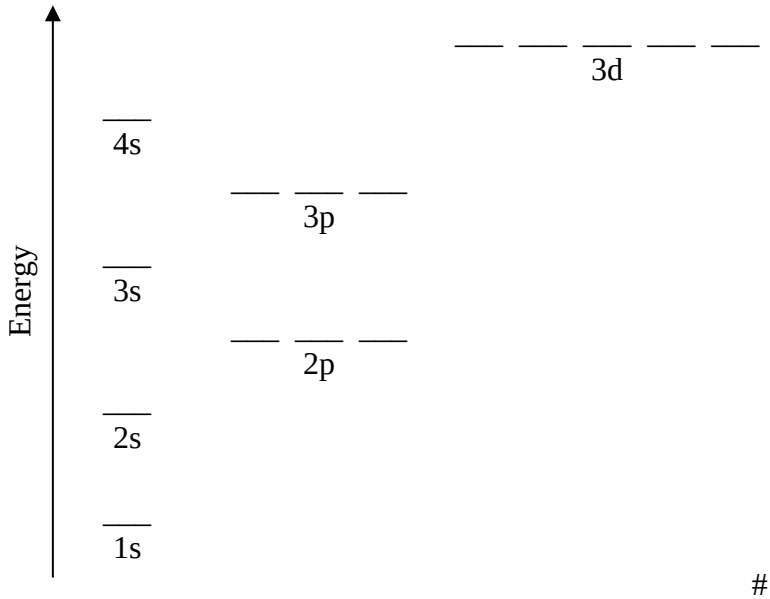
   Abbreviated: _____

6. Arrange the following forms of electromagnetic radiation in order of increasing energy:

   A. gamma rays from a supernova
   B. infrared rays from a hot plate
   C. ultraviolet light from the sun
   D. radiowaves from an MP3 player
   E. green light from chlorophyll

   _____

7. Complete the orbital energy diagram below for Co. How many unpaired electrons does the Co atom have?



unpaired electrons _____

Name: _____ Section: _____

Workshop 9 – Mole Conversions

Show calculation setups and answers for all problems below. Use scientific notation for very large or very small numbers.

1. Find the molar mass of (a) carbonic acid, H_2CO_3; (b) aluminum sulfate, $Al_2(SO_4)_3$; and (c) ammonium dichromate, $(NH_4)_2Cr_2O_7$.

   (a) _____

   (b) _____

   (c) _____

2. A sample of nickel(II) phosphate, $Ni_3(PO_4)_2$, weighs 114 g. How many moles are in this sample?

   _____

3. What is the mass (in kg) of 35.6 moles of methane gas, CH_4?

   _____

4. Calculate the molecules of copper(II) nitrite, $Cu(NO_2)_2$, in 0.92 mol $Cu(NO_2)_2$.

   _____

5. How many molecules of water, H_2O, are present in 28.4 g of H_2O?

   _____

Name: _____ Section: _____

6. Find the weight (in mg) of one atom of gold, Au.

_____

7. Determine the weight (in g) of nitrogen atoms in 6.14×10^{30} molecules of dinitrogen tetroxide, N_2O_4.

_____

8. Calculate the percent composition by mass of aluminum hydroxide, $Al(OH)_3$.

Al _____

O _____

H _____

9. Caffeine, a compound found in coffee, tea, and cola drinks is found to contain 49.47% C, 5.19% H, 28.86% N, and 16.48% O by mass. Its experimentally determined molar mass is 194 g/mol. What is the empirical formula of caffeine? What is its molecular formula?

Empirical _____

Molecular _____

10. How many mL of liquid mercury (Hg) with a density of 13.6 g/mL must you dispense to have 1.56×10^{-3} mol?

_____

Name: _____ Section: _____

Workshop 10 – Stoichiometry I

Show calculation setups and answers for all problems below.

1. Ammonia gas will react with oxygen gas to yield nitrogen monoxide gas and water vapor.

   (a) Write the balanced chemical equation for this reaction.

   (b) How many moles of ammonia will react with 6.73 g of oxygen?

   _____

   (c) If 6.42 g of water is produced, how many grams of oxygen gas reacted?

   _____

   (d) If the reaction uses up 9.43×10^5 g of ammonia, how many kilograms of nitrogen monoxide will be formed?

   _____

   (e) When 2.51 g of ammonia react with 3.76 g of oxygen, 2.27 g of water vapor are produced. What is the percentage yield of water?

   _____

Name: _____ Section: _____

2. Use the balanced equation below to solve the following problems:

$$2\ KMnO_4 + 16\ HCl \rightarrow 5\ Cl_2 + 2\ KCl + 2\ MnCl_2 + 8\ H_2O$$

(a) How many moles of HCl are required to react with 28 g of $KMnO_4$?

_____

(b) How many Cl_2 molecules will be produced using 1.5 mol $KMnO_4$?

_____

(c) To produce 29.0 g of $MnCl_2$, what mass (in g) of HCl will need to react?

_____

(d) How many moles of water will be produced when 5.0 mol of $KMnO_4$ are consumed?

_____

(e) What is the maximum mass of Cl_2 that can be produced by reacting 65.9 g of $KMnO_4$ with 18.0 g of HCl?

_____

Name: _____ Section: _____

Workshop 11 – Gas Laws

Show calculation setups and answers for all problems below.

1. You have a sample of 2.0 L of oxygen gas at 3.0 atm pressure. If you reduce the pressure to 0.50 atm, what is the volume of the gas?

_____

2. A sample of argon gas occupies 2.50 L at 25.0 ^{o}C. If the gas is heated at constant pressure, what will the volume be at 99.9 ^{o}C?

_____

3. A 252 mL sample of nitrogen gas is at 715 torr and 25.0 ^{o}C. What volume would the sample occupy at 760. torr and 0 ^{o}C?

_____

4. How many moles of methane (CH_4) are present in a 10.0 L sample at STP?

_____

5. How many liters would 14.0 grams of chlorine gas occupy at 300.0 K and 1.51 atm?

_____

6. How many grams of CH_4 at STP would fill a 1.00 L flask?

_____

7. A gas has a pressure of 1.07 atm, a volume of 13.7 L, and a mass of 28.0 g at a temperature of 294 K. What is the molar mass of this gas?

_____

8. A sample of O_2 gas is stored at 30.0 ^oC and 755 torr. If the volume was 125 mL, how much did the oxygen weigh?

_____

9. Small quantities of hydrogen gas can be prepared in the laboratory by the addition of aqueous hydrochloric acid to metallic zinc according to the following balanced equation:

$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

Suppose 240. mL of hydrogen gas is collected at 40.0 ^oC and has a pressure of 1.030 atm by this process. How many grams of zinc must have reacted to produce this quantity of hydrogen?

_____

Name: _____ Section: _____

Workshop 12 – Stoichiometry II

Show calculation setups and answers for all problems below.

1. Consider the balanced chemical equation to solve the following problems:

$$6\ KI + 8\ HNO_3 \rightarrow 6\ KNO_3 + 2\ NO + 3\ I_2 + 4\ H_2O$$

(a) If 26.0 g of KI are reacted, how many grams of I_2 will be formed?

_____

(b) What volume of NO gas, measured at STP, will be produced if 39.0 g of HNO_3 are reacted?

_____

(c) How many milliliters of 6.00 M HNO_3 will react with 26.0 g of KI?

_____

(d) When the reaction produces 0.500 g of NO, how many molecules of I_2 will be produced?

_____

(e) How many grams of iodine can be obtained by reacting 25.0 mL of 0.350 M KI solution?

_____

Name: _____ Section: _____

2. Consider the Haber Process for the synthesis of ammonia shown below. Use the given equation to solve the following problems:

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

(a) If 4.0 g of H_2 react, how many grams of NH_3 will be formed?

_____

(b) When 3.25 mol of N_2 react, what volume of NH_3, measured at STP, will be formed?

_____

(c) What volume of NH_3 will be formed when 16.0 L of H_2 are reacted at STP?

_____

(d) How many molecules of NH_3 will be formed when 20.0 L of N_2 react at STP?

_____

(e) What volume of NH_3, measured at 35 ºC and 720. torr, will be produced from 12.0 g of H_2?

_____

(f) If a mixture of 14.0 L of N_2 and 24.0 L of H_2 are reacted, what volume of NH_3 can be produced at STP?

_____

Name: _____ Section: _____

Workshop 13 – Solution Concentrations

Show calculation setups and answers for all problems below.

1. What is the percent composition by mass of a solution made by dissolving 25.0 g of sodium phosphate, Na_3PO_4, in 50.0 g of water?

Na_3PO_4 _____

H_2O _____

2. How many moles of magnesium hydroxide, $Mg(OH)_2$ are required to prepare 2.50 L of a 0.350 M solution?

_____

3. Determine the molarity of a solution if 2.75 g of potassium hydroxide, KOH, are dissolved in water to make 250. mL of solution.

_____

4. How many milliliters of a 0.250 M solution can be prepared by dissolving 4.00 g of NaCl in water?

_____

5. How many grams of lithium bromide, LiBr, could be recovered by evaporating 550. mL of 20.0 percent LiBr solution to dryness (d = 1.34 g/mL)?

_____

Name: _____ Section: _____

6. How many milliliters of 6.0 M HCl is needed to prepare 500. mL of a 0.150 M HCl solution?

_____

7. A sample of potassium hydrogen phthalate, $HKC_8H_4O_4$, weighing 0.512 g was dissolved in water and titrated with 24.82 mL of an NaOH solution. Calculate the molarity of the NaOH solution.

_____

8. How many grams of hydrogen nitrate are in 75. mL of concentrated (18 M) HNO_3 solution?

_____

9. A sulfuric acid solution has a density of 1.49 g/mL and contains 32 percent H_2SO_4 by mass. What is the molarity of this solution?

_____

10. Oxalic acid reacts with sodium hydroxide according to the following equation:

$$H_2C_2O_4 + 2\ NaOH \rightarrow Na_2C_2O_4 + 2\ H_2O$$

A 25.00 mL sample of the $H_2C_2O_4$ solution required 19.62 mL of 0.341 M NaOH for neutralization. Calculate the molarity of the acid.

_____

Name: _____ Section: _____

Workshop 14 – Trends on the Periodic Table

Exercise I

This chart represents the main group (representative elements) portion of the periodic table.

A. Several trends are listed to the sides and below the chart. Use a periodic table with proper values to determine the direction of these trends. Convert the underlines into arrows by adding heads (i. e. → or ←) to each underline to indicate the direction of each trend.

B. In each box, write the electronic configuration of the valence electrons of that element. See the box containing element 84 (polonium) as an example.

Atomic Radii Increase

Metallic Properties Increase

IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA or 0
3	4	5	6	7	8	9	10
11	12	13	14	15	16	17	18
19	20	31	32	33	34	35	36
37	38	49	50	51	52	53	54
55	56	81	82	83	84 $6s^2 6p^4$	85	86
87	88						

Ionization Energy Increase

Electronegativity Increase

Nonmetallic Properties Increase

Atomic Radii Increase

Ionization Energy Increase

Electronegativity Increase

Exercise II

Fill in the blank spaces.

Group Number	IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA
Number of valence electrons				4				
Electronic configuration of valence electrons. Omit principle quantum number.				s^2p^2				
Common oxidation states				±4				

Name: _____ Section: _____

Exercise III

Fill in all the boxes on this periodic table with the atomic numbers of the elements and the electronic configurations of the last ground state electron to be added to the element.

1 $1s^1$																	
3	4 $2s^2$											5 $2p^1$					
															$3p^4$		
			$3d^2$														
$5s^1$													$5p^2$				
	56	57	72					$5d^7$									
	88	89	104														

58													
90										$5f^{10}$			

Name: _____ Section: _____

Workshop 15 – Simple Nomenclature of Inorganic Compounds

I. Ionic Compounds (Compounds composed of a metal and a nonmetal or a metal and a polyatomic ion.)

A. Monatomic cations (positive ions formed from one atom) from Groups IA, IIA, IIIA and hydrogen take the name of the element from which they were derived.

H^+	hydrogen	K^+	potassium
Mg^{+2}	magnesium	Al^{+3}	aluminum

B. When a metal forms more than one ion (if it has variable ionic charge), it is necessary to distinguish between the possible ions. We will use the Stock method which gives the charge of the ion as a Roman number in parentheses immediately after the name of the metal. This will occur with most of the transition metals and the metals of groups IVA and VA.

Fe^{+2}	iron(II)	Ni^+	nickel(I)	Pb^{+2}	lead(II)
Fe^{+3}	iron(III)	Ni^{+2}	nickel(II)	Pb^{+4}	lead(IV)

C. Monatomic anions (negative ions formed from one atom) are named by adding the suffix **–ide** to the stem of the name of the nonmetal from which they are derived. These names should be memorized.

F^-	fluoride	O^-	oxide	N^{-3}	nitride
Cl^-	chloride	S^{-2}	sulfide	H^-	hydride
Br^-	bromide	Se^{-2}	selenide	I^-	iodide

D. The names and formulas of these polyatomic ions must be memorized. The charge is an essential part of the formula.

$C_2H_3O_2^-$	acetate	ClO^-	hypochlorite
CO_3^{-2}	carbonate	ClO_2^-	chlorite
HCO_3^-	bicarbonate (hydrogen carbonate)	ClO_3^-	chlorate
OH^-	hydroxide	ClO_4^-	perchlorate
NO_3^-	nitrate	MnO_4^-	permanganate
NO_2^-	nitrite	SO_4^{-2}	sulfate
CrO_4^{-2}	chromate	SO_3^{-2}	sulfite
$Cr_2O_7^{-2}$	dichromate	HSO_3^-	bisulfite (hydrogen sulfite)
PO_4^{-3}	phosphate	HSO_4^-	bisulfate (hydrogen sulfate)
HPO_4^{-2}	hydrogen phosphate	O_2^{-2}	peroxide
NH_4^+	ammonium	CN^-	cyanide

E. An ionic compound is a combination of one or more cations, and one or more anions. To name the compound, name the cation, then name the anion.

K_2S	potassium sulfide	NH_4Cl	ammonium chloride
$AlCl_3$	aluminum chloride	NH_4NO_3	ammonium nitrate

F. If the cation is a metal with variable ionic charge, you must determine the charge on the metal so that you know what number to put in the parentheses. To do this, look at the anion(s). The charge on the anion(s) multiplied by the number of anions gives the total negative charge. Since the number of positive charges and negative charges in a compound must equal, the total positive charge must be the absolute value of the total negative charge. The total positive charge should be divided by the number of metal ions in the formula to give the charge on an individual ion. This is the number which goes in the parentheses.

CuBr	copper(I) bromide	$Pb(C_2H_3O_2)_4$	lead(IV) acetate
$CuBr_2$	copper(II) bromide	$PbSO_4$	lead(II) sulfate
CuS	copper(II) sulfide	$NiCl_2$	nickel(II) chloride
$Fe(OH)_3$	iron(III) hydroxide	Cu_2SO_3	copper(I) sulfite

G. The formula of an ionic compound must contain equal numbers of positive charges and negative charges. When you are given a name and you need to write a formula, you may need to use several cations and/or anions for the number of charges to be equal. Often, you can use the charge on the **cation** as the number of **anions** and the **absolute value** of the charge on the **anion** as the number of **cations**. However, sometimes when you try to do this you will get a formula where the number of cations and the number of anions have a common factor. In this case you must divide both numbers by that common factor to give you the correct empirical formula.

aluminum iodide	AlI_3	sodium sulfide	Na_2S
tin(IV) chloride	$SnCl_4$	iron(III) oxide	Fe_2O_3
chromium(VI) oxide	CrO_3	magnesium oxide	MgO

II. Binary Compounds of Two Nonmetals (Covalent Compounds)

A. A compound composed of two nonmetals is a covalent compound. The compound's name is written by taking the less electronegative element first, writing the name of that element, then taking the more electronegative element and adding the **–ide** suffix to the stem of the name of the element. If more than one atom of an element is in the formula, prefixes are used to indicate the numbers. These prefixes are:

2	di–	5	penta–	8	octa–
3	tri–	6	hexa–	9	nona–
4	tetra–	7	hepta–	10	deca–

The prefix for one is mono–, but it no longer has to be used.

P_4O_{10}	tetraphosphorus decoxide	NF_3	nitrogen trifluoride
CCl_4	carbon tetrachloride	SiO_2	silicon dioxide
CS_2	carbon disulfide	NO	nitrogen oxide
Cl_2O	dichlorine oxide	N_2O_3	dinitrogen trioxide

B. There are several binary compounds that have common names.

H_2O	water	NH_3	ammonia	CH_4	methane*

*For organic hydrocarbons (carbon and hydrogen), a different method is employed for naming.

III. Acids

A. Acids are compounds that contain hydrogen and which, under certain conditions, ionize to form hydrogen ions and a negative nonmetal ion or a negative polyatomic ion. You can always recognize the formula of an acid because in acids, but not in other compounds, the H is written first. (Water is a very weak acid.)

B. Binary acids: Binary acids contain hydrogen and one other element. They are formed from hydrogen ions and a monatomic nonmetal ion. They are given two different names depending on whether or not they are dissolved in water. If they are dissolved in water their names are formed by taking the name of the anion, dropping the –**ide** suffix, and then adding both the **hydro–** prefix and the **–ic acid** suffix. If binary acids are not dissolved in water, they are named as ionic compounds.

HCl(aq)	hydrochloric acid	HCl(g)	hydrogen chloride
HF(aq)	hydrofluoric acid	HF(g)	hydrogen fluoride
H_2S(aq)	hydrosulfuric acid	H_2S(g)	hydrogen sulfide

C. Oxyacids: Oxyacids are acids that contain oxygen in addition to hydrogen and another element. They can be formed by combining hydrogen ions and polyatomic anions. For Chem 12, you only need to worry about the acids of polyatomic ions that end in **–ate**. For these acids, the acid is named by taking the name of the polyatomic ion and changing the **–ate** ending to **–ic acid**. Note that the "hydro–" prefix is only used for binary acids, not for oxyacids.

The names of oxyacids are the same whether or not they are dissolved in water.

HNO_3	nitric acid	$HC_2H_3O_2$	acetic acid
$HClO_3$	chloric acid	H_2CO_3	carbonic acid

There are several acids whose names are not quite what you would expect. Memorize these names.

H_2SO_4	sulfuric acid (not sulfic acid)
H_3PO_4	phosphoric acid (not phosphic acid)

D. To write the formula of an acid when given the acid's name, determine the name of the anion that corresponds to the acid by using the rules in section B and C in reverse. For each negative charge on the formula of the anion, add one H^+ in order to give a neutral formula.

hydroselenic acid	H_2Se(aq)
perchloric acid	$HClO_4$

Name: _____ Section: _____

Write the formulas and the names of the compounds formed by combining these ions.

	SO_4^{-2}	NO_3^-	ClO_3^-	CO_3^{2-}	PO_4^{3-}	HSO_4^-	S*	OH^-	I*
NH_4^+									
Na*									
Mg*									
Al*									
Cu^{+2}									
Fe^{+3}									

* Predict the oxidation number and write it on the symbol.