Name: _____ Section: _____

Data and Calculations for Experiment 1

Mass of $CuSO_4$/sand mixture _____

Mass of empty evaporating dish _____

Mass of evaporating dish and dry $CuSO_4$ _____

Mass of $CuSO_4$ _____

Mass of filter paper _____

Mass of filter paper and sand _____

Mass of sand _____

Total mass of recovered sand and $CuSO_4$ _____

Calculated total percent recovery _____

Percent by mass of $CuSO_4$:

Show Calculation _____

Percent by mass of sand:

Show Calculation _____

Name: _____ Section: _____

Questions

1. Many students do NOT recover 100% of the original mixture. Describe at least TWO possible problems that could cause LESS than 100% recovery of the mixture.

2. A student obtained the following data:

Mass of beaker	25.87 g
Mass of beaker with mixture sample	28.12 g
Mass of evaporating dish	146.36 g
Mass of evaporating dish with dried salt	147.10 g
Mass of beaker with dried sand	???

   However, this student spills her sand sample out of the evaporating dish before weighing it. If the student believes in the Law of Conservation of Mass, what should have been the weight of the beaker with the dried sand in it? Show all your work.

3. A student receives a sample of a mixture with three components: (1) solid iodine that is first removed from the mixture by evaporation, (2) solid salt that is dissolved to separate it from the third component, and (3) solid sand. The salt and sand are dried and weighed, but the iodine escapes as a gas and is not recovered. The student starts with 4.25 g of the mixture and recovers 1.16 g of salt and 2.40 g of sand. What is the percent of each component in the original mixture? Show all your work.

Name: _____ Section: _____

Data and Calculations for Experiment 2

Measurements

A. Temperature

1. Water at room temperature _____ ^{o}C

2. Boiling point _____ ^{o}C

3. Ice water
   Unstirred _____ ^{o}C

   Stirred _____ ^{o}C

4. Ice water with salt added _____ ^{o}C

B. Mass

1. 100 mL beaker _____ g

2. 250 mL Erlenmeyer flask _____ g

3. Weighing boat _____ g

4. Mass of weighing boat + sodium chloride _____ g

   Mass of sodium chloride (show calculation setup) _____ g

C. Length

1. Length of $\longleftrightarrow$ _____ cm

2. Height of 250 mL beaker _____ cm

3. Length of test tube _____ cm

D. Volume

1. 200 mL mark (from Erlenmeyer flask) water transferred to graduated cylinder _____ mL

2. Height of 5.0 mL of water in test tube _____ cm

3. Height of 10.0 mL of water in test tube _____ cm

Name: _____

Section: _____

E. Data Sheet for Density of an Object

Name of Object: _____

Sample #	Object Mass (g)	Initial mL H_2O	mL H_2O w/ Object	Volume object (mL)	Density (g / mL)	Cumulative Sample #s	*Using Microsoft Excel®, graph the following:* Cumulative volume (mL) (x-axis)	Cumulative object mass (g) (y-axis)
1	_____	_____	_____	_____	_____	1	_____	_____
2	_____	_____	_____	_____	_____	1 + 2	_____	_____
3	_____	_____	_____	_____	_____	1 + 2 + 3	_____	_____
4	_____	_____	_____	_____	_____	1 + 2 + 3 + 4	_____	_____
5	_____	_____	_____	_____	_____	1 + 2 + 3 + 4 + 5	_____	_____

Average Density from Table = _____

Average Density from Graph (slope of line) = _____

Be sure to show your properly formatted graph to your instructor to receive credit for this part of the experiment (or print your graph and attach it to this report).

Name: _____ Section: _____

Questions

1. Which would work better in this experiment as an unknown solid whose density is to be determined, wood chips or small quartz rocks? Explain your choice.

2. Why is it best to use a smaller graduated cylinder as opposed to a larger graduated cylinder for this experiment?

3. How well does the average density from the table and density from the slope of the graph compare? Which value is closer to the accepted density of your metal? (Refer to the *Handbook of Chemistry and Physics*). Calculate the percent error between your better value and the handbook value.

4. What is the density of a 9.343 gram piece of metal that causes the level of water in a graduated cylinder to rise from 5.1 to 8.1 mL when the metal is submerged in the water? Consider significant figures when doing the calculation.

Name: _____ Section: _____

Post-Lab Questions

Use your graphs to answer the following questions. Note: The accepted freezing point of acetic acid, according to the *CRC Handbook of Chemistry and Physics*, is: 16.6 °C

1. a. What is the experimental freezing point of acetic acid in Trial 1? _____

   b. What is the experimental freezing point of acetic acid in Trial 2? _____

   c. Calculate the percent error in the Trial 1 measurement of the freezing point:

      SHOW CALCULATION:

      _____

2. What is supercooling? Did you observe supercooling in your experiment? Explain.

3. What is the difference between melting and freezing a substance?

Name: _____ Section: _____

Data and Calculations for Experiment 4

A. Qualitative Determination of the Released Liquid

1. Record observations regarding the solid before, during, and after heating the copper(II) sulfate pentahydrate.

2. Compare and record observations after adding liquid to the anhydrous cobalt(II) chloride test strips.

3. Compare and record observations after adding liquid to the residue on the watch glass.

4. What conclusions can you draw from the above observations?

5. Write the balanced chemical equation for the decomposition of copper(II) sulfate pentahydrate, include phases.

B. Quantitative Determination of Mass Lost in a Hydrate

Sample number: _____

1. Mass of crucible and cover _____
2. Mass of crucible, cover and sample _____
3. Mass of crucible, cover and sample after 1st heating _____
4. Mass of crucible, cover and sample after 2nd heating _____
5. Mass of crucible, cover and sample after 3rd heating _____
6. Mass of sample after final heating _____
7. Mass of original sample _____
8. Total mass lost by sample _____

9. Percentage of water in sample _____

10. Ask your instructor for the name of the anhydrous salt of your residue and solve for the formula and name of your original unknown hydrate.

Formula: _____ Name: _____

11. Is it possible that the decrease in mass from heating is something other than water?

Yes or *No* Explain and include an example.

Pre-Lab (to be completed before coming to lab)

A student heated a hydrated salt sample with an initial mass of 2.244 grams. After the second heating, the mass had decreased to 1.798 grams. Make the assumption that all the lost mass is water.

a) Solve for the mass lost.

b) Calculate the percentage of water in the original hydrated salt sample.

c) The instructor has informed you that the sample is a hydrate of $ZnSO_3$. Use the information above and molar masses from the periodic table to solve for the moles of $ZnSO_3$ in the residue and the moles of H_2O lost.

d) Solve for the *X* in the formula of the hydrate of $ZnSO_3 \cdot XH_2O$ and name it.

Moles of water / moles of $ZnSO_3$ = *X*

Formula: _____ Name: _____

Name: _____ Section: _____

Data and Calculations for Experiment 5

A. Concentration of a Saturated Solution (record all masses as x.xxx g)

1. a) Mass of evaporating dish _____

   b) Mass of evap. dish and potassium chloride solution _____

   c) Mass of evap. dish and residue _____

2. Calculate: (show setups)
   a) Mass of potassium chloride solution _____

   b) Mass of residue _____

   c) Mass of water in potassium chloride solution

   _____

   d) Mass percent of potassium chloride in the solution

   _____

   e) Grams of potassium chloride per 100 g of water in the solution

   _____

B. Relative Solubility of a Solute in Two Solvents

1. a) Which liquid is denser, decane or water? _____

   b) How did you decide which layer was water?

2. What is the color of iodine in water? _____

   What is the color of iodine in decane? _____

3. Which solvent dissolves more iodine? How did you decide this?

Name: _____ Section: _____

C. Miscibility of Liquids

1. Which liquids were miscible with each other?

2. Which liquids were immiscible with each other?

D. Particle Size and Dissolution Rates

1. How long did it take the fine salt crystals to dissolve?

2. How long did it take the coarse salt crystals to dissolve?

3. Based on these observations, how does particle size affect the rate at which a substance is able to dissolve?

E. Temperature and Dissolution Rates

1. How long did it take the salt crystals to dissolve in hot water?

2. How long did it take the salt crystals to dissolve in cold water?

3. Based on these observations, how does temperature affect the rate at which a substance is able to dissolve?

F. Temperature and Solubility

1. Was the solution with 1.0 g of NaCl in 5.0 mL water saturated at room temperature?

2. Was the solution with 1.0 g of NH_4Cl in 5.0 mL water saturated at room temperature?

3. Was the solution with 2.4 g of NaCl in 5.0 mL water saturated at room temperature?

4. Was the solution with 2.4 g of NH_4Cl in 5.0 mL water saturated at room temperature?

5. Which salt was least soluble at higher temperatures?

6. At the higher temperatures, was the NaCl solution saturated?

7. At the higher temperatures, was the NH_4Cl solution saturated?

8. What happened to the NaCl solution when it was cooled back to room temperature?

9. What happened to the NH_4Cl solution when it was cooled back to room temperature?

10. Solubility is defined as the amount of solute that can dissolve in a given quantity of solvent. Based on your observations in this part, how does temperature affect the solubility of solid solutes? Does it affect different substances in identical ways?

G. Ionic Reactions in Solution

1. Write the formulas for the following substances. Include states of matter (e.g. $_{(aq)}$ or $_{(s)}$) based on the results of your experiment:

   barium sulfate _____

   barium chloride _____

   sodium sulfate _____

   sodium chloride _____

2. Write the equation that shows the reaction of barium chloride and sodium sulfate. Use state indicators (e.g. $_{(aq)}$ or $_{(s)}$) for all compounds.

3. Which compound is the white precipitate? How do you know this?

Name: _____ Section: _____

Data and Calculations for Experiment 6

A. Quantitative Determination of Percent Composition

1. When solid $KClO_3$ is heated above 400 °C, it decomposes to solid potassium chloride and elemental oxygen gas. Write the balanced equation for the decomposition of $KClO_3$ solid.

2. What is the remaining residue in the crucible after heating?

3. What substance is lost during the heating?

	Sample 1	Sample 2
4. Mass of crucible and cover		
5. Mass of crucible, cover and sample		
6. Mass of crucible, cover and sample after 1st heating		
7. Mass of crucible, cover and sample after 2nd heating		
8. Mass of crucible, cover and sample after 3rd heating		
9. Mass of original sample		
10. Mass of the residue		
11. Mass lost upon heating		

12. Experimental percentage of KCl in the $KClO_3$ sample.

    Sample 1:

    Sample 2:

13. Experimental percentage of oxygen in the $KClO_3$ sample.

    Sample 1:

    Sample 2:

Name: _____ Section: _____

14. Using the atomic masses from the periodic table, solve for the molar mass of $KClO_3$.

_____

15. Theoretical percentage of KCl in the $KClO_3$ sample _____

16. Theoretical percentage of oxygen in the $KClO_3$ sample _____

17. Percent error in oxygen determination

    Sample 1:

    Sample 2:

B. Qualitative Examination of the Residue

1. Record what you observed when $AgNO_3$ solution was added to the following:
    i. KCl

    ii. $KClO_3$

    iii. Residue

2. What does the evidence lead you to believe about the residue?

3. Does the evidence from the $AgNO_3$ test prove conclusively (without a doubt) that the residue is KCl? Explain.

Name: _____ Section: _____

Pre-Lab Assignment (to be completed before coming to lab)

1. a) Write the balanced equation for the decomposition of $Mg(ClO_3)_2$ solid.

   b) A student heated 1.228 grams of $Mg(ClO_3)_2$ until a stable weight was determined. The remaining residue weighed 0.584 grams. Solve for the experimental percentage of oxygen.

   c) Calculate the theoretical percentage of oxygen in $Mg(ClO_3)_2$.

   d) Calculate the percent error in oxygen determination.

2. Given the mass percent of each element:

   18.8% Na 29.0% Cl 52.2% O

   Solve for the empirical formula and name it.

3. Predict the products and balance the equations for the following decomposition reactions:

   a) $NaClO_3(s) \rightarrow$

   b) $Ca(ClO)_2(s) \rightarrow$

   c) $Al(ClO_3)_3(s) \rightarrow$

   d) $Mg(ClO_2)_2(s) \rightarrow$

Name: _____ Section: _____

Data for Experiment 7

Record your observations for each combination below. If a reaction occurs, write balanced MOLECULAR, IONIC, and NET-IONIC equations. If no reaction occurs, write NR. Make sure to include the physical states of all the products.

1. NaCl(aq) and KNO_3(aq)

   Observations:

   Molecular:

   Ionic:

   Net-Ionic:

2. NaCl(aq) and $AgNO_3$(aq)

   Observations:

   Molecular:

   Ionic:

   Net-Ionic:

3. Na_2CO_3(aq) and HCl(aq)

   Observations:

   Molecular:

   Ionic:

   Net-Ionic:

4. NaOH(aq) and HCl(aq)

   Observations:

   Molecular:

   Ionic:

   Net-Ionic:

Name: _____ Section: _____

5. $BaCl_2(aq)$ and $H_2SO_4(aq)$

   Observations:

   Molecular:

   Ionic:

   Net-Ionic:

6. $NH_4OH(aq)$ and $H_2SO_4(aq)$

   Observations:

   Molecular:

   Ionic:

   Net-Ionic:

7. $CuSO_4(aq)$ and $Zn(NO_3)_2(aq)$

   Observations:

   Molecular:

   Ionic:

   Net-Ionic:

8. $Na_2CO_3(aq)$ and $CaCl_2(aq)$

   Observations:

   Molecular:

   Ionic:

   Net-Ionic:

Name: _____ Section: _____

9. $CuSO_4(aq)$ and $NH_4Cl(aq)$

   Observations:

   Molecular:

   Ionic:

   Net-Ionic:

10. $NaOH(aq)$ and $HNO_3(aq)$

    Observations:

    Molecular:

    Ionic:

    Net-Ionic:

11. $FeCl_3(aq)$ and $NH_4OH(aq)$

    Observations:

    Molecular:

    Ionic:

    Net-Ionic:

12. $Na_2SO_3(aq)$ and $HCl(aq)$

    Observations:

    Molecular:

    Ionic:

    Net-Ionic:

Name: _____ Section: _____

Questions

1. For each of the reactions listed below, write balanced molecular, ionic, and net-ionic equations. If no reaction occurs, write NR. Assume all reactants are aqueous unless otherwise noted. Include all physical states.

   A. Lead(II) nitrate and magnesium sulfate solutions are combined.

      Molecular:

      Ionic:

      Net-Ionic:

   B. Barium chloride solution is poured into a solution of ammonium carbonate.

      Molecular:

      Ionic:

      Net-Ionic:

   C. Magnesium chloride solution is mixed with nickel(II) nitrate solution.

      Molecular:

      Ionic:

      Net-Ionic:

   D. Cobalt(II) sulfate and lithium sulfide solutions are combined.

      Molecular:

      Ionic:

      Net-Ionic:

   E. Hydrochloric acid solution is reacted with a solution of lithium carbonate.

      Molecular:

      Ionic:

      Net-Ionic:

F. Hydroiodic acid and ammonium sulfite solutions are mixed.

Molecular:

Ionic:

Net-Ionic:

G. Sodium hydroxide solution is poured into a solution of cobalt(II) chloride.

Molecular:

Ionic:

Net-Ionic:

H. Ammonium chloride and potassium hydroxide solutions are reacted.

Molecular:

Ionic:

Net-Ionic:

I. Solid strontium bromide is mixed with a solution of potassium phosphate.

Molecular:

Ionic:

Net-Ionic:

J. Solutions of ammonium sulfate and sodium chloride are combined.

Molecular:

Ionic:

Net-Ionic:

Name: _____ Section: _____

Data and Calculations for Experiment 9

A. Electrolytes and Instructor Demo

Place an "X" on the label that properly describes each compound below:

	Non-Electrolyte	Strong Electrolyte	Weak Electrolyte
1. Tap water			
2. Distilled water			
3. Sugar solution			
4. NaCl solution			
5a. Pure (glacial) acetic acid			
5b. Diluted acetic acid			
5c. Twice diluted acetic acid			
6a. 1 M acetic acid			
6b. 1 M HCl			
6c. 1 M NH_4OH			
6d. 1 M NaOH			
7a. $NaNO_3$			
7b. NaBr			
7c. $Ni(NO_3)_2$			
7d. $CuSO_4$			
7e. NH_4Cl			

1. What reaction occurs when barium hydroxide and sulfuric acid are mixed?

2. Explain why the light becomes dimmer as two strong electrolytes are mixed with each other.

3. Why does the light come back on after more of the electrolyte is added?

4. What happens to the glacial acetic acid as it is diluted? How does this explain the changes in light intensity?

Name: _____ Section: _____

B. Properties of Acids

1. Reactions of Acids with Metals

   a) Which acids reacted with the magnesium to produce H_2 gas?

   b) Represent the reaction between the metal and ONE acid that occurred with an equation.

2. Measurement of pH and Acidity

   a) Acids turned the red litmus paper _____.

   b) Acids turned the blue litmus paper _____.

   c) What is the color of phenolphthalein in acidic solution? _____

   d) What is the pH of the 0.1 M solution? _____

      What is the pH of the 0.01 M solution _____

      What is the pH of the 0.001 M solution? _____

   e) Which solution has the greatest concentration of H^+?

   f) Calculate the H^+ concentration of a pH = 4.6 solution. Write the answer in scientific notation.

3. Reactions of Acids with Carbonates and Bicarbonates

   a) What is the name and formula of the gas formed in this reaction?

   b) What happened to the burning stick when it was placed in the beaker?

c) Write out the products of the reactions in a balanced equation:

$NaHCO_3$ + HCl →

$CaCO_3$ + HCl →

4. Neutralizing Acids with Base: Using Indicators

a) Write a balanced equation for the reaction of HCl and NaOH.

b) What happened when the acid was all neutralized?

5. Reaction of a Non-Metal Oxide and Water

a) Write a balanced equation for the reaction of sulfur and oxygen.

b) What happens when the product of the above reaction reacts with water? Write a balanced equation that represents this reaction.

c) Write a balanced equation for the reaction of carbon dioxide and water.

d) How do you know that the product in the reaction above is acidic?

Name: _____ Section: _____

C. Properties of Bases

1. Properties of ammonium and sodium hydroxides

   a) What did the sodium hydroxide feel like?

   b) What did the ammonium hydroxide feel like?

   c) Bases turned the red litmus paper _____.

   d) Bases turned the blue litmus paper _____.

   e) What is the pH of the ammonium hydroxide solution? _____

   f) What is the pH of the sodium hydroxide solution? _____

   g) Calculate the concentration of H^+ in the more basic solution _____

2. The Reaction of Metal Oxides and Water

   a) What is the color of phenolphthalein with CaO? _____

      What is the color of phenolphthalein with MgO? _____

      What is the color of phenolphthalein with $Ca(OH)_2$? _____

   b) Write the balanced equations for the following reactions:

      $CaO + H_2O \rightarrow$

      $MgO + H_2O \rightarrow$

   c) Marble is calcium carbonate ($CaCO_3$). Write a balanced equation for the reaction that occurs when you heat the marble chip.

   d) Write a balanced equation for the reaction that occurs when you put the heated marble chip in water.

Name: _____ Section: _____

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
I_2						
NO^{-1}						
CO						
BeH_2						

Name: _____ Section: _____

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
H_2S						
PBr_3						
ClO_4^{-1}						
CS_2						

Name: _____ Section: _____

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
$CHCl_3$						
PO_3^{-3}						
PO_4^{-3}						
CH_2O						

Name: _____ Section: _____

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
SO_3						
SO_3^{-2}						
SO_4^{-2}						
SCN^{-1}						

Name: _____ Section: _____

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
NO_2^-						
KCl						
BrO_3^-						
IO_2^-						

Name: _____ Section: _____

Formula	Number of valence electrons	Lewis dot structure (including ALL resonance)	VSEPR structure (with dipole moments)	Molecular Geometry	Polar? Nonpolar? Ionic?	Bond angle on central atom(s)
CH_2Cl_2						
CO_2						
PH_3						
NaH						

Name: _____ Section: _____

Data and Calculations for Experiment 11

Pressure of the air in the room: _____

Temperature of the air in the room: _____

Actual Volume (mL)	1 / Volume (mL^{-1})	Pressure * Vol. = *k* (Pa·L)	Plunger Position	Pressure (kPa)
These will be calculated in Excel®. Submit your spreadsheet and your graphs.			5	
			6	
			7	
			8	
			9	
			10	
			11	
			12	
			13	
			14	
			15	
			16	
			17	
			18	
			19	
			20	

Average *k* = _____

Name: _____ Section: _____

Questions

1) On your linear graph, do any points deviate from the straight line?

2) Write down the equation of the trendline (y = mx + b) from your linear graph. How does the slope (m) compare to the average P*V=*k* value from the table of data?

3) Using the equation of your trendline, solve for the pressure at a volume of 2.0 mL.
Hint: x = 1/V in your equation!

4) Why must the temperature be constant during this experiment? Use observations from your experiment and the graphs to support your answer!

5) If you repeated this experiment at a higher temperature, how would the P vs. V curve obtained differ from the curve on your 1st graph?

6) You have a 1.00 L sample of Argon gas at 700.0 mmHg. You decrease the pressure to 500.0 mmHg. What is the new volume?

7) Describe (quantitatively) what you would do to the volume of a container of gas if you wanted to double the pressure inside.

Name: _____ Section: _____

Data and Calculations for Experiment 12

	Sample 1	Sample 2
Mass of flask and KHP		
Mass of empty flask		
Mass of KHP		
Initial buret reading		
Final buret reading		
Volume of base used		

1. Moles of acid (KHP, Molar mass = 204.2)

   Sample 1:

   Sample 2:

2. Moles of base used to neutralize acid

   Sample 1:

   Sample 2:

3. Molarity of base (NaOH)

   Sample 1:

   Sample 2:

4. Average Molarity of Base:

Name: _____ Section: _____

Questions

1. A titration required 13.42 mL of 0.1638 M NaOH solution. How many moles of NaOH were in this volume?

2. A student weighed a sample of KHP and found it weighed 1.396 g. Titration of this KHP required 21.36 mL of base (NaOH). Calculate the molarity of the base.

3. Write and balance the equation for the neutralization of a sulfuric acid solution of unknown concentration by sodium hydroxide. Calculate the molarity of an unknown sulfuric acid solution if a 25.0 mL sample of the acid solution consumes 27.2 mL of 0.138 M NaOH solution in a titration.

4. What might happen to your calculated NaOH molarity if you used tap water instead if D.I. water to dissolve the KHP crystals or to rinse down the walls of the flask during the titration? *Hint: Tap water contains some calcium carbonate*.

Name: _____ Section: _____

Experiment 13 – Weighing by Difference

The purpose of this experiment is to learn how to correctly and accurately use the analytical mass balance.

Procedure

NOTE: Always use the same balance during an experiment and leave it clean.

A. Check to see if the balance is level by looking at the bubble in the level gauge. If the bubble is not centered, adjust the legs of the balance until the bubble is centered. Use the same balance throughout the experiment.

B. Place a weighing boat on the balance pan. Zero the balance by pushing down on the tare button or zero button and waiting a few seconds before placing anything on it. Place approximately 3 grams of salt on the boat. Record the exact mass of the salt. Remove the weighing boat and salt from the balance and save them for step D.

C. Zero the balance. Place a clean dry evaporating dish on the balance pan. Record its mass.

D. Pour the salt from the weighing boat into the evaporating dish.

E. Record the mass of the evaporating dish with the salt sample.

F. Return the salt to its original container. Wipe clean and return the evaporating dish.

Data and Calculations for Experiment 13

1. Mass of salt sample (from step B)	
2. Mass of evaporating dish	
3. Mass of evaporating dish and salt	
4. Mass of salt in evaporating dish (calculate)	
5. Difference between 1 and 4	

Show how you determined 4 and 5.

Name: _____ Section: _____

Experiment 14 – Atomic Spectra

The purpose of this experiment is to show that different elements give off unique colors of light when atoms of the elements are excited by heating. By identifying the unique colors the element can be identified.

Part I

There will be three gas discharge tubes set up in the lab. Observe the color of light given off by each discharge tube. Record the colors in the data table below. After recording the color of the light, observe the light through the diffraction grating (look off to one side). Draw a picture of the spectral lines. Identify the color of each line.

1. Element _____ Color of light _____

Spectral diagram:

Violet Red

2. Element _____ Color of light _____

Spectral diagram:

Violet Red

3. Element _____ Color of light _____

Spectral diagram:

Violet Red

Name: _____ Section: _____

Part II-A:

There will be seven containers with wooden splints soaking in salt solutions. Each solution will be labeled with its chemical name.

Procedure

Light the bunsen burner and adjust its flame until you see a blue inner cone. Use crucible tongs to remove a splint from the soaking solution and place it in the flame. Observe the color of the flame and record the color in the table below. If two solutions give colors which seem similar, repeat the experiment until you can notice the differences in color well enough that you can describe the differences. Always use the same burner with a given chemical. If you mix up burners, you can contaminate the colors.

Chemical	Color of Flame
lithium chloride	
calcium chloride	
potassium chloride	
copper(II) nitrate	
strontium chloride	
sodium chloride	
barium chloride	

Part II-B.

There will be seven containers having unknown chemicals. Repeat the procedure that you used for known chemicals and identify the unknown chemicals. Record results below.

Unknown #	Color of Flame	Chemical
1		
2		
3		
4		
5		
6		
7		

Name: _____ Section: _____

Data and Calculations

	Trial 1		Trial 2		Trial 3
Mass dry calorimeter	_____	=	_____	=	_____
Mass calorimeter + volume H_2O	_____		_____		_____
Initial temperature of water in calorimeter	_____		_____		_____
Mass of metal	_____	=	_____	=	_____
Initial temperature of hot metal (before adding it to calorimeter)	_____		_____		_____
Final temperature of water + metal in calorimeter	_____		_____		_____
Δt_{water}	_____		_____		_____
Δt_{metal}	_____		_____		_____

1. Calculate the specific heat of the metal from each trial and find the average value. If the two values do not agree to within 0.06 J/g ^oC, a third trial must be run. SHOW CALCULATIONS:

Trial 1 _____ Trial 2 _____ Trial 3 _____

Average Specific Heat_____ J/g ^oC

2. Find the actual value for the specific heat of your metal in a reference book. Give this value in J/g ^oC or J/g K. Calculate the % error of your average value.

Name: _____ Section: _____

Post-lab Questions

1. Do objects that have the same temperature have the same amount of heat? Briefly explain.

2. What is the difference between something which is hot and something which has a lot of heat?

3. How much heat would it take to raise the temperature of 645 g of water by 25°C? SHOW CALCULATIONS.

4. When a 15.411 gram sample of metal gains 128.0 J of heat, its temperature changes from 18.55 °C to 83.00 °C. What is the specific heat of the metal? SHOW CALCULATIONS.

5. A metal sample weighing 71.9 g and at a temperature of 100.0 °C was placed in 41.0 g of water in a calorimeter at 24.5 °C. At equilibrium, the temperature of the water and metal was found to be 35.0 °C.

   A. What was Δt_{water}?

   B. What was Δt_{metal}?

   C. How much heat flowed into the water?

   D. Calculate the specific heat of the metal.

Name: _____ Section: _____

Experiment 20 – Precipitation of Strontium Sulfate

In this experiment, you will study a precipitation reaction between sodium sulfate and strontium chloride. You will collect, dry, and weigh the precipitate and compare this experimental yield to the theoretical yield.

Procedure

Weigh a clean, dry, 100-mL beaker. Add about 0.25 g (0.350 g max!) of solid sodium sulfate to the beaker and weigh it again. Dissolve the sodium sulfate in about 20 mL of D.I. water. Add 5.0 mL of 0.50 M strontium chloride solution and heat for fifteen minutes. Try to keep the mixture from boiling.

After the heating period has passed for the mixture, set it aside so as to return to room temperature, and then cool it further by putting the beaker in a cold water bath. Your precipitate should settle to the bottom, leaving a relatively clear solution above it. Obtain a piece of filter paper and weigh it on the analytical balance. Set up a vacuum filtration apparatus with a Büchner funnel and your weighed filter paper (your instructor will show you how). Using a stirring rod to guide the stream of liquid, pour the contents of the beaker into the Büchner funnel. Use your wash bottle (filled with D.I. water) to rinse any solid out of the beaker and into the filter. Make sure no precipitate remains in the beaker or on the stirring rod. Fill the beaker with 15 mL of D.I. water, swirl it around, and then pour it into the filter. Repeat the washing process, and then draw air through the funnel for a few minutes to help dry the crystals.

Turn off the vacuum, carefully remove the filter paper containing your precipitate with a spatula, and place it over a watch glass. Fill a 100-mL beaker half-way with water, place the watch glass with filter paper over the beaker, and heat to boil for twenty minutes to dry the precipitate (alternatively, you can place the watch glass with filter paper in a drying oven at 130 °C for twenty minutes). Allow to cool, then determine the mass of your precipitate. Heat for another five minutes, cool, and reweigh. The two weights should agree within $\pm$0.05 g or a third heating should be done.

Data and Calculations for Experiment 20

1. Weight of empty beaker _____

2. Weight of beaker and sodium sulfate _____

3. Weight of sodium sulfate

   Show Calculation _____

4. Moles of sodium sulfate:

   Show Calculation _____

5. Moles of strontium chloride

   moles $SrCl_2$ = 5.0 mL $SrCl_2$ $\left(\frac{10^{-3}\text{ L } SrCl_2\text{ solution}}{1\text{ mL } SrCl_2\text{ solution}}\right)\left(\frac{0.50\text{ mol } SrCl_2}{1\text{ L } SrCl_2\text{ solution}}\right)$ =

   Solve the Equation Shown _____

6. Write a balanced MOLECULAR equation for the reaction:

7. Write a balanced NET-IONIC equation for the reaction:

8. Weight of empty filter paper _____

9. Weight of filter paper and dried precipitate (first time) _____

   Weight of filter paper and dried precipitate (second time) _____

   Weight of filter paper and dried precipitate (third time) _____

10. Weight of precipitate:

    Show Calculation _____

11. Determine the limiting reactant and excess reactant for your reaction. Also, calculate the theoretical yield (in grams) of strontium sulfate.

    Limiting Reactant: _____ Excess Reactant: _____

    Show Calculation (theoretical product yield) _____

Name: _____ Section: _____

12. Determine the percentage yield of your reaction.

Show Calculation _____

13. Calculate the theoretical yield (in grams) of strontium sulfate if you had used half as much $SrCl_2(aq)$?

Show Calculation _____

14. Calculate the theoretical yield (in grams) of strontium sulfate if you had used twice as much $SrCl_2(aq)$?

Show Calculation _____

15. Briefly describe how you could have improved your percentage yield in this experiment.

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: _____

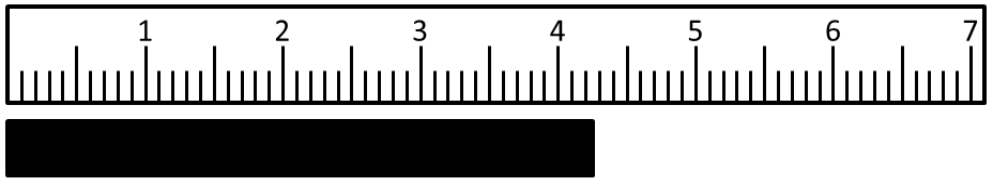
Workshop 3 – Significant Figures

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 → 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.

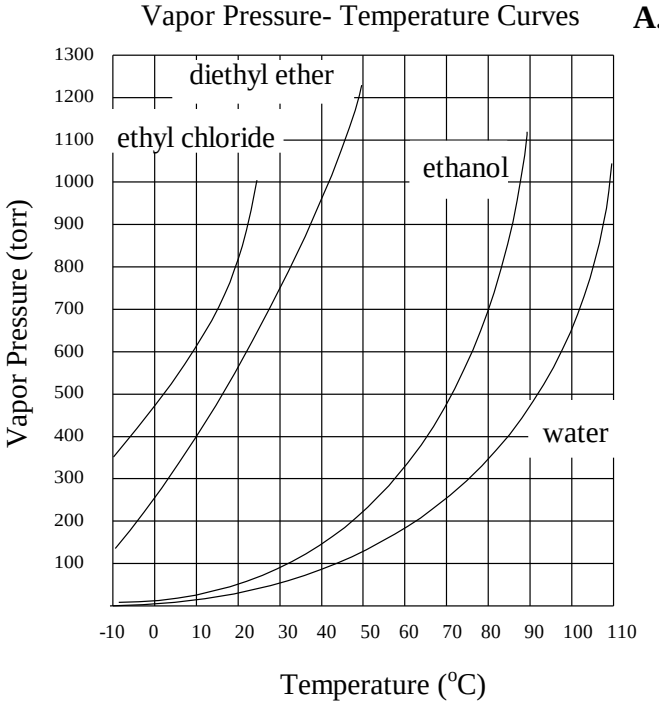
    b) A method of preparing pure iron involves heating iron(III) oxide and carbon monoxide together; they react to produce solid iron and carbon dioxide gas.

    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.

   _____

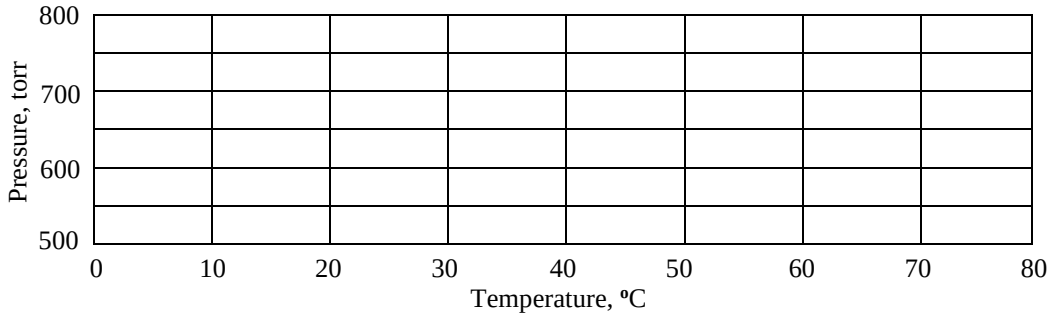
3. The temperature at which ethyl chloride has the same pressure ethanol has at 80 ºC.

   _____

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 ($\Delta y/\Delta x$).

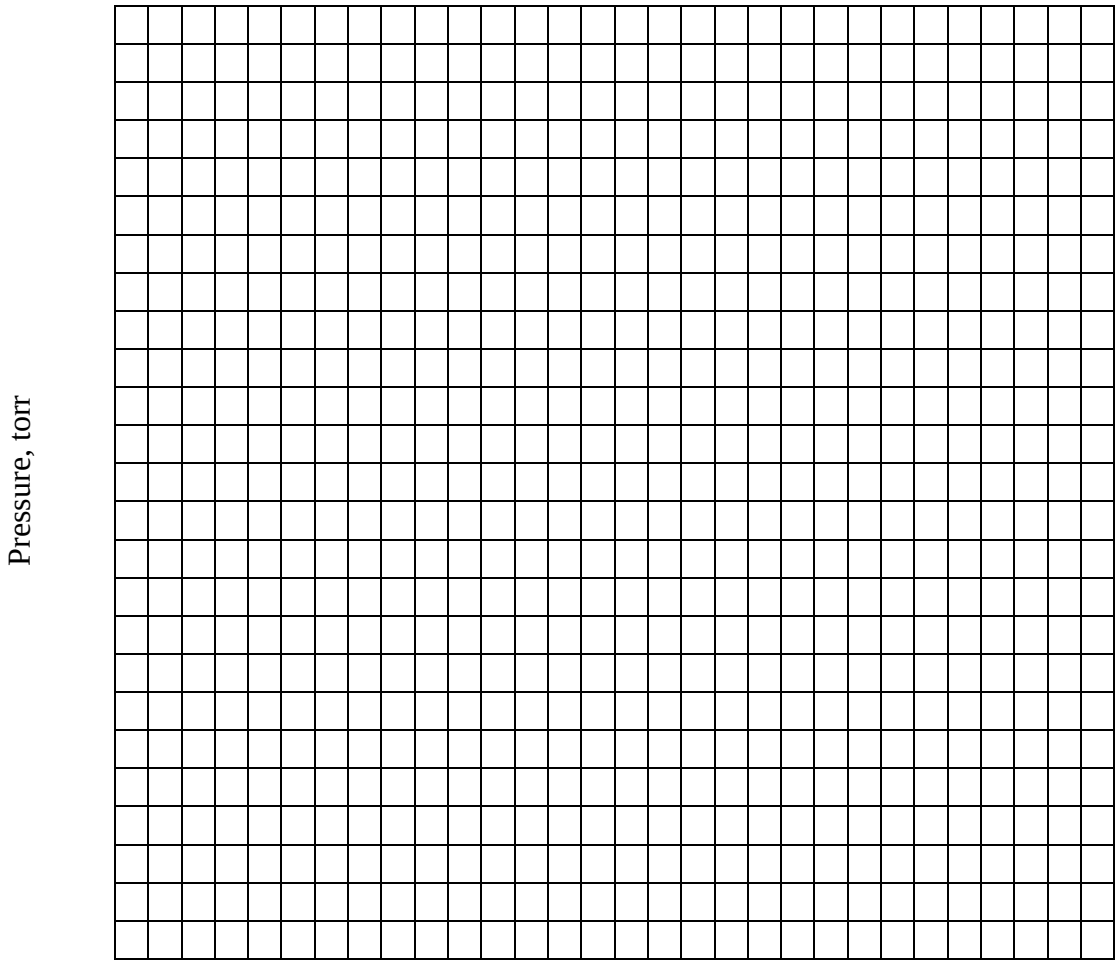
Slope = _____ (include units)

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: _____

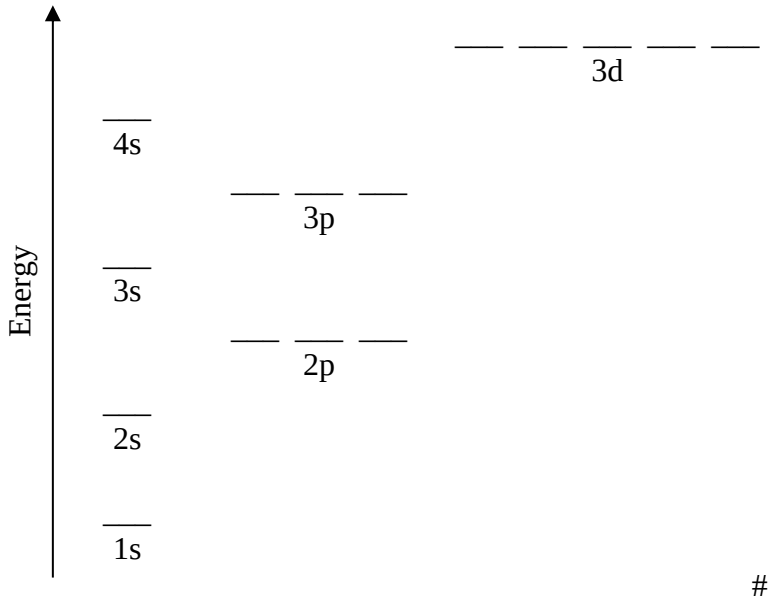
   Abbreviated: _____

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?

_____

Name: _____ Section: _____

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: _____

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.