LAB [25 pts]	**Name** ______________________
% Composition + Empirical formulas	**Lab Partner** ______________________
	Period _________ **Date** ______________

PART I: Experimentally determining the percent composition of baking soda

Pre-lab question: [1 pt] Determine the actual % of carbon in $NaHCO_3$ based on its chemical formula.

(Do NOT use your answer to this question in your calculation in chart at bottom of page!!!)

Purpose: To experimentally determine the percentage of carbon by mass in baking soda ($NaHCO_3$)

Introduction: You will do the following reaction:

$$\mathbf{NaHCO_3\ (s) + HCl\ (aq) \rightarrow NaCl\ (aq) + H_2O\ (l) + CO_2\ (g)}$$

When the baking soda has completely reacted, the mass lost will be due to the loss of CO_2 gas. Since all the carbon atoms in the baking soda end up in only the CO_2 gas, one can determine the mass of carbon in the $NaHCO_3$ based on mass of CO_2 lost. Use the calculation below:

* *Calculation used to find* *mass of carbon* *in sample of* $NaHCO_3$ $\quad$ $\_\_\_\_\ \text{g } CO_2 \times \dfrac{12.0\text{ g C}}{44.0\text{ g } CO_2} = \_\_\_\_\ \text{g C}$

Now, knowing the mass of carbon, one can calculate the % carbon in baking soda.

Procedure: GOGGLES are ABSOLUTELY required. Acid is corrosive. Wear an apron too!!

1) Bring an empty multiwell plate to a balance that measures to the 0.01 g. Tare (zero) the multiwell plate. Then, in a well in the middle of the plate, add a small scoop of $NaHCO_3$ (s). Use between 0.4 g & 0.5 g. Don't spill it! Record mass.
2) Fill a plastic pipet with acid (3 M HCl). Remove the well plate from the balance and place the pipet in any empty well with its stem up. Re-zero the balance then find total mass. *(This is mass of system before reacting)*
3) Now, **slowly** add the acid to the baking soda. Be patient-- let bubbles subside before adding more acid. Try not to let it spill over well walls, but it is OK if it does. Just make sure to react all $NaHCO_3$.
4) When adding more acid fails to produce any more bubbles, STOP. Don't empty out the pipet. Instead, simply place pipet with stem up in adjoining well as before.
5) Find the mass of entire system. *(This is mass of system after reacting.)*
6) Before cleaning up, do the calculations below for trial one. If your % C is off by more than 6% from the actual value (see pre-lab question above), do another trial.
7) Once you are satisfied with your results, rinse out well-plate and throw out plastic pipets in the trash.

DATA: [2 pts]

	Trial 1	**Trial 2 (if necessary)**
Mass of $NaHCO_3$ solid		
Mass of system before reacting		
Mass of system after reacting		
Mass of CO_2 lost		

Calculations: [4 pts]

	Trial 1	**Trial 2 (if necessary)**
1) *Calculate the mass of carbon in your sample of $NaHCO_3$		
2) Calculate your experimental value for the % of Carbon in your sample of $NaHCO_3$		

PART II: Finding the empirical formula of magnesium oxide

Purpose: To experimentally determine the empirical formula for magnesium oxide, Mg_xO_y.

Introduction: You will do the following reaction: **$Mg\ (s) + O_2\ (g) \rightarrow Mg_xO_y\ (s)$**

You will measure the mass of magnesium used and the mass of the magnesium oxide product produced. This will allow you to calculate the mass of oxygen in the product. Subsequently, you will be able to determine magnesium oxide's empirical formula.

Procedure: Goggles are ABSOLUTELY required! Don't touch a HOT crucible! It will burn you.

1) Record the total mass of the crucible with the lid.
2) Mass out a ~12-13 cm strip of magnesium metal.
3) Loosely roll the magnesium metal into a coil and place it into the crucible.
4) Place the crucible (with magnesium inside) on a clay triangle. Cover crucible with lid (leave a small gap for air to get in).
5) Light the Bunsen burner and begin to heat the crucible. It is best to start with a gentle blue flame. Once the crucible is hot, gently lift the lid with the tongs a little to allow some oxygen to get in. You may see the magnesium begin to flare up. If it doesn't, heat the crucible more strongly and periodically lift the lid to see if the reaction has started. Once the reaction has started, keep heating and lifting the lid periodically until you see no further reaction. *(The product should look white. There should be no metal and it should only glow weakly.)* It takes about 10 minutes.
6) When done, turn off Bunsen burner and use tongs to put the crucible and lid on the lab bench.
7) Cool the crucible until it is cool enough to comfortably touch. (~ 5 minutes)
8) Obtain the total mass of crucible, lid and the product (magnesium oxide).

Data [2 pts]:

Mass of crucible with lid = ___________

Mass of magnesium metal = ___________

Mass of crucible, lid and product = ___________

Mass of product (magnesium oxide) =_________

Calculations: [4 pts]

a) What is the mass of **oxygen** that must have combined with the magnesium metal to form the magnesium oxide product? *Show a simple calculation here. Be sure to label substances.*

b) Based on your data, determine the empirical formula for magnesium oxide.
Clearly show all your work. Make sure you show your mole ratio with correct # of sig figs before you write the rounded chemical formula. (In the mole ratio, one of the mole values should be a "one." Thus, just divide your mole values by the smallest number, but do NOT multiply by a multiple. Your data could have significant error.) Show all UNITS!!!

Post Lab questions:

1) [1 pt] In class I will tell you the actual empirical formula of magnesium oxide. What is it? ___________
2) [1 pt] Since we can assume that the mass of your magnesium metal was accurate, were your **moles of oxygen too high or too low** compared to your moles of magnesium? ___________________

3) [2 pts] In this lab, the only measurement with any significant experimental error is the **mass of the magnesium oxide product**. (Again, the mass of the magnesium metal should be accurate.)
   a) If one's **moles of oxygen were too high** compared to the moles of magnesium, the experimental mass of the magnesium oxide product must have been too high or too low? ___________________
   b) If one's **moles of oxygen were too low** compared to the moles of magnesium, the experimental mass of the magnesium oxide product must have been too high or too low? ___________________

4) For any experimental procedure, it is important to think about all of the possible sources of error. Below is a list of possible sources of error for this particular experiment. For each error, determine how the error would affect the experimental mass of the magnesium oxide product (circle too high or too low) and give a short explanation for your answer.
   a) [2 pts] When heating the crucible, a white smoke was seen escaping the crucible when the lid was lifted.
   Product mass: **too high** **too low** Explain why.

   b) [2 pts] After massing out the product, it was noticed that there was some magnesium metal in the crucible. Product mass: **too high** **too low** Explain why.

   c) [2 pts] The crucible (with the product inside) was massed when it was still very hot.
   Product mass: **too high** **too low** Explain why.

   d) [2 pts] When heated in air, magnesium mainly reacts with oxygen gas. However, Mg can react, to a small extent, with nitrogen gas and form magnesium nitride, Mg_3N_2. How is the mass of the product affected if some magnesium nitride was mixed in with the magnesium oxide product?
   Product mass: **too high** **too low** Explain why.

[1 pt] Practice question to help understand #4d: Suppose one heated some Fe metal in air and produced what one assumed to be pure FeO. However, suppose that in reality, some Fe reacted to form Fe_2O_3 along with the FeO. Would the mass of the product with the Fe_2O_3 mixed in, be higher or lower than the mass if pure FeO formed? Compare the relative mass of O for *each* Fe in each compound.