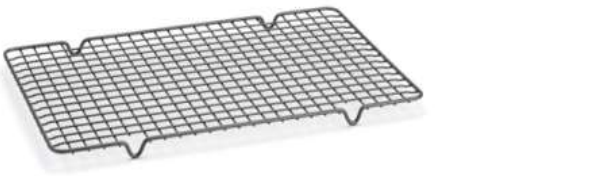
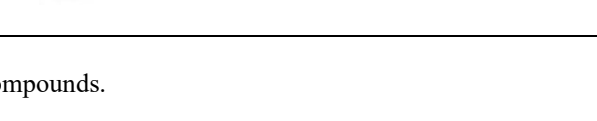
Lab 03 Molar Relationships
Decomposition of Sodium Hydrogen Carbonate

Equipment you will need: Kit	
	Baking soda    
Lab Notebook Electronic balance 50 mL beaker baking pan trivet or cooling rack to protect counter from hot baking pan large glass tumbler that can fit over beaker small square of cardboard or paper coaster Oven mitt Oven	

Heating substances can often make them decompose into other compounds.

One such case is heating baking soda, sodium hydrogen carbonate.

This is what this experiment is about.

You are going to heat sodium hydrogen carbonate and use experimental data to analyze the reaction's stoichiometry to predict the amount of product and compare it to the experimental amount.

Baking soda is 99.8% pure sodium hydrogen carbonate. It starts to decompose into sodium carbonate, water vapor and carbon dioxide at 120°F (50°C) and at above 212°F (100°C) will decompose completely.

Now for the procedure:

1. Preheat the oven to 400°F (200°C). Once the oven is preheated, take the clean 50-mL glass beaker, place it on the pan and heat it in the oven for 10 minutes. This will dry the beaker of any water that has condensed on its surface. You will be weighing to the centigram range so this will improve your accuracy.

2. Taking care not to burn yourself, use the oven mitt to remove the baking pan and place the pan on a cooling rack. Let the dried beaker cool for a few minutes.

The proper procedure for weighing hot objects is to let them cool in a desiccator and then to weigh them once they have cooled.

Labs will typically have desiccators.

A desiccator is a container that can be sealed and has a drying chemical in it so that the atmosphere in the container is very dry. Hot objects are placed in a dedicator to cool in a dry environment.

The reason for not weighing hot objects on scales is that convection currents can decrease the accuracy of weighing. This convection effect usually is in the range of milligrams. Also, there is the danger of the hot object damaging the balance. Since your balance is a centigram balance, convection currents will not affect your accuracy of measurement. You will protect the balance using a small square of cardboard.

3. Find the mass of the dry empty beaker.

4. Using a weighing paper, pour in about 15 grams of pure sodium hydrogen carbonate (baking soda). Record the exact mass of the beaker and the sodium hydrogen carbonate.

5. Preheat the oven to 400°F again and put the baking pan and beaker with the baking soda back into the oven.

6. After 15 minutes, taking care not to burn yourself, take the baking pan and beaker out of the oven and place it onto the cooling rack. Invert the glass tumbler over the beaker. Let the beaker and soda cool for two minutes. Record any changes that you see.

7. As the beaker may still be hot, place a small square of cardboard on your balance to protect it from the hot beaker. Tare the balance with the cardboard square. Remove the cooled beaker from the "desiccator" and weigh the beaker and soda.

9. Repeat four more times allowing the beaker to cool for two minutes without tumbler to get a total heating time of 75 minutes. You should notice changes in weight until the reaction has gone to completion.

The baking soda, sodium hydrogen carbonate, decomposed into sodium carbonate, carbon dioxide, and water.

$$2\ NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2 + H_2O$$

Sodium carbonate, washing soda, is a strong cleaner since it is much more alkaline than sodium hydrogen carbonate. It is used as a detergent booster and dishwasher detergent. It is sold as Arm & Hammer Washing Soda.

When making pretzels, an alkali solution is required. Home bakers will convert baking soda into sodium carbonate just as you did. Then to make an alkaline solution, they will dissolve the sodium carbonate in water. The soda solution is brought to a boil and used to parboil the dough to be baked as pretzels. The alkaline solution reacts with the dough denaturing the proteins in the flour so that when the dough bakes it turns the classic pretzel dark brown. Baked soda (sodium carbonate) is also a standard ingredient in Chinese kitchens.[1]
Use the sample lab report to see how to complete the lab.

[1] For Old-Fashioned Flavor, Bake the Baking Soda
https://www.nytimes.com/2010/09/15/dining/15curious.html?smid=pl-share

Lab 03	Decomposition of a Carbonate	Unambiguous Date

Purpose:

To determine the stoichiometry of the decomposition of sodium hydrogen carbonate.

Equipment:

Glass 50-mL beaker	*Electronic balance*
Oven	*Makeshift desiccator*
Cooling rack	*Baking pan*

Procedure:

I dried a beaker by placing it in an oven on a baking pan at 400°F for 10 minutes. After letting it cool for three minutes I found its mass.

I then added approximately two teaspoons of Arm & Hammer baking soda to the beaker. I remassed the beaker.

After preheating the oven to 400°F, I placed the beaker on the baking pan and heated for 15 minutes. On removing from the oven, I let it cool for 2 minutes using an inverted glass as a "desiccator"." I noticed during this time that water condensed at the top inside of the beaker. I believe this was due to the continued decomposition of the baking soda.

After the cooling, I found the mass of the beaker and soda. I repeated the heating and weighing but without the tumbler four more times.

The total heating time was 1 hour and 15 minutes

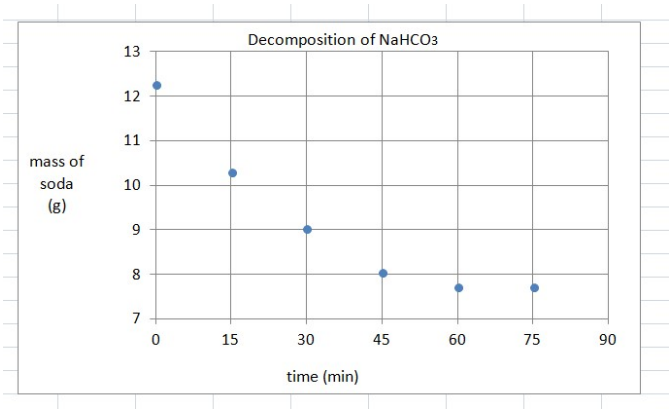
Data:

(a)	*mass of empty beaker*	*28.70 g*
(b)	*mass of beaker and $NaHCO_3$ before heating*	*40.97 g*
(c1)	*mass of beaker and product after 15 min @ 400°F*	*39.00 g*
(c2)	*mass of beaker and product after 30 min*	*37.74 g*
(c3)	*mass of beaker and product after 45 min*	*36.75 g*
(c4)	*mass of beaker and product after 60 min*	*36.42 g*
(c5)	*mass of beaker and product after 75 min*	*36.42 g*

Since the mass stabilized at 75 minutes, I stopped heating because I believed that the reaction had gone to completion.

Calculations:

Time (min)	*mass of $NaHCO_3$ & Product (g)*	*Calculation*
0	*12.27 g*	*(b-a)*
15	*10.30 g*	*(c1-a)*
30	*9.04 g*	*(c2-a)*
45	*8.05 g*	*(c3-a)*
60	*7.72 g*	*(c4-a)*
75	*7.72 g*	*(c5-a)*



(Excel graphing file available at ChemAdvantage)

The experimental final mass of the product was 7.72 grams

Calculations for the predicted product based on the initial $NaHCO_3$ mass of (b-a) and reaction stoichiometry for the decomposition of $NaHCO_3$ and

(Complete the table)

	$2\ NaHCO_3$	→	Na_2CO_3	+	H_2O	+	CO_2
moles	0.146		0.0730				
molar mass	84.01 g/mol		105.99 g/mol				
mass	12.27 g		7.74 g predicted mass				

The final mass from my experiment was 7.72 grams. This is slightly less than my predicted mass of Na_2CO_3. This confirms the prediction and stoichiometry of the reaction and the accuracy of my experiment.

$$Deviation = Your\ Experimental\ Mass\ Na_2CO_3 - Predicted\ Mass\ Na_2CO_3$$

$$\%\ error = \frac{Deviation}{Predicted\ Mass\ of\ Na_2CO_3} \times 100$$

If your deviation was negative, that would indicate that there had been a greater loss of mass than expected. This could be because some of the product had splattered out of the beaker or that the beaker had been wet so in addition to the loss of mass by the conversion some water evaporated too. A positive deviation indicates that the loss in mass was too small which could be explained by the possibility that all the $NaHCO_3$ had not been converted to the *Na_2CO_3* or that the converted the *Na_2CO_3* had absorbed water while cooling converting back into $NaHCO_3$.