**Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Wack-a-Pack Lab: Ideal Gas Law**

Guiding Question: How are these packs constructed?

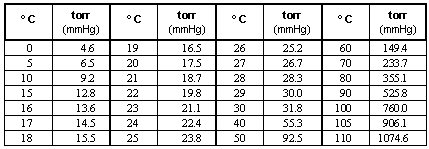
Background Information: The Wack-A-Pack™ balloon inflates due to a chemical reaction that occurs when you “whack it” and rupture an internal, perforated pouch containing a solution of citric acid (vitamin C, H3C8H5O7), which then leaks out and reacts with sodium hydrogen carbonate (baking soda, NaHCO3). The reaction forms sodium citrate (Na3C8H5O7), water, and carbon dioxide. We will reverse engineer this pack to determine the mass of each initial ingredient . We will need to measure and calculate the moles of carbon dioxide that fill the pack in order to find the initial ingredients using the formula: **PV = nRT**

Materials: Beakers, Cylinders, Water, Thermometer, Wack-A-Pack™.

PreLab Questions:

1. Write the balanced chemical equation that occurs when the citric acid reacts with sodium hydrogen carbonate to form sodium dihydrogen citrate, water and carbon dioxide.
2. Why will the pack inflate as the reaction occurs? Model the particles in the balloon before and after the reaction occurs.

| Before | After |
| --- | --- |

1. When the pack stops inflating,
   1. What will we assume about the pressure of the gas inside of the balloon compared to the room pressure?
   2. Why might that assumption lead to small errors in your calculated moles of Carbon dioxide?
2. As the reaction occurs liquid water will be formed. The liquid water may also evaporate a little, creating a vapor pressure.
   1. What is the relationship between temperature and vapor pressure?
   2. Measure the temperature of the room. Use the table provided to determine the vapor pressure of water at that temperature. Then, using the room pressure and vapor pressure, determine the pressure of the CO2 only in the bag. Convert to atmospheres.
3. When the pack is completely inflated,
   1. What chemicals will be present inside and in what phases?
   2. Why might the presence of these chemicals lead to small errors in your measured volume of gas?
4. When the pack stops inflating what can we assume about the temperature of the gas inside of the balloon compared to the room temperature?

Procedure: Using the Wack-A-Pack™ balloon and the other materials provided, collect the data necessary to complete the tasks which follow. Determine the minimum number of moles of carbon dioxide gas that would be required to inflate the balloon. Be sure to label all data, record all observations, and show all work in calculations.



Post Lab Analysis:

1. Using number of moles of carbon dioxide you calculated,
   1. Determine the moles of citric acid used in the pack.
   2. Determine the mass of citric acid used in the pack.
   3. Determine the moles of sodium hydrogen carbonate used in the pack.
   4. Determine the mass of sodium hydrogen carbonate used in the pack.
2. A student points out that the bag felt cold to the touch as it was inflating and claims the absorption of heat from the endothermic reaction would alter the calculation of moles of carbon dioxide produced. Construct your argument by providing:
   1. A model of how the gas in the balloon would behave at room temperature versus if the balloon is cold.
   2. An justification (explain or calculate) of how the calculated number of moles of carbon dioxide gas would or would not change at a lower temperature. 