Gas Laws and Stoichiometry

What's the Wow?: You will observe what liquid nitrogen does, see the atmosphere collapse a can, and discover what is meant by limiting reagent.

Procedure:

A. PV = nRT[1]

Safety Note: The temperature of liquid nitrogen is -196°C (-321°F). It can burn you if it gets on your clothes where it can get trapped next to your skin.

1. a. Pour some liquid nitrogen on a balloon or push the balloon into the liquid nitrogen.
   b. Add a grape to the liquid N_2 and after a couple minutes remove it with a tongs.
   c. Pour some liquid N_2 in a small Erlenmeyer flask and cover the opening with a balloon.

   How is the temperature affecting the volume of the gas in the balloon? Why is the balloon blowing up?
2. a. Obtain a pop can and add 5 mL of water.
   b. Boil the contents of the can for several minutes until the liquid water is nearly entirely vapor.
   c. Using a tongs, quickly invert the can into an ice bucket filled with water.

   Why did the can collapse? This experiment is sometimes called the "invisible giant"

B. Stoichiometry[2]

1. Weigh three portions of sodium bicarbonate: A-2.0 g; B-3.5 g; and C-5.0 g and transfer each portion to a balloon using a powder funnel. Use a marking pen to mark the balloon with the mass of sodium bicarbonate added. You will need to do some calculations to determine how many moles of $NaHCO_3$ there are.
2. Place 50 mL of vinegar into each of 3 250 mL Erlenmeyer flasks and a couple drops of universal indicator solution. Vinegar is a 5% solution of $HC_2H_3O_2$ which means that for every 100 mL of solution there are 5 mL acetic acid. If the molarity of concentrated acetic acid is 17.5M, how many moles of acetic acid are in the 50 mL of vinegar?
3. Attach a balloon containing the preweighed sodium bicarbonate to each of the three flasks.
4. Lift and jostle each balloon so as to add the sodium bicarbonate to each flask. Note the apparent amount of gas produced and the appearance of the material inside each flask.
5. Set the middle flask aside. Remove the balloons from the remaining flasks. Mix their contents and note any evidence for reaction.

It is worthwhile to calculate the number of moles of each container to see if experimental results match predicted results.

Waste: Everything can go in the garbage or down the drain (except liquid nitrogen).

[1] Adapted from *Chemical Demonstrations: A Sourcebook for Teachers, Vol.* 2., L.R. Summerlin, C.L. Borgford, J.B. Ealy, ACS, Washington, D.C., 1987.
[2] Adapted from *http://129.93.84.115/Chemistry/DoChem/DoChem024.html#Description*