Experiment 17   **Determining the Molar Mass of Butane**

Problem:
   Experimentally determine the molar mass of butane, C_4H_{10}.

Introduction:
   The ideal gas law, $PV = nRT$, provides us with a tool for the determination of molar masses from physical measurements (mass, pressure (of dry gas), volume and temperature). A sample of butane gas, C_4H_{10}, is obtained from a disposable cigarette lighter. The lighter is weighed both before and after the gas is withdrawn. The volume, temperature and pressure of the butane gas are also determined. From these four quantities, the molar mass of the gas is calculated. Since the gas is collected over water, a correction is made for the pressure caused by the water vapor in the sample of collected gas.

Materials:
   Disposable butane lighter
   Electronic Balance
   Paper towel
   Hair dryer
   Barometer
   Burette
   Funnel

Procedure:
   1. Fill the burette completely full with tap water.
   2. Fill the plastic container 2/3 full with tap water. Invert the burette placing a finger over the opening and place the open end under water in the plastic container. Make sure that no air enters into the burette during this step. Insert the narrow end of the funnel into the burette.
   3. Submerse a butane lighter and then dry it completely using paper towel. Measure the mass of the butane lighter when it is completely dry.
   4. Carefully hold the lighter under the water directly under the opening of the funnel.
   5. Dispense butane from the lighter being careful to collect all the gas in the burette. Collect a volume of approximately 100mL of butane.
   6. Dry the lighter in the same manner used in Step #3 and determine the mass of butane dispensed from the lighter.
   7. Do not remove the gas filled burette from the water filled plastic container. Carefully raise or lower the burette so that the level of water inside the burette perfectly matches the level of water outside of the burette. Determine the volume of butane contained in the burette.

Data and Calculations:

   1. Determine the partial pressure of the butane gas. The gas in the flask is not all from the butane lighter since there is also water vapor present. Use *Dalton's Law of Partial Pressures* to find the pressure of the butane. Pbutane = Patmos- Pwater.
   2. Use $PV = nRT$ to calculate the number of moles of butane gas that were collected in the flask. When using this formula ensure that all measurements (P, V, R & T) pertain to butane!
   3. Use the mass of butane released to find the experimental *molar mass* (g/mol) of butane.
   4. Calculate the theoretical molar mass of butane (C_4H_{10}).
   5. Calculate the percentage error for your experiment.
   6. Discuss possible sources of error in your experiment.