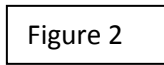
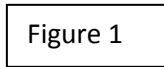


# Physics Exploration Homework Supplement P110-14

## Bernoulli's Equation and the Pitot Tube

Today you will work on a three part experiment to investigate some of the parameters inherent in the Equation of Continuity and Bernoulli's Equation.

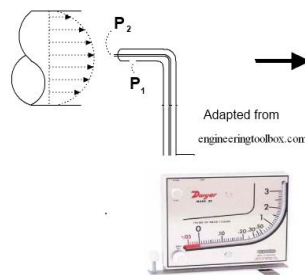
### PART ONE:



In this experiment we are going to explore the use of the Equation of Continuity. Although we normally restrict the usage of these equations to incompressible Laminar flow fluids, we are going to investigate their application to a relatively slow moving gas. In this case air. Before we begin this exploration, please answer the following questions.

1. The equation of continuity is a mathematical statement of fact that the net mass flow rate inward across any surface is equal to the rate of increase of the mass within the surface. In the case of a pipe with a single entry point and a single exit point, the mass flow rate must be constant throughout the pipe.  
Using a couple sentences and sketches (as appropriate), briefly explain what this statement implies in for a fluid flowing through a straight section of pipe and through a pipe with a restriction in it.
2. In your own words, define or describe in a sentence the meaning of: "the fluid exhibits laminar flow".
3. **Investigation of the Equation of Continuity:** On the table you will find a smaller white plastic pipe coupled to a larger diameter plastic pipe, a Pasco Blower, and a Vernier anemometer connected up to a computer.
  - A. Measure the inside diameter of the small plastic pipe and the large plastic pipe.
  - B. Align the blower hose to blow directly through the smaller of the coupled pipes. Turn the PASCO Blower up to full (highest speed) and measure the velocity of the air stream coming out of the large pipe (See Figure 1).
  - C. Flip the coupled pipe over and measure the velocity of the air stream coming out of the smaller pipe (See Figure2)
  - D. Using your measured quantities; see if they satisfy the Equation of Continuity.

### PART TWO:



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### Bernoulli's Equation and the Pitot Tube

A Pitot tube is used to measure the velocity of a moving fluid. The way this is accomplished is by measuring the pressure difference between the static pressure ( $P_1$ ), which is measured from a hole (or holes) placed along the outside casing of the pitot tube parallel to the direction of the flow of the fluid and the stagnation pressure ( $P_2$ )\* measured at the tip of the pitot tube (inside tube, see diagram above). \*The stagnation pressure is the pressure needed to slow the flow of the fluid at the tip of the Pitot tube to zero velocity.

$P_2 = P_1 + \frac{1}{2} \rho V^2$        $\rho$  is the density of the fluid (in this case air),  $V$  is the velocity of the fluid.

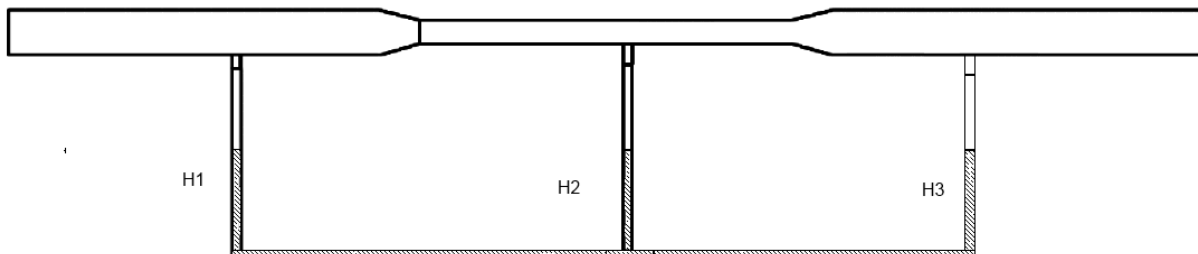
Go to the table that has the Pitot tube, PASCO blower, and inclined manometer calibrated in Pascal's.

Turn on the Pasco Blower and adjust the blower to its highest setting.

Place the Pitot tube in the center of the air stream of the 3 inch plastic tube and record the manometer readings.

4. From the measured readings of the Pitot tube calculate the wind speed in the 3 inch plastic pipe.
5. Compare the calculated Pitot tube measurement of the velocity of the air stream to the Anemometer measurement of the wind speed.
6. Industry has a tenacity to use pitot tubes more often than anemometers. Please give two advantages that a pitot tube has over an anemometer.

### PART THREE:



In the final section of this assignment we will be examining a Venturi tube. In its simplest form, a Venturi tube is a pipe with a restriction in it. Here we have water filled manometers attached to the Venturi tube so that we can measure the relative pressures at three points along the tube. The height of each water column is an indication of the relative pressure at that point.

7. Where do you expect the pressure to be relatively high and /or low along the Venturi tube? (Consider the points at H1, H2, and H3)
8. Turn on the PASCO Blower to full (6 on the scale from 1 to 6) and measure the pressure in each of the manometers. Rank your observations from highest to lowest.
9. Adjust the PASCO Blower to half-way (3 on the blower's scale) and measure the pressure in each of the manometers. Rank your observations from highest to lowest.
10. Compare your observed rankings in questions 8 and 9 to the predictions you made in question 7.