Lab Activity: Fluid mechanics plays an important role in the life sciences curriculum. The majority of life science majors pursue careers in the health sciences profession. A counterintuitive model students must confront is that *increased* velocity of fluid results in a *decrease* in fluid pressure. A common example is that of plaque buildup in an artery: Plaque can lead to the collapse of the artery as the pressure decreases inside the affected region because of increased speed of blood through the artery. This phenomena can be modeled qualitatively and quantitatively using the Vernier barometer and motion detectors in the physics lab (Figure 1).

The barometer's pressure tube is rotated above the student's head at different speeds and recorded in real time. Simultaneously the motion detector is used to record the period of motion as the tube crosses the motion detectors path, from which speed information can be quantitatively extracted (Figure 2): $v_{in}= 2\pi r/T$. Qualitatively the students observe in real time that *increasing* the speed of the motion of the air tube results in a *decrease* in pressure (Figure 2). Quantitatively the pressure can be plotted versus the square of the speed of the air tube to yield a linear relationship with a slope related to the density of air. Analysis of the dimensions of this slope clearly indicate a density since the units $(N/m^2)/(m^2/s^2)$ reduce to kg/m^3. These are the essential features of dynamic portion of Bernoulli's Principle.

Note that the details of this lab activity are intentionally sparse. Students would be first asked to observe what happens, determine the salient variables (speed – independent, pressures – dependent), collect and plot their data, linearize the data to generate a meaningful mathematical model, and only through Socratic conversations with the lab instructor would they make sense of their findings.

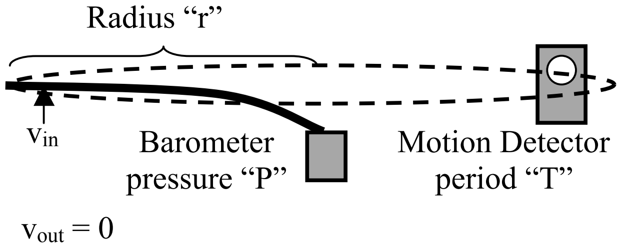

Figure 1

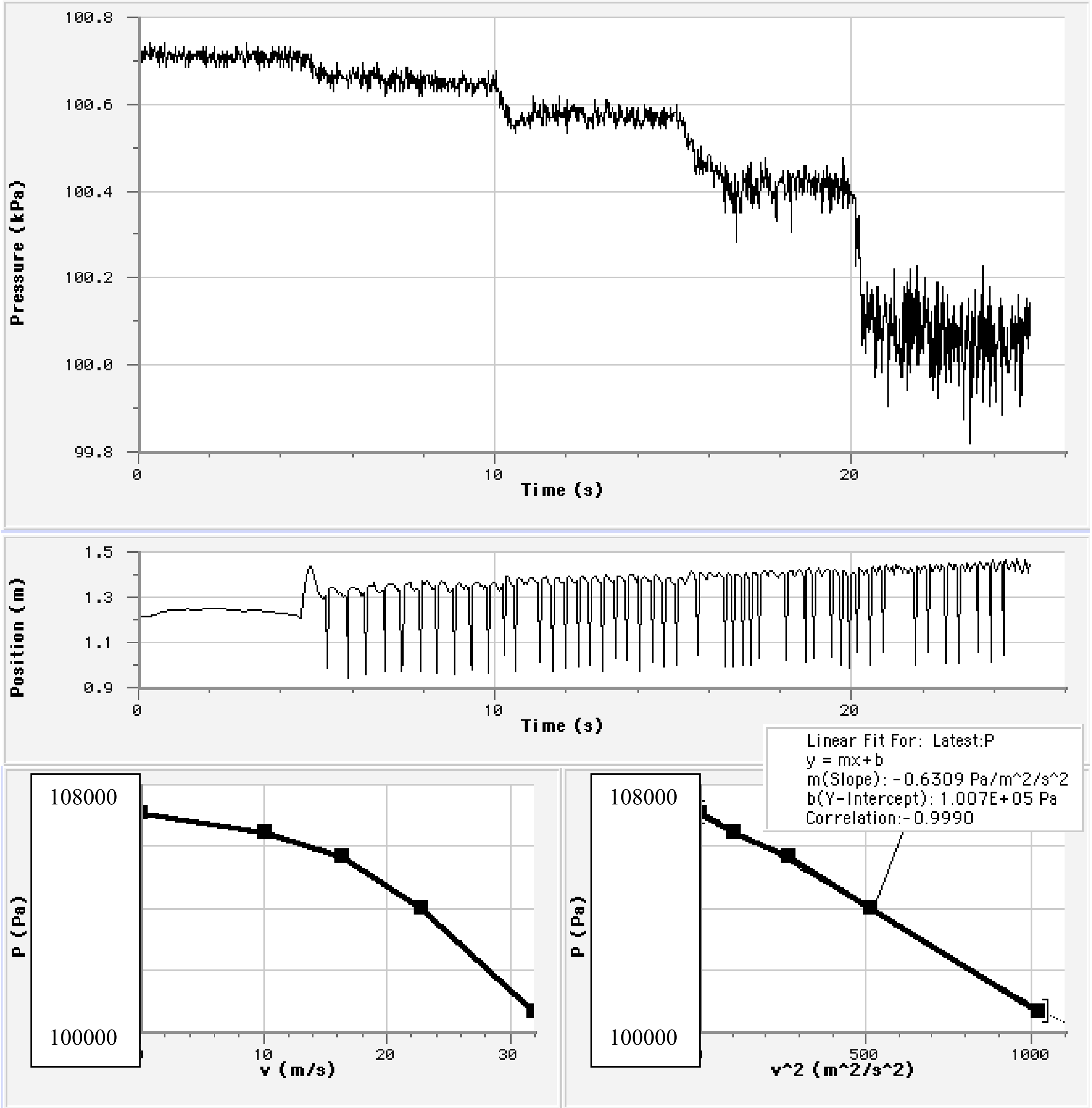

Figure 2

From Bernoulli's Principle:

$$\Delta P = (1/2)\rho\Delta(v^2) + \rho g\Delta z = -(1/2)\rho v^2$$

Since $v_{out} = 0$ and $\Delta z = 0$. The slope of the above graph is 0.631 kg/m^3, about half the value of the density of air, as expected from theory. The y-intercept of the linearized data yields the ambient pressure of the room.