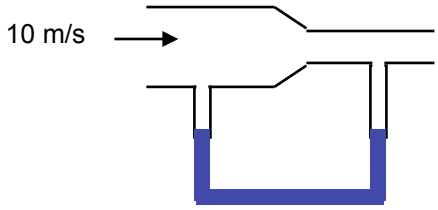
SUSTAIN Physics II, Problem Set 6, Due. Monday May 25 Name_____

1) Calculate the approximate force on a square meter of sail, given the horizontal velocity of the wind is 6.90 m/s parallel to its front surface and 3.90 m/s along its back surface. Take the density of air to be 1.29 kg/m^3. (The calculation, based on Bernoulli's principle, is approximate due to the effects of turbulence.) (Discuss whether this force is great enough to be effective for propelling a sailboat.)

2) I find a perfectly vertical dam of height, H = 100 m above a flat lake. I am curious, and (before I am arrested) I drill some large holes in the dam to see the water come out of the dam, and fall, under perfect parabolic trajectory to the lake's surface!
   a) At the very base of the dam, what is the pressure of the water? What is the speed of the water that would come out of a hole if I drilled it there? How far would this water get before hitting the lake surface 0 m below?
   b) If I drill a hole at the very top of the dam, how far will the water come before it hits the lake's surface.
   c) At what distance in terms of H would I drill a hole to maximize the distance from the base of the dam that the water travels before hitting the lake's surface. You can solve this analytically, or with an Excel Spreadsheet changing the height until you find the maximum distance.

3) Below, you see some air at Standard Temperature and Pressure moving at 10 m/s to the right where it encounters a constriction to half its diameter. This causes a change in elevation of the water in the pipe below.



a) What is the speed in the narrower nozzle.
b) What should be the difference in pressure because of the difference in air speeds?
c) What should be the difference in height of the water in the two sides of the pipe?

4) I have three plastic bags, each with one m^3 volume at standard temperature pressure. One is full of Helium, one of Nitrogen, one of Argon.
   a) Do they all have the same number of molecules in them? If so, please find this number. If not, please find the number for each one of them.
   b) Does each balloon have the same mass of gas? If so, please find this mass. If not, please find the mass of each.
   c) Is the average speed of the molecules in each balloon the same? If so, please find this speed. If not, please find the speed of each balloon.

5) A very strange unit of power is the Ton, and is only used for refrigeration or air conditioning. It is the rate of heat absorption by a ton of ice melting each day. I guess it comes from people buying a ton of ice each day to keep their refrigerators cold. Please calculate the amount of latent heat necessary to melt a ton of ice at the freezing point, and calculate the power this represents if it happens over a 24-hour period. Then please look up the accepted value of a Ton and see how close you are.

6) Know the difference between using the ideal gas law and kinetic gas theory to explain pressure. How are these two lenses very different? Which one treats gas like a fluid? Which one treats it like an ensemble of particles? Which one is theory, and which one is empirical (based on experimental measurements)?