PHYSICS 4B QUIZ 1 SPRING QUARTER 2018
PROF. HIRSCH 3 Problems APRIL 9

Problem 1 (10 pts (a)-(d), + 3 pts extra credit (e), (f))
A cylindrical glass is empty and floats in water exactly half-way submerged, in vertical orientation (see picture at bottom right of the page). When I pour 100g of water into the glass, it floats with 3/4 of its volume in the water.
(a) What is the mass of the glass, in g? Assume water density = $1g/cm^3$.
(b) If the glass height is 15cm, what is its radius, in cm?
(c) When I fill the glass fully with water it sinks, and its apparent weight when fully submerged is as if it had a mass 120g. How much water in total (in grams) do I need to fill the glass?
(d) What is the density of the glass of which this glass is made of? (in g/cm^3)
(e) What is the average thickness of the glass walls? (in mm)
(f) Assume I put the glass in the water upside down, and no air escapes from the glass in the process, and that I hold it so it stays vertical (otherwise it will tilt). Will it float submerged exactly half way as before, or more submerged, or less submerged? Explain your answer, using a diagram may help.

Problem 2 (10 pts)
Consider a tall rectangular building of height 100m and width 10m. At earth's surface, atmospheric pressure and air density are $P_0=1.013\text{x}10^5$Pa, $\rho_0=1.29kg/m^3$. As you learned in class, assuming pressure is proportional to air density, $P = P_0 e^{-(\rho_0 g/P_0)y}$ at height y.
(a) Find the total force (in N) exerted by air on one of the side walls of this building, assuming pressure doesn't vary with height.
(b) Taking into account that pressure does vary with height, by how much (in N) did you overestimate or underestimate the total force in (a)?
(c) Find an approximate answer for (b) using the Taylor expansion of the exponential.

Problem 3 (10 pts)

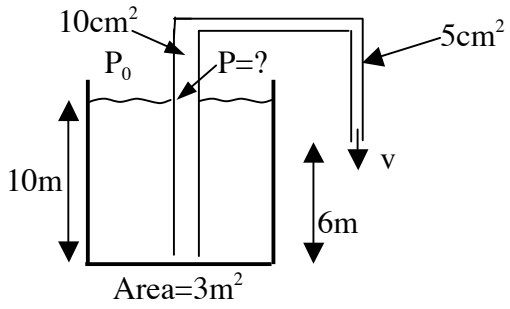
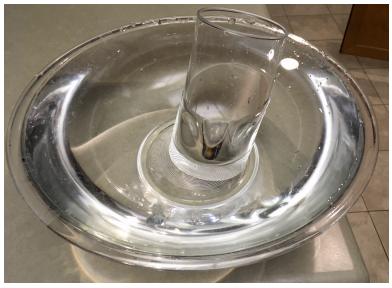


Figure for Problem 1



The open water tank in the figure above has cross-sectional area $3m^2$. The pipe has cross sections $10cm^2$ and $5cm^2$ as shown and is full of water. The initial height of the water in the tank is 10m, the left end of the pipe is very close to the bottom of the tank, the right end of the pipe is 6m above the bottom of the tank, as the picture shows. Atmospheric pressure is $P_0= 1.013\text{x}10^5$Pa.
(a) At what speed v approximately does the water flow out of the pipe? Give answer in m/s. Use the fact that $3m^2$>>(cross sections of the pipe) to simplify the calculation.
(b) What is the pressure at the point inside the pipe where the arrow labeled (P=?) points?
(c) Estimate how long it will take for water to stop flowing. Give your answer in minutes.