Problems for Exam 1
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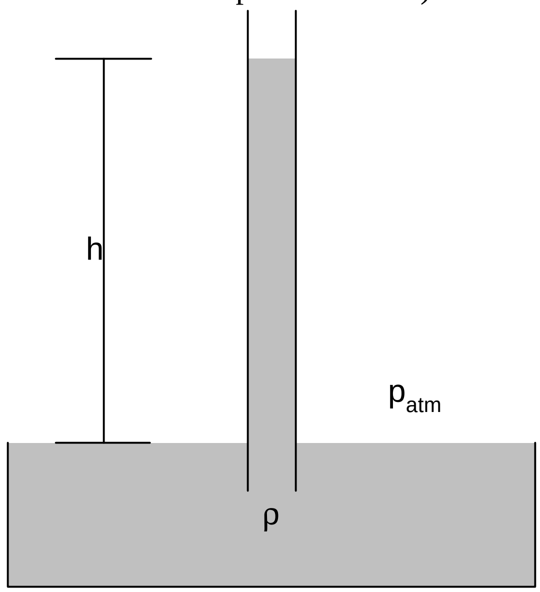
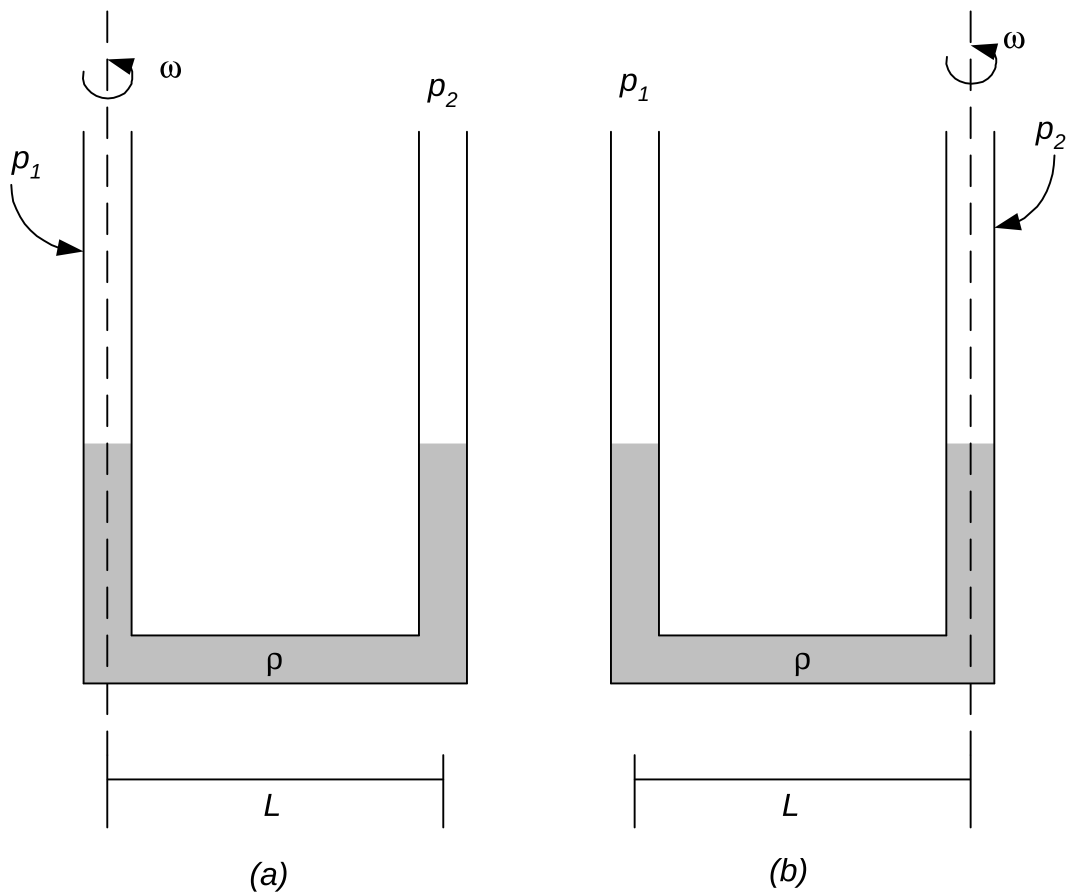
1. Consider a tub of fluid with density ρ open to the atmosphere at a pressure P_{atm} = 1 bar. What is the highest column of fluid *h* which can be sucked out of the tub if the fluid is (a) water and (b) mercury? Report the answer for water in ft. and the answer for mercury in mm (these are common units of pressure heads).

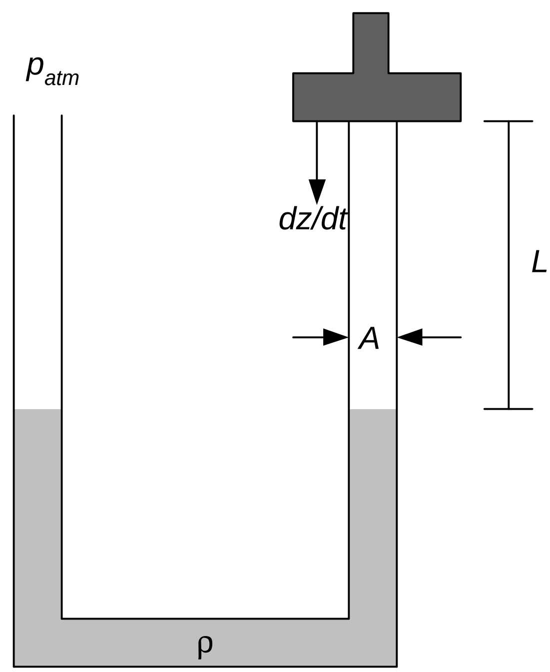


2. Consider a submerged sphere of radius *a* and a submerged cylinder of radius *a* and length *l*. Both objects possess a density ρ_p, and the fluid is of density ρ_f, where the inequality $\rho_p < \rho_f$ holds. We apply an identical force *F* to both the cylinder and the sphere to hold them in place. What is the length *l* of the cylinder?

3. Consider a U-tube manometer filled with a fluid of density ρ whose arms are separated by a distance L. The pressure in the gas above the left arm is P_1, and the pressure in the right arm is P_2, where $P_2 > P_1$. We want to rotate the manometer at an angular velocity ω about one of its arms so that the fluid levels in both arms are at the same height. Which arms should we choose as the axis of rotation, (a) or (b), and what is the angular speed ω?



4. Consider a U-tube manometer containing a fluid of density ρ, where the arms have cross-sectional area *A*. The right arm of the manometer is closed with a piston at a distance *L* above the fluid. Both arms are initially at atmospheric pressure and the fluid heights are equal. **(Revision) At time *t*=*0*, the volume of the gas above the fluid is decreased by decreasing the length *L* at the rate (dz/dt).** The motion is sufficiently slow that the process is quasistatic and the hydrostatic equation applies at each instant in time. Assume that the trapped gas is ideal and that the piston is always far from the fluid below (i.e. we are only interested in short times after we start moving the piston or for very long arms). (a) After the piston starts to move, which leg will have the higher fluid level, the left (open) leg or the right (piston) leg? (b) How does the height difference depend upon time?



Manometer at time t=0.

5. We want to measure the density ρ_2 of the fluid in the tank depicted in the figure by attaching a manometer containing a fluid of known density ρ_1 to the side of the tank. Both the manometer and the tank are open to the atmosphere. The manometer is connected at depth h_t below the fluid level in the tank. This gives rise to a height difference h_m between the levels of fluid in the manometer, and the top of the fluid in the manometer is at a depth h below the fluid level in the tank. Derive an equation to measure ρ_2 from the various fluid heights and the known density ρ_1.