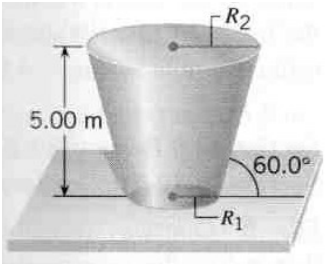
KC's Quantitative Problems
Hydrostatics

- *Fluids.Hydrostatics*.**QP.KC.1:** A cylindrical chemical silo is open on the top. Mercury and water, which do not mix, are poured into the silo. After they separate it is seen that the water occupies 10 vertical meters of the silo. At the bottom of the silo is a circular hole (radius = 1 cm) that is plugged with a stopper that is restraining 200 N of force. (a) Which fluid rests on the bottom and why? (b) How much vertical height does the mercury occupy?

- *Fluids.Hydrostatics*.**QP.KC.2:** There is a maximum depth at which a diver can breath through a tube, or snorkel, due to the difference in pressure between the inside and outside of their lungs. The muscles used for breathing cannot physically push outward and the pressure difference compresses the lungs into a collapsed state, unable to expand. The pressure inside their lungs is atmospheric due to being connected to the atmosphere while the pressure outside is determined by the depth of the diver in the fluid. A lung collapse occurs at a pressure difference of around 5% of atmospheric pressure (1.01×10^5 Pa). How deep can a diver breath through a snorkel in fresh water of density 1.00 g/cm^3?

- *Fluids.Hydrostatics*.**QP.KC.3:** A standard atmosphere has a pressure versus altitude relation approximated by $\mathbf{P = P_o e^{-\alpha h}}$, where $\boldsymbol{\alpha} = 0.116$ km^{-1}, $\mathbf{P_o}$ is atmospheric pressure at sea level, and $\boldsymbol{h}$ is your altitude. An aircraft flies at 9150 m but maintains a cabin pressure of that at sea level. What is the *net* force exerted by air pressure on a square meter of cabin wall area?

- *Fluids.Hydrostatics*.**QP.KC.4:** A huge bucket of water is illustrated in the figure as having the shape of an inverted cone with it's top (bottom in the figure) cut off. The water's height is 5.00 m and there is atmospheric pressure acting on the top of it. Both the circular top of radius $\mathbf{R_2}$ and the circular bottom of radius $\mathbf{R_1}$ are parallel to the ground. The force acting on the top surface of the water is equal in magnitude to that on the bottom surface. Determine $\mathbf{R_2}$ and $\mathbf{R_1}$.

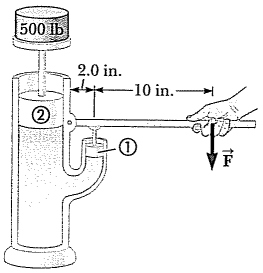


- *Fluids.Hydrostatics*.**QP.KC.5:** A cylindrical chemical silo is open on the top. Mercury (ρ=13.6 x 10^3 kg/m^3) and water (ρ=1000 kg/m^3), which do not mix, are poured into the silo. After they separate it is seen that the water is 10 m deep. At the bottom of the silo is a circular hole (radius=1 cm) that is plugged with a stopper that is restraining 200 N of force.
  A.) Which fluid rests on the bottom and why?
  B.) How deep is mercury?

- *Fluids.Hydrostatics*.**QP.KC.6:** In a hydraulic press used in a trash compactor, the radius of the input piston and the output plunger are 6.4×10^{-3} m and 5.1×10^{-2} m, respectively. If the height difference between the input piston and the output plunger can be neglected, what force is applied to the trash when the input force is 330 N?

- *Fluids.Hydrostatics*.**QP.KC.7:** There is a maximum depth at which a diver can breath through a tube, or snorkel, due to the difference in pressure between the inside and outside of their lungs. The muscles used for breathing cannot physically push outward and the pressure difference compresses the lungs into a collapsed state, unable to expand. The pressure inside their lungs is atmospheric due to being connected to the atmosphere while the pressure outside is determined by the depth of the diver in the fluid. A lung collapse occurs at a pressure difference of around 0.05 atm. (a) How deep can a diver breath through a snorkel in fresh water? The number may surprise you. (b) How would this depth change, e.g. what would the new depth be, on a planet with the same atmospheric conditions as Earth but the effect of gravity is three fourths that here on Earth? (Do not try to test this effect as it is probably dangerous) (1 atm = 101 kP)

- *Fluids.Hydrostatics*.**QP.KC.8:** Piston 1 in the figure to the right has a diameter of 0.250 in. Piston 2 has a diameter of 1.50 in and is 2 inches higher than piston 1. Determine the magnitude (F) of the force necessary to support the 500 lb. load in the absence of friction. The hydraulic fluid is oil.



- *Fluids.Hydrostatics*.**QP.KC.9:** Mercury is poured into a U-tube whose right and left side have different cross-sectional areas. The left arm of the tube has a cross-sectional area of $A_1=10$ cm^2, and the right arm has a cross-sectional area of $A_2=5$ cm^2. One hundred grams of water are then poured into the right arm. (a) Determine the length of the water column in the right arm of the U-tube. (b) Given that the density of mercury is 13.6 g/cm^3, what distance, h, does the mercury rise in the left arm?