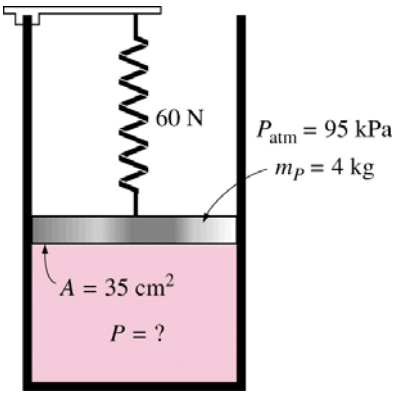
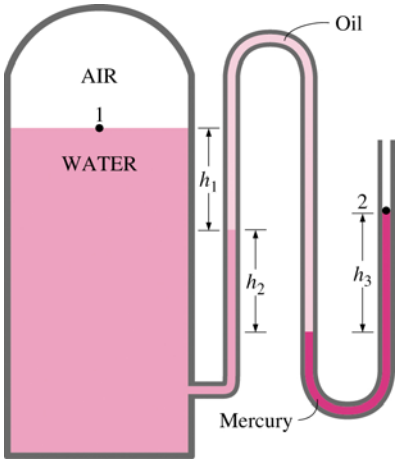
10.303 & 14.301 Fluid Mechanics

Homework Assignment #3 Fall 2006

Fluid Statics

1. A gas is contained in a vertical frictionless piston-cylinder device as shown. The piston has a mass of 4 kg and a cross sectional area of 35 cm^2. A compressed spring above the piston exerts a force of 60 N on the piston. If the atmospheric pressure is 95 kPa, determine the pressure inside the cylinder.

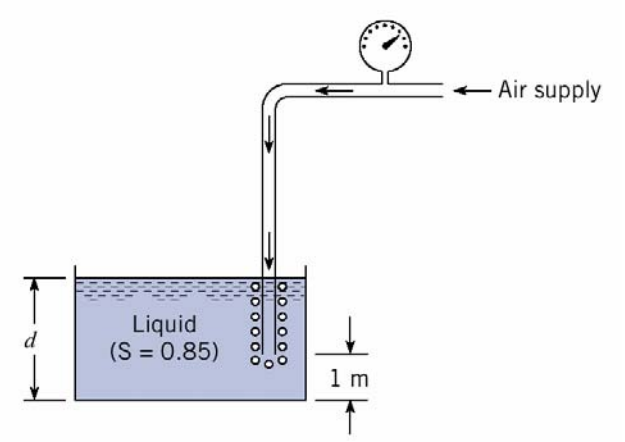




2. The water in a tank is pressurized by air, and the pressure is measured by a multi-fluid manometer as shown. Determine the gage pressure of air in the tank if h_1 = 0.2 m, h_2 = 0.3 m, and h_3 = 0.46 m. Take the densities of water, oil, and mercury to be 1000 kg/m^3, 850 kg/m^3, and 13,600 kg/m^3, respectively.

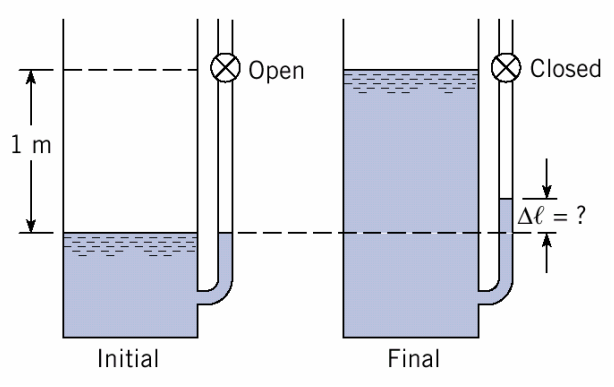
3. One means of determining the surface level of a liquid in a tank is by discharging a small amount of air through a small tube, the end of which is submerged in the tank, and reading the pressure on the gage that is tapped into the tube. With this information, the level of the liquid surface in the tank can be computed.

In the tank shown, if the pressure reading is 20 kPa, what is the depth, d, of the liquid in the tank?



4. A tank with an attached manometer contains water at 20 C. The atmospheric pressure is 100 kPa. There is a valve located 1 m from the surface of the water in the manometer.

Now, the valve is closed, trapping air in the manometer, and water is added to the tank to the level of the valve. For this situation, find the increase in elevation of the manometer, assuming the air in the manometer is compressed isothermally.



5. A pump very slowly introduces mercury into the bottom of the closed cylindrical tank shown in the diagram. At the instant shown, the air pressure is 80 kPa. The pump stops when the air pressure is 110 kPa. All fluids remain at 25 C. The pressures are absolute.

What is the final thickness of air and what is the manometer reading, h, at the final stage, if it is connected to sea-level ambient air at P_{atm} = 101.3 kPa?