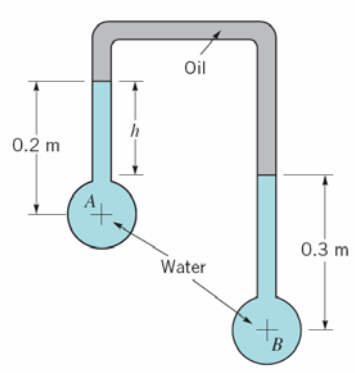
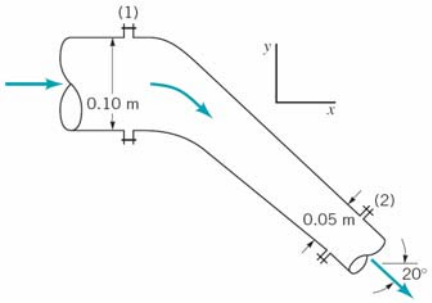
Examination problems, 5th semester Fluid Dynamics and Microfluidics, Jan 15th, 2007

1. The inverted U-tube manometer contains oil (SG=0.9) and water as shown (see figure). The pressure difference between pipes A and B $\mathbf{p_A - p_B = -\ 5kPa}$. Determine the differential reading, **h**.

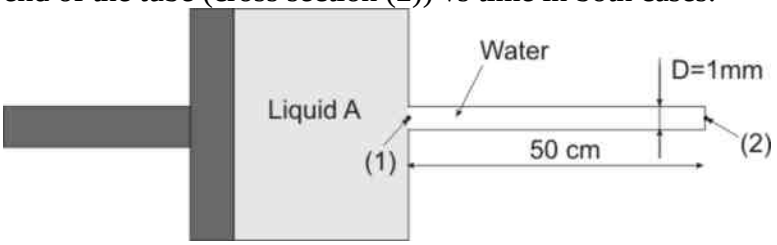


2. A nozzle is designed to accelerate the fluid from V_1 to V_2 in a linear fashion, so **V=ax+b**, where **a** and **b** are constants. If the flow is constant with V_1=10m/s at x_1=0 and V_2=25m/s at x_2=1m write formulas for local acceleration and convective acceleration vs x and calculate acceleration of the fluid at points (1) and (2).



3. Water flows through a 20° reducing bend (as shown) at a rate of 0.025 m^3/s. The flow is frictionless, gravitational effects are negligible and the pressure at section (1) is 150 kPa. Determine **x** and **y** components of the force required to hold the bend in place

4. Liquid A (considered as a viscous, incompressible fluid with properties of water) is injected with the rate of 0.1 ml/min into a tube with inner diameter of d=1mm and length of 50 cm initially filled with pure water. Assume that liquids are immiscible (no diffusion) and that the fully developed flow profile is formed instantly. Check that the flow is laminar and determine (a) the pressure at the tube entrance (at cross section (1)) required to propel the solution through the tube; (b) the average concentration of liquid A at the end of the tube (cross section (2)) in 250s after beginning the injection. What would change if both liquids are inviscid. Sketch the average concentration of A at the end of the tube (cross section (2)) vs time in both cases.



5. When a small pebble is dropped into a liquid, small waves travel outward as shown in the figure. The speed of these waves is assumed to be a function of liquid density ρ, wavelength λ, the wave height, and the surface tension of the liquid σ. Use h, ρ, σ as repeating variables to determine a suitable set Pi terms.