057:20 **TEST # 2** **Fall 2005**

1. Water flows through a horizontal pipe at a rate of 1 gal/s. The pipe consists of two sections of diameters 4 in and 2 in with a smooth reducing section. The pressure difference between the two pipe sections is measured by a mercury manometer. Neglecting frictional effects, determine the differential height of mercury between the two pipe sections. ($1gal = 0.13368\,ft^3$. The densities of mercury and water are $\rho_{\mathrm{Hg}} = 847\,lbm/ft^3$ and $\rho_w = 62.4\,lbm/ft^3$)

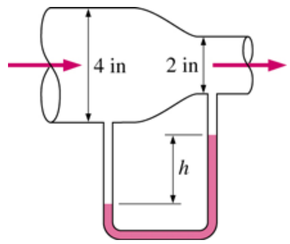

Fig 1 (for Problem 1)

2. Firefighters are holding a nozzle at the end of a hose while trying to extinguish a fire. If the nozzle exit diameter is 6 cm and the water flow rate is $5m^3$/min, determine (a) the average water exit velocity and (b) the horizontal resistance force required of the firefighters to hold the nozzle. You can take the nozzle and the horizontal portion of the hose as the control volume such that water enters the control volume vertically and outlets horizontally (This way the pressure force and momentum flux at the inlet are in the vertical direction, with no contribution to the force balance in the horizontal direction). (Water density $\rho_w = 1000\,kg/m^3$)

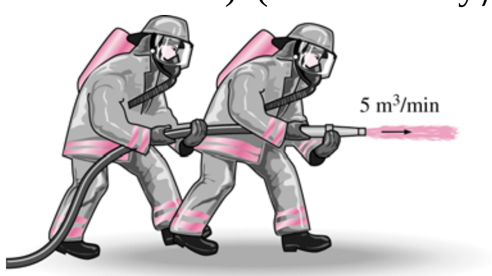

Fig 2 (for Problem 2)

3. Using the Reynolds-number criterion, a 1:1 scale model of a torpedo is tested in a wind tunnel. If the velocity of the torpedo is in water is 10m/s, what should be the air velocity (standard atmospheric pressure) in the wind tunnel? (The kinematic viscosities of air and water are $\nu_a = 1.41\times10^{-5}\,m^2/s$ and $\nu_w = 1.31\times10^{-6}\,m^2/s$)

4. Liquid ammonia at -20°C is flowing through a 30-m-long section of a 5-mm-diameter copper tube at a rate of 0.15 kg/s. Determine the head loss. (The density and dynamic viscosity of liquid ammonia at -20°C are $\rho = 665.1\,kg/m^3$ and $\mu = 2.361\times10^{-4}\,kg/m\cdot s$)