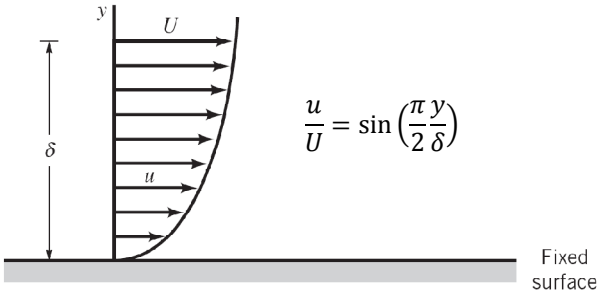
EXAM #1 October 8, 2007

1. A Newtonian fluid having a specific gravity of 0.92 ($\rho_{H_2O@4°C}$ = 1000 kg/m^3) and a kinematic viscosity ν of 4×10^{-4} m^2/s flows past a fixed surface. The velocity profile near the surface is shown in Fig. 1. Determine the (a) magnitude and (b) direction of the shearing stress developed on the plate when U = 1 m/s, δ = 2 mm. (Hint: $\mu = \rho\nu$)

2. The Panel AB in the slanted side of a water tank (γ_{water} = 9790 N/m^3) is a rectangle of width 2m, as in Fig. 2. Find (a) the water force on the panel and (b) its line of action (center of pressure). (Hint: $I_{xc} = bL^3/12$)



$$\frac{u}{U} = \sin\left(\frac{\pi}{2}\frac{y}{\delta}\right)$$

Figure 1

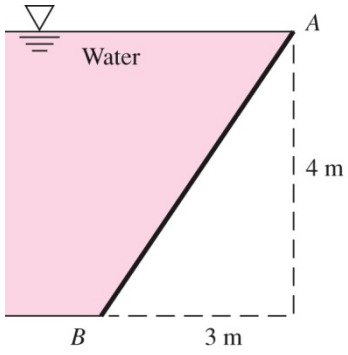


Figure 2

3. In Fig. 3 the flowing fluid is water at 20°C. Neglect losses. If p_1 = 170 kPa and the manometer fluid is a liquid M which is heavier than water, estimate (a) p_2 and (b) the flow rate Q in m^3/hr. ($\rho_M = 1360\ \mathrm{Kg/m^3}$, $\rho_{H_2O} = 998.2\ \mathrm{Kg/m^3}$ @20°C)

4. Flow through the converging nozzle in Fig.4 can be approximated by the one-dimensional unsteady velocity distribution along the centerline

$$u(x,t) = C\left(1 + \frac{2x}{L}\right)t, \quad C = 1\ \mathrm{ft/s^2}\ \text{and}\ L = 6\ \mathrm{in}$$

Find the (a) local and (b) convective accelerations and (c) the pressure gradient dp/dx of the fluid at the middle of the nozzle ($x = L/2$) at t = 1 second. Assume that viscosity effects are negligible. ($\rho = 1.0\ \mathrm{lbm/ft^3}$, Hint: Euler equation $\rho\left(\frac{\partial u}{\partial t} + u\frac{\partial u}{\partial x}\right) = -\frac{dp}{dx}$)

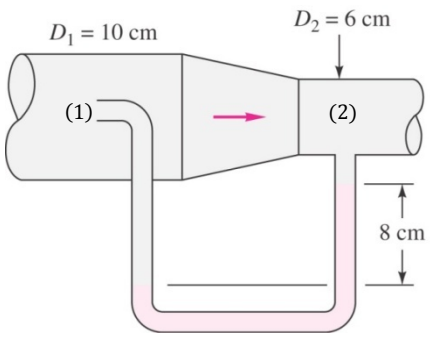


Figure 3

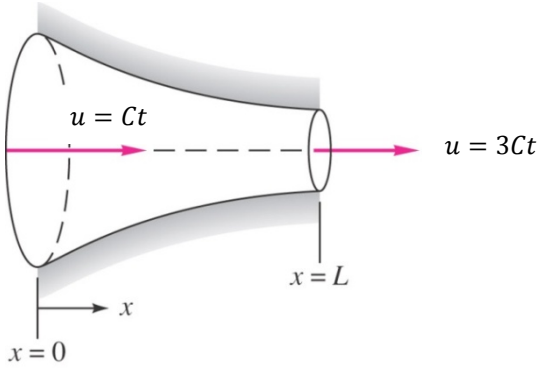


Figure 4