October 12, 2016

1. A viscous fluid (specific weight γ_f = 80 lb/ft^3; viscosity μ_f = 0.03 lb·s/ft^2) is contained between two infinite, horizontal parallel plates as shown in Fig. 1. The fluid moves between the plates under the action of a pressure gradient and the upper plate moves with a velocity U while the bottom plate is fixed. A U-tube manometer connected between two points along the bottom indicates a differential reading h = 0.1 in. (a) Determine the pressure drop between the two points (1) and (2), $\Delta p = p_1 - p_2$. (b) If the upper plate moves with a velocity of 0.02 ft/s, what is the shear stress on the fixed plate? The velocity profile is given as

$$u(y) = \frac{Uy}{b} + \frac{1}{2\mu_f}\left(\frac{\Delta p}{L}\right)(by - y^2)$$

where, u = fluid velocity, b = distance between two plates and L is the distance between point (1) and (2).

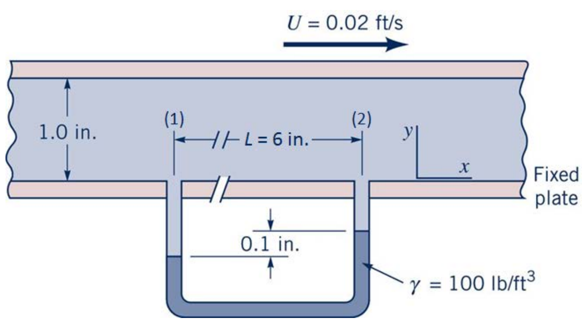

Fig. 1

2. The gate in Fig. 2(a) is 4 ft wide (into the paper), is hinged at point B, and rests against a smooth wall at A. Compute (a) the force F on the gate due to seawater pressure, (b) the center of pressure y_{cp} as indicated in Fig. 2b, and (c) the force P exerted by the wall at point A. Note: Specific weight γ = 64 lb/ft^3 for seawater.

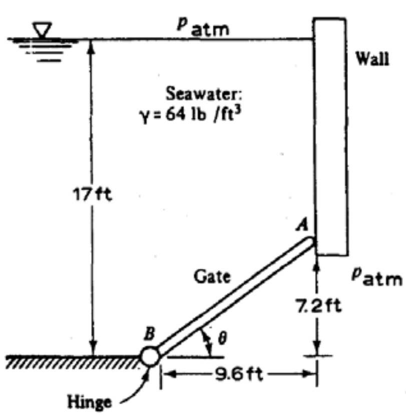

Fig. 2a

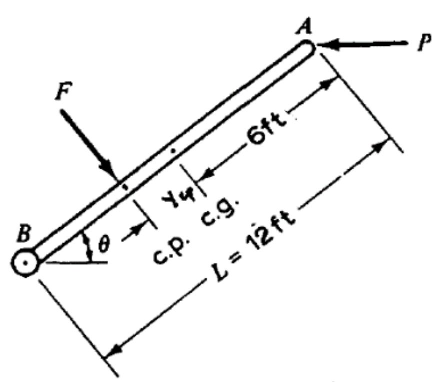

Fig. 2 b

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3. Air (specific weight, γ_a= 12 N/m^3) flows through the device shown in Fig. 3. If the flow rate Q is large enough, the pressure within the constriction will be low enough to draw the water up into the tube. Determine the flowrate to draw the water into section (1). Water will begin to rise when p_1 (gage) = $-\gamma_w h$, where γ_w = 9.8 $\times$ 10^3 N/m^3 is the specific weight of water. Neglect compressibility and viscous effects.

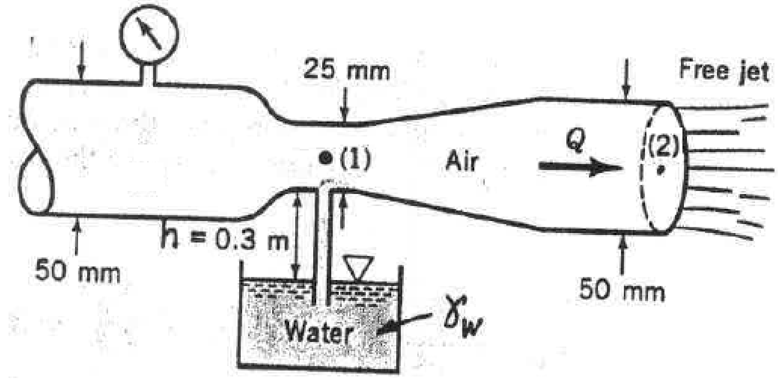

Fig. 3

4. The two-dimensional velocity components u = 3y and v = 2x are used to represent the flow illustrated in Fig. 4. Find the (a) acceleration components a_x and a_y and (b) the pressure gradient, both at a point x = 1 m and y = $\sqrt{3/2}$ m. For part (b), use the following Euler equation,

$$\nabla p = -\rho \underline{a}$$

where, $\nabla = \frac{\partial}{\partial x}\hat{\imath} + \frac{\partial}{\partial y}\hat{\jmath}$, $\underline{a} = a_x\hat{\imath} + a_y\hat{\jmath}$, and ρ = 998 Kg/m^3.

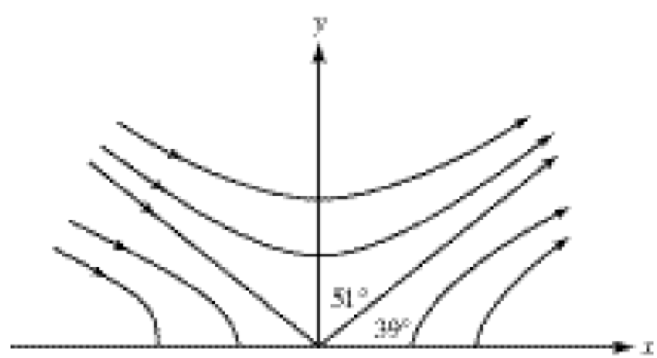

Fig. 4