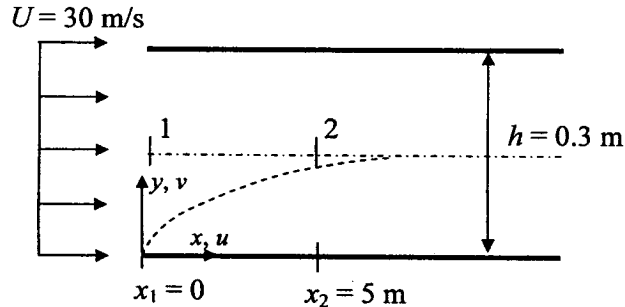


4. Air flows between parallel plates, as shown in the following schematic. If the boundary layer thickness, δ , on each wall is given by $\frac{\delta}{x} = 0.37 \left(\frac{\mu}{\rho U x} \right)^{1/5}$, and the velocity profile in the boundary layer is given by $\frac{u}{U} = \left(\frac{y}{\delta} \right)^{1/7}$. In the above expressions, ρ and μ represent density and viscosity of air, respectively. If the free stream velocity is given by $U = 30$ m/s and the width of the plate is W . Find the pressure drop, $p_1 - p_2 = ?$ (in units of Pa). (10%)



5. A circular disk with radius R is put on a fix plate as shown in the figure. The gap height between the disk and plate is δ . The gap is filled with glycerin (Newtonian fluid, coefficient of viscosity $= \mu$). Assuming a linear velocity distribution between the gap, find the torque needed to rotate the disk with angular velocity ω . (25%)

