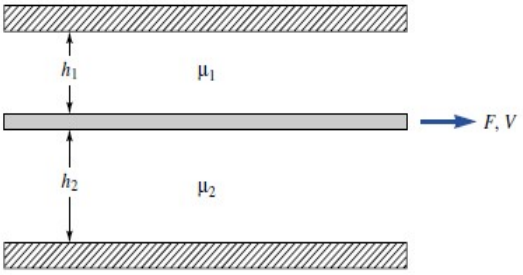
# Fluid Mechanics

## Assignment # 1

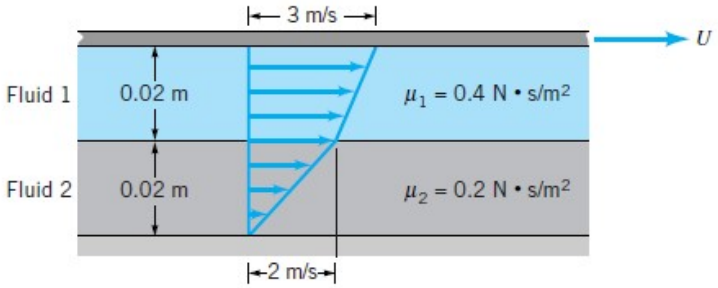
**P1.** Assume that the viscosity of blood is to be determined by measurements of shear stress, $\tau$, and rate of shearing strain, *du/dy*, obtained from a small blood sample tested in a suitable viscometer. Based on the data given below determine if the blood is a Newtonian or non-Newtonian fluid. Explain how you arrived at your answer.

| $\tau$(N/m$^2$) | 0.04 | 0.06 | 0.12 | 0.18 | 0.30 | 0.52 | 1.12 | 2.10 |
|---|---|---|---|---|---|---|---|---|
| *du/dy* ($s^{-1}$) | 2.25 | 4.50 | 11.25 | 22.5 | 45.0 | 90.0 | 225 | 450 |

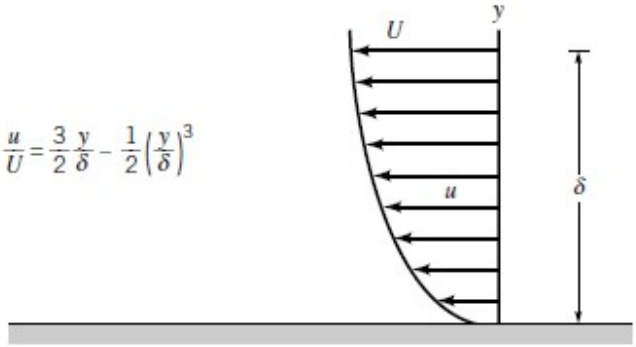
**P2.** A thin plate is separated from two fixed plates by very viscous liquids $\mu_1$ and $\mu_2$, respectively, as in Fig. P2. The plate spacing $h_1$ and $h_2$ are unequal, as shown. The contact area is $A$ between the center plate and each fluid.
($a$) Assuming a linear velocity distribution in each fluid, derive the force $F$ required to pull the plate at velocity $V$.



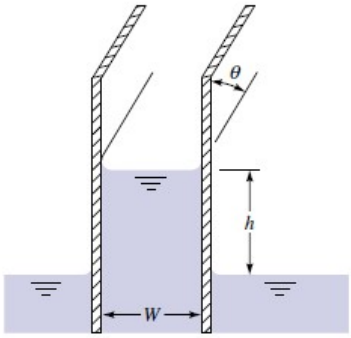

**P3.** Let two layers of fluid be dragged along by the motion of an upper plate as shown in Fig. P5. The bottom plate is stationary. The top fluid puts a shear stress on the upper plate, and the lower fluid puts a shear stress on the bottom plate. Determine the ratio of these two shear stresses.



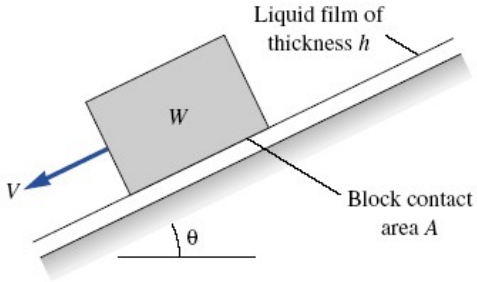

**P4.** Determine the magnitude and direction of the shearing stress developed on the plate. Express your answer in terms of $U$ and $\delta$ (the fluid is Newtonian).



**P5.** Derive an expression for the capillary height change $h$ for a fluid of surface tension $Y$ and contact angle θ between two vertical parallel plates a distance $W$ apart, as in Fig. P4. What will $h$ be for water at 20°C if $W$ = 0.5 mm?




**P1.45** A block of weight $W$ slides down an inclined plane while lubricated by a thin film of oil, as in Fig. P1.45. The film contact area is $A$ and its thickness is $h$. Assuming a linear velocity distribution in the film, derive an expression for the "terminal" (zero-acceleration) velocity $V$ of the block.




**1.65** A 12-in.-diameter circular plate is placed over a fixed bottom plate with a 0.1-in. gap between the two plates filled with glycerin as shown in Fig. P1.65. Determine the torque required to rotate the circular plate slowly at 2 rpm. Assume that the velocity distribution in the gap is linear and that the shear stress on the edge of the rotating plate is negligible.