1. A viscous fluid (specific gravity, \(SG = 1.26\); kinematic viscosity, \(\nu = 1.28 \times 10^{-2} \text{ ft}^2/\text{s}\)) is contained between two large, horizontal parallel plates as shown in Fig. 1. The fluid moves between the plates under the action of a pressure gradient \(B\). When the lower plate is pulled with a velocity \(V\) while the upper plate is fixed, the velocity distribution for this flow takes the form

\[
u(y) = \frac{B}{2\mu} (y^2 - hy) + V \left(1 - \frac{y}{h}\right)
\]

For \(V = 0.02 \text{ ft/s}\), \(h = 1.0 \text{ in.}\), \(B = -0.334 \text{ lb/ft}^3\), and the plate area \(A = 100 \text{ ft}^2\), determine (a) the shearing stress \(\tau\) acting on the moving plate and (b) the required force \(F = \tau \cdot A\) and (c) power \(P = F \cdot V\) to pull the plate. (Note: \(\nu = \mu/\rho\) and use \(\rho_{\text{water}} = 1.94 \text{ slugs/ft}^3\))

![Figure 1](image1.png)

2. The 0.5-m-radius half-cylinder barrier in Fig. 2 is 8 m long into the paper and rests in static equilibrium against a wall. The contact between cylinder and wall is frictionless. Find (a) the horizontal force (magnitude \(F_H\) and location \(y_{cp}\)) and (b) vertical force (magnitude \(F_V\)) exerted on the curved surface of the barrier and (c) the barrier weight \(W\). You can use geometric properties shown on Figure 3. (Note: \(\gamma = 9.80 \text{ kN/m}^3\))

![Figure 2](image2.png)
Figure 3: Geometric Properties of some common shapes
3. Water ($\gamma = 62.4 \text{ lb/ft}^3$) flows steadily from a large tank as shown in Fig. 4. The deflection in the mercury manometer is 1 in. and viscous effects are negligible. Determine (a) the volume flow rate $Q$ and (b) the water-jet velocity $V_j$ leaving the 3-in. diameter nozzle exit. (Note: $SG = 13.56$ for mercury and $g = 32.2 \text{ ft/s}^2$)

![Figure 4](image1.png)

4. According to potential theory for the flow approaching a rounded two-dimensional body, as in Fig. 5, the velocity approaching the stagnation point is given by $V = U(1 - a^2/x^2)i$, where $a$ is the nose radius and $U$ is the velocity at far-upstream. If the fluid is SAE 30 oil ($\rho = 917 \text{ kg/m}^3$) with $U = 2 \text{ m/s}$ and $a = 6 \text{ cm}$, calculate (a) the fluid velocity $u$, (b) the acceleration $a_x$, and (c) the pressure gradient $dp/dx$ at point 1 (i.e., at $x = -2a$). For part (c), use the Euler equation, $\rho a_x = -dp/dx$.

![Figure 5](image2.png)