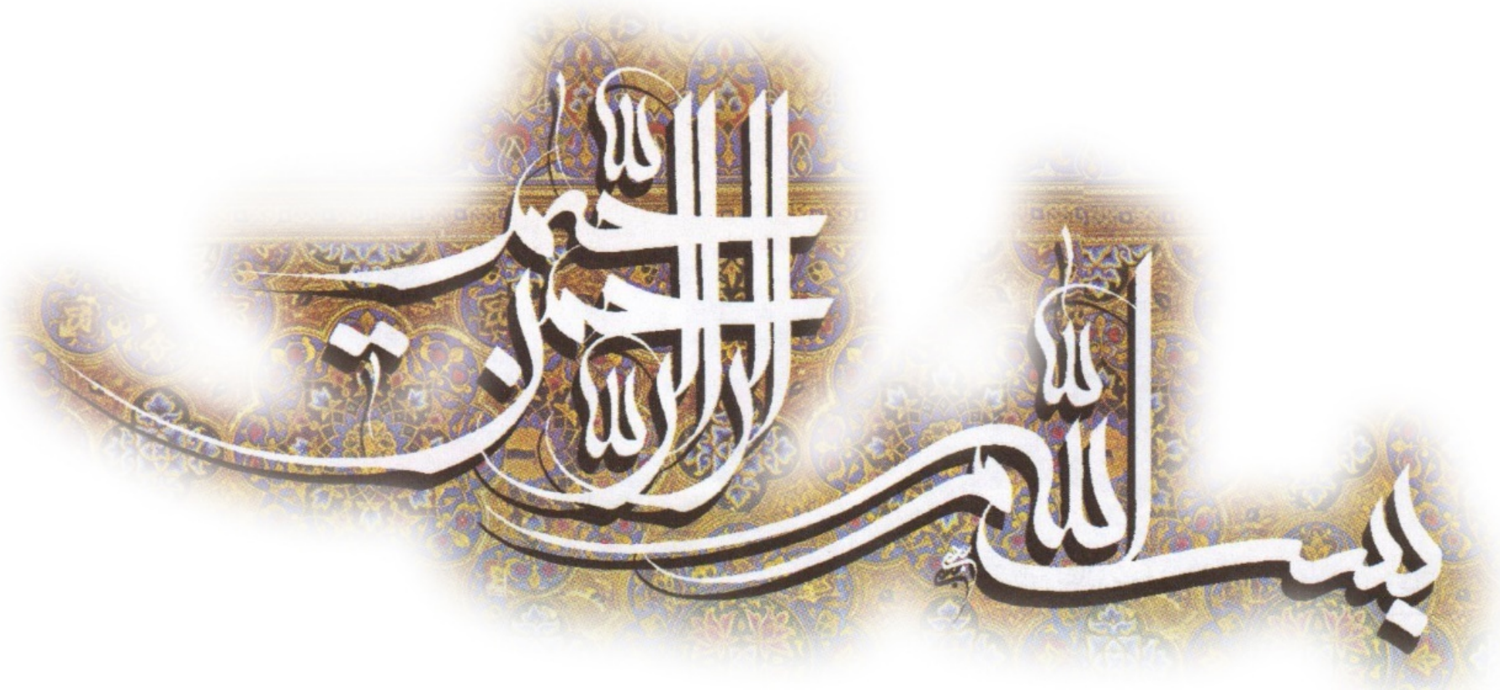
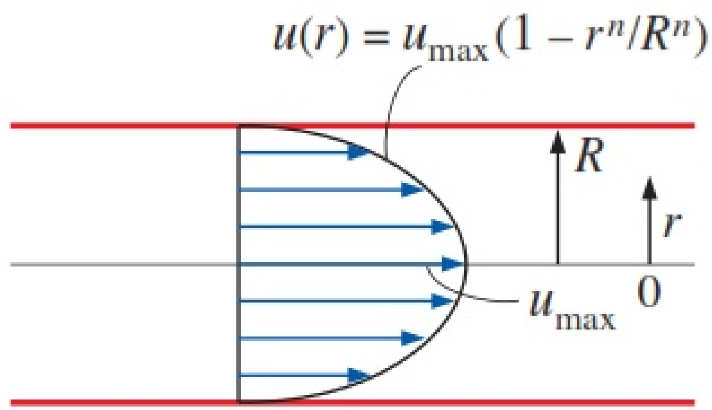
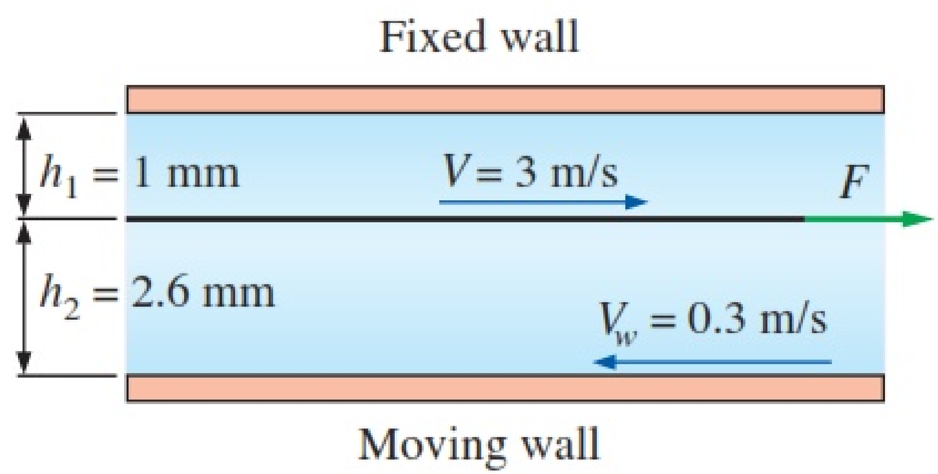

بسم الله الرحمن الرحيم

2–48 The density of seawater at a free surface where the pressure is 98 kPa is approximately 1030 kg/m^3. Taking the bulk modulus of elasticity of seawater to be 2.34×10^9 N/m^2 and expressing variation of pressure with depth z as $dP = \rho g\, dz$ determine the density and pressure at a depth of 2500 m. Disregard the effect of temperature.

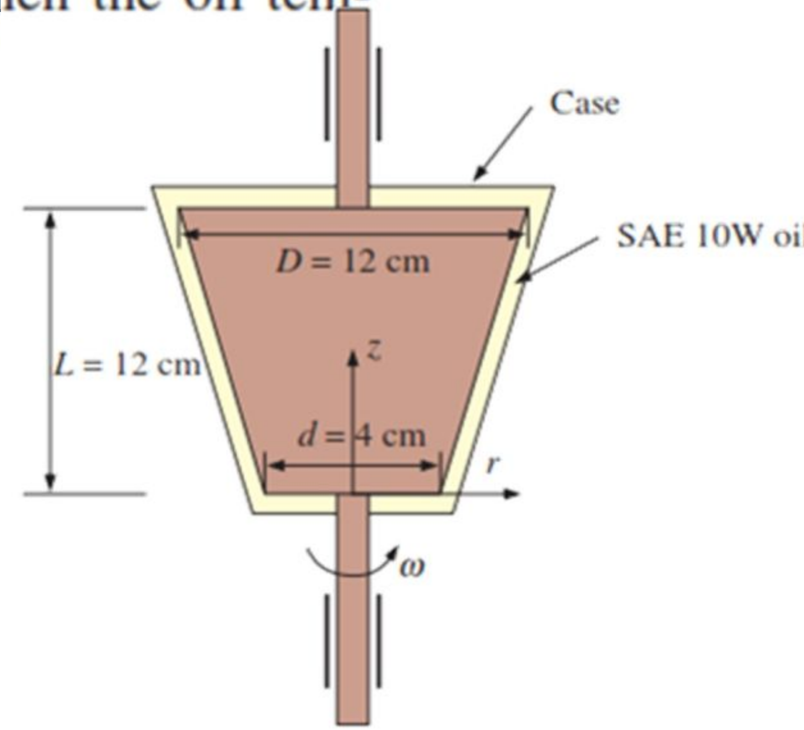
2–80 Consider the flow of a fluid with viscosity μ through a circular pipe. The velocity profile in the pipe is given as $u(r) = u_{max}(1 - r^n/R^n)$, where u_{max} is the maximum flow velocity, which occurs at the centerline; r is the radial distance from the centerline; and $u(r)$ is the flow velocity at any position r. Develop a relation for the drag force exerted on the pipe wall by the fluid in the flow direction per unit length of the pipe.

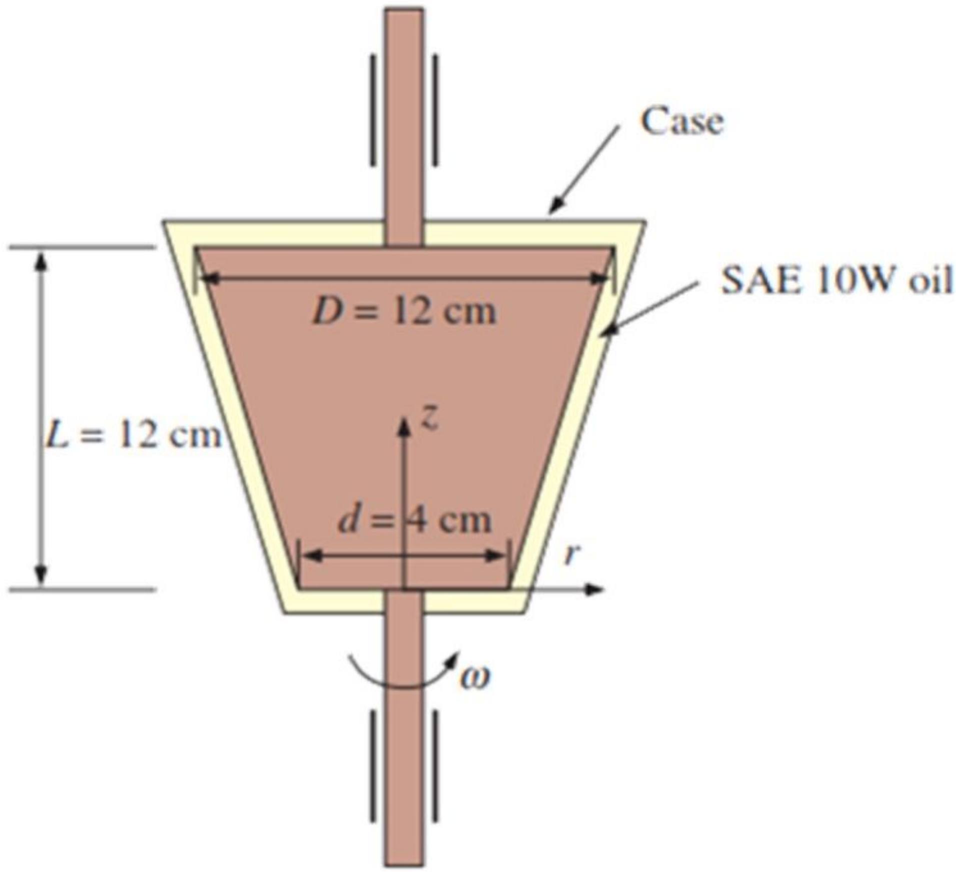


2–81 A thin 30-cm × 30-cm flat plate is pulled at 3 m/s horizontally through a 3.6-mm-thick oil layer sandwiched between two plates, one stationary and the other moving at a constant velocity of 0.3 m/s, as shown in Fig. P2–81. The dynamic viscosity of the oil is 0.027 Pa·s. Assuming the velocity in each oil layer to vary linearly, (*a*) plot the velocity profile and find the location where the oil velocity is zero and (*b*) determine the force that needs to be applied on the plate to maintain this motion.



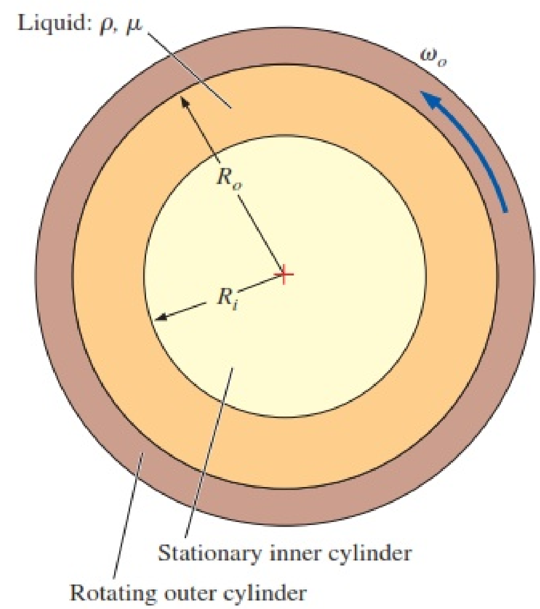
2–90 A frustum-shaped body is rotating at a constant angular speed of 200 rad/s in a container filled with SAE 10W oil at 20°C ($\mu = 0.100$ Pa·s), as shown in Fig. P2–90. If the thickness of the oil film on all sides is 1.2 mm, determine the power required to maintain this motion. Also determine the reduction in the required power input when the oil temperature rises to 80°C ($\mu = 0.0078$ Pa·s).

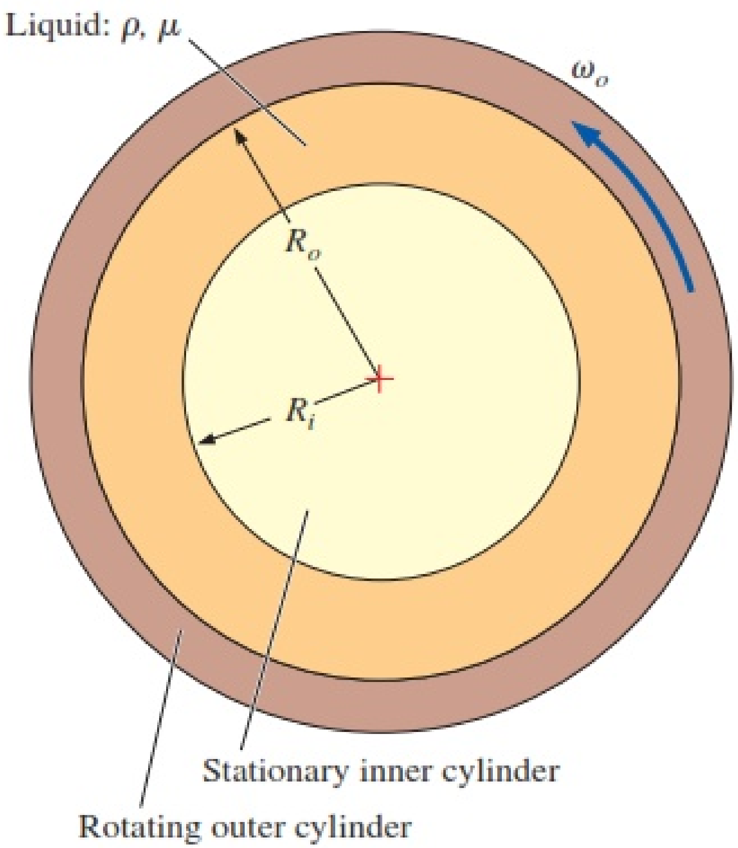




Case
SAE 10W oil
D = 12 cm
L = 12 cm
z
d = 4 cm
r
ω

2–91 A rotating viscometer consists of two concentric cylinders—a stationary inner cyliner of radius R_i and an outer cylinder of inside radius R_o rotating at angular velocity (rotation rate) ω_o. In the tiny gap between the two cylinders is the fluid whose viscosity (μ) is to be measured. The length of the cylinders (into the page in Fig. P2-91) is L. L is large such that end effects are negligible (we can treat this as a two-dimensional problem). Torque (T) is required to rotate the inner cylinder at constant speed. Showing all your work and algebra, generate an approximate expression of T as a function of the other variables.

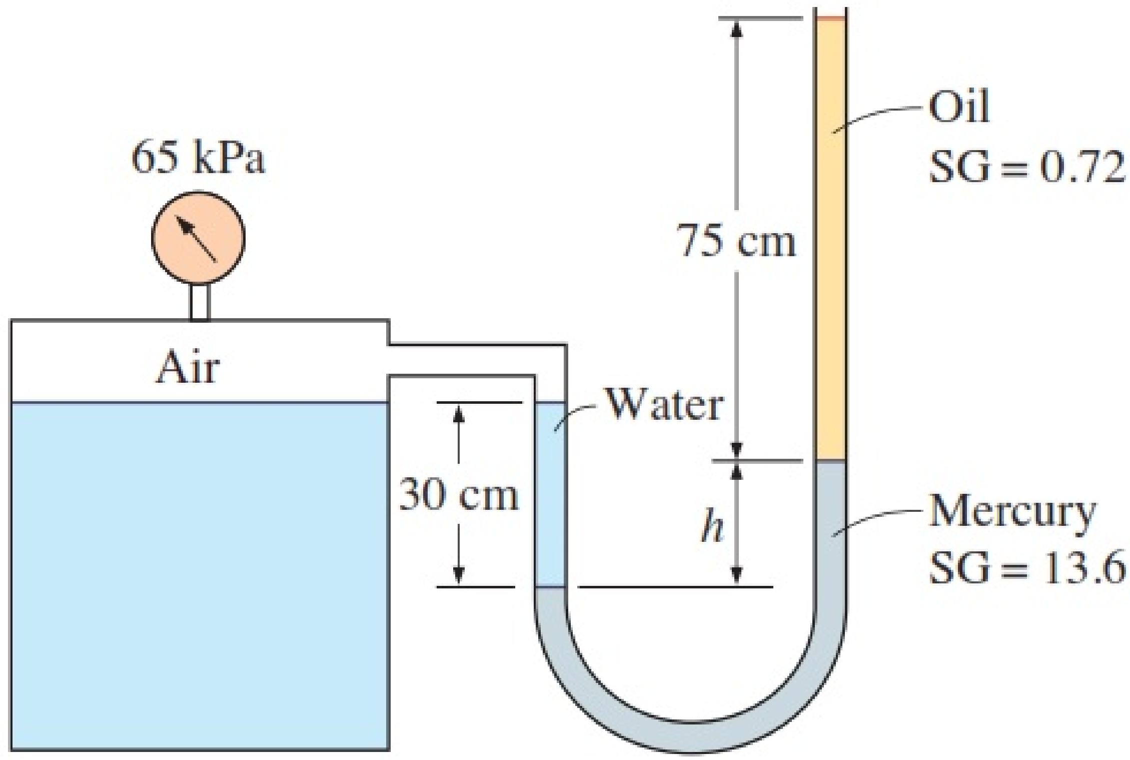



Liquid: ρ, μ
ω_o
R_o
R_i
Stationary inner cylinder
Rotating outer cylinder

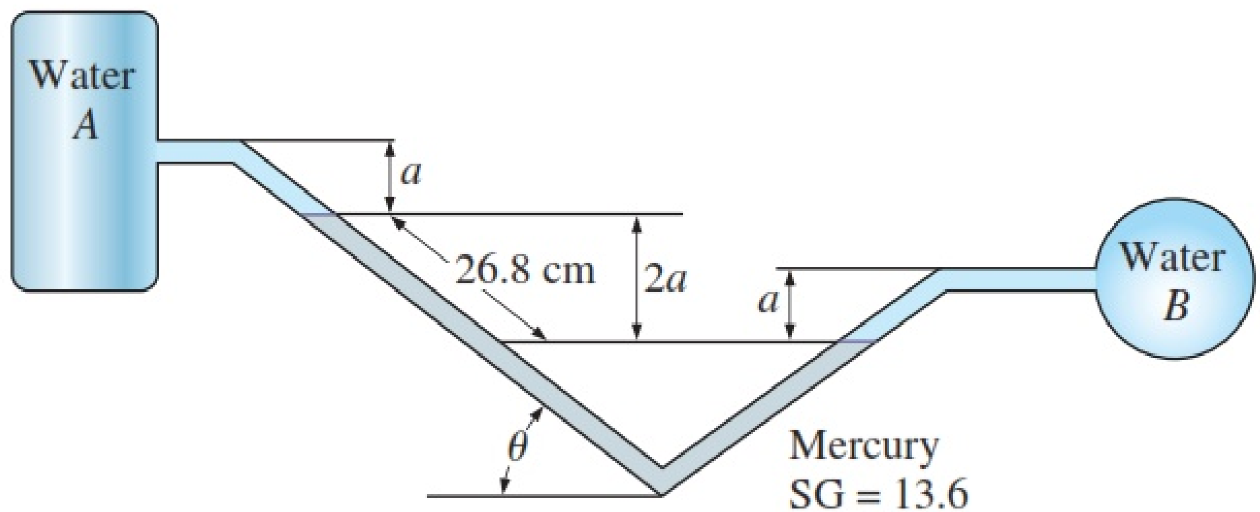
2–103 A 1.2-mm-diameter tube is inserted into an unknown liquid whose density is 960 kg/m^3, and it is observed that the liquid rises 5 mm in the tube, making a contact angle of 15°. Determine the surface tension of the liquid.

2–111 Derive a relation for the capillary rise of a liquid between two large parallel plates a distance t apart inserted into the liquid vertically. Take the contact angle to be ϕ.

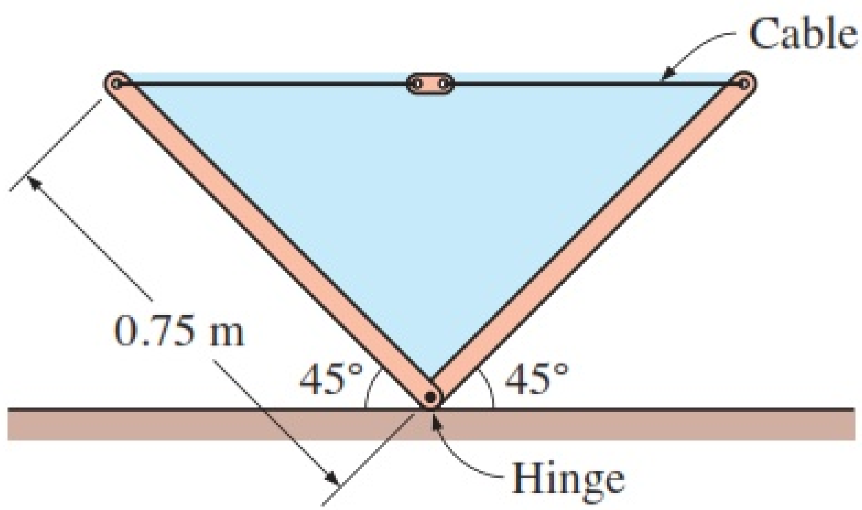
3–49 The gage pressure of the air in the tank shown in Fig. P3–49 is measured to be 65 kPa. Determine the differential height *h* of the mercury column.



3–58 Two water tanks are connected to each other through a mercury manometer with inclined tubes, as shown in Fig. P3–58. If the pressure difference between the two tanks is 20 kPa, calculate *a* and *θ*.



3–84 The two sides of a V-shaped water trough are hinged to each other at the bottom where they meet, as shown in Fig. P3–84, making an angle of 45° with the ground from both sides. Each side is 0.75 m wide, and the two parts are held together by a cable and turnbuckle placed every 6 m along the length of the trough. Calculate the tension in each cable when the trough is filled to the rim. *Answer:* 5510 N



3–86 A retaining wall against a mud slide is to be constructed by placing 1.2-m-high and 0.25-m-wide rectangular concrete blocks ($\rho = 2700$ kg/m^3) side by side, as shown in Fig. P3–86. The friction coefficient between the ground and the concrete blocks is $f = 0.4$, and the density of the mud is about 1400 kg/m^3. There is concern that the concrete blocks may slide or tip over the lower left edge as the mud level rises. Determine the mud height at which (*a*) the blocks will overcome friction and start sliding and (*b*) the blocks will tip over.