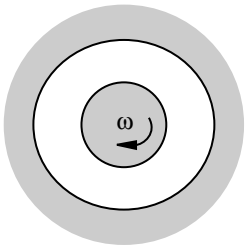
Remark 7.14. There is also a kinetic theory for liquids but, in general, it is much more technical.

Problems

7.1 A rod of 15 cm diameter turns at 1800 rpm in the interior of an orifice of 15.05 cm diameter and 30 cm length. The space between the rod and the orifice is filled with an oil of viscosity $\mu = 0.018$ kg/(m s). What is the power P necessary to equilibrate the viscous resistance to turn the rod?



Problem 7.1. Axle turning into a concentric bearing.

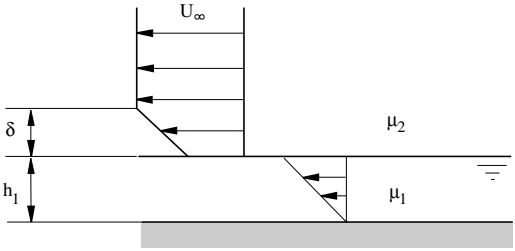
7.2 If the angular velocity of the axle in the above problem is doubled, how many times does the power P increases?

7.3 A plastic panel of surface 1 m^2 and thickness 1 cm transports heat at a rate of 3 W at steady state when the top and bottom surface temperatures are, respectively, $T_0 = 24$ °C and $T_1 = 26$ °C. What is the thermal conductivity κ of the plastic?

7.4 The space between two parallel plates separated 1.5 cm is filled with an oil of viscosity $\mu = 0.05$ kg/(m s). Between the plates, a rectangular thin flat plate with dimensions 30×60 cm is placed at 0.5 cm from the top plate. What is the necessary force to move the middle plate at 0.4 m/s?

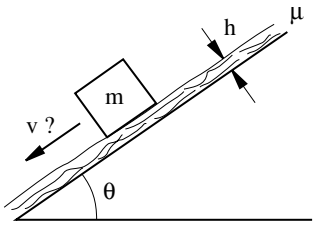
Problem 7.4. A plate immersed in a fluid presents resistance to the motion.

7.5 On a windy day, the wind blows at 30 m/s causing the free surface of a puddle to move at a speed of 1 m/s. The thickness of the puddle is 5 cm. Assuming that the velocity profile is linear within the puddle and the air boundary layer, estimate the air boundary layer thickness δ. Data: $\mu_{air} = 1.82 \times 10^{-5}$ kg/(m s); $\mu_{water} = 1.00 \times 10^{-3}$ kg/(m s).



Problem 7.5. The wind drives the surface of the water by friction.

7.6 A block of mass m slides down an inclined plane as the Figure shows. Determine the terminal speed of the block (i.e. the maximum speed that the block reaches at steady state) if between the block and the plane there exists a thin film of thickness h of a fluid with viscosity μ. Assume that the velocity profile is linear in the film and that the contact area is A.



Problem 7.6. A thin film of fluid acts as a lubricant.