

[pex16] Measuring viscosity and shear modulus

Consider two coaxial cylinders of length $l = 10\text{cm}$. The inner surface of the outer cylinder has radius $r_1 = 10\text{cm}$ and the outer surface of the inner cylinder has radius $r_2 = 9.5\text{cm}$. What torque is measured on the outer cylinder if

(a) the gap is filled with oil (viscosity $\eta = 10\text{P}$) and the inner cylinder rotates with angular velocity $\omega = 5\text{rad/s}$,

(b) the gap is filled with rubber (shear modulus $G = 5 \times 10^5\text{Pa}$) and the inner cylinder is turned an angle $\theta = 0.01\text{rad}$?

(c) What if the torque is measured on the inner cylinder and the outer cylinder is turned?

Note: Pascal (Pa) is an SI unit but poise (P) is not.

[adapted from Jones 2002]

Solution: