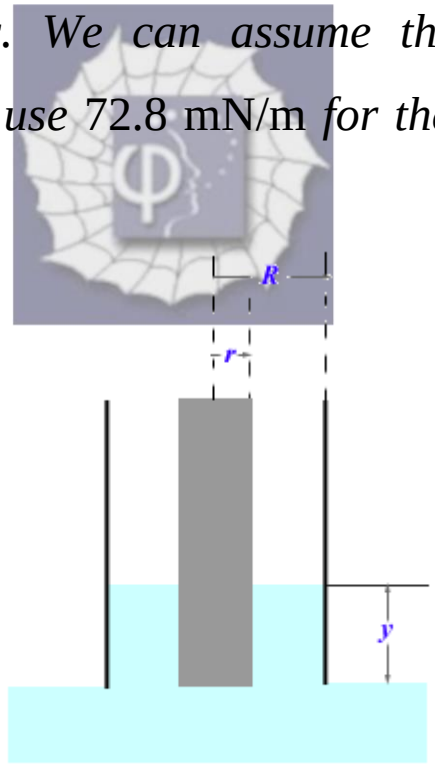
80.

Problem 17.56 (RHK)

A solid glass rod of radius r= 1.3 cm *is placed inside and coaxial with a glass cylinder of internal radius R=*1.7 cm. *Their bottom ends are aligned and placed in contact with, and perpendicular to, the surface of an open tank of water. We have to find the height y up to which the water will rise in the region between the rod and the cylinder. We can assume that the angle of contact is* 0^0 *and use* 72.8 mN/m *for the surface tension of water.*



Solution:

Problem is a modification of the standard capillary rise in a tube due to surface tension. Total upward force on the

liquid column contained between the coaxial glass rod and the cylinder is

$$F = 2\pi\left(R + r\right)\gamma,$$

where R is the radius of the cylinder, r is the radius of the glass rod and γ is the surface tension of water.

Weight of the liquid column supported by F is

$$Mg = \pi\left(R^2 - r^2\right)y\rho_{water}g.$$

Equating F and Mg,

$$y = \frac{2\gamma}{\left(R - r\right)g\rho_{water}}$$

$$= \frac{2 \times 72.8 \times 10^{-3}}{(1.7 - 1.3) \times 10^{-2} \times 10^{3} \times 9.8}\ \text{m} = 3.7\ \text{mm}.$$

Water will rise by 3.7 mm in the region between the rod and the cylinder.