Problem 14-07 Capillary elevation and depression, contact angle

The liquid A with the surface tension γ_A = 28 mN m^{-1} and density ρ_A = 1.16 g cm^{-3}, climbs in a glass capillary of the inner diameter of 0.04 mm up to the height of 92 mm above the level of the liquid in a broad tube.

(a) Calculate the contact angle of the liquid A on glass.

(b) A small amount of another liquid, B, with the same surface tension and density, forms on a flat glass plate a drop with the contact angle θ_B = 100.4°. How will this liquid behave in a vertical glass capillary – will it exhibit an elevation or a depression? Calculate it.

[(a) θ_A = 68°; (b) deprese h_B = –44 mm]

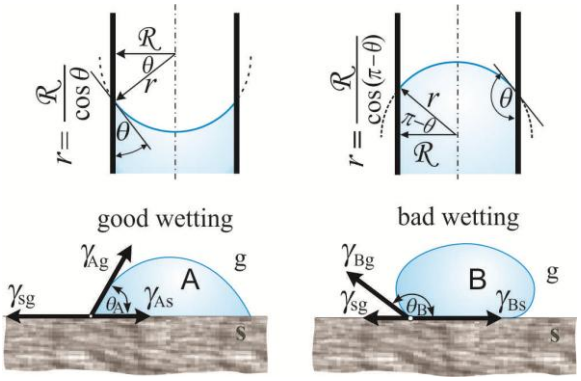
Solution:

h_A = 92 mm = 0.092 m
$\gamma_A = \gamma_B$ =28 mN m^{-1} = 0.028 N m^{-1}
$\rho_A = \rho_B$ = 1.16 g cm^{-3} = 1160 kg m^{-3}
$\mathcal{R}$ = 0.04/2 mm = 2 · 10^{-5} m
θ_B = 100.4°

(a) $\cos\theta_A = \dfrac{h\rho g\mathcal{R}}{2\gamma} =$

$$\frac{0.092\cdot 1160\cdot 9.81\cdot 2\cdot 10^{-5}}{2\cdot 0.028} = 0.3739$$

θ_A = 68°



(b) $h = \dfrac{2\gamma\cos\theta}{\rho g\mathcal{R}} = \dfrac{2\cdot 0.028\cdot\cos 100.4}{1171\cdot 9.81\cdot 2\cdot 10^{-5}}$ = –0.044 m = –44 mm