2.25 Advanced Fluid Mechanics

Problem 2.5
This problem is from "Advanced Fluid Mechanics Problems" by A.H. Shapiro and A.A. Sonin
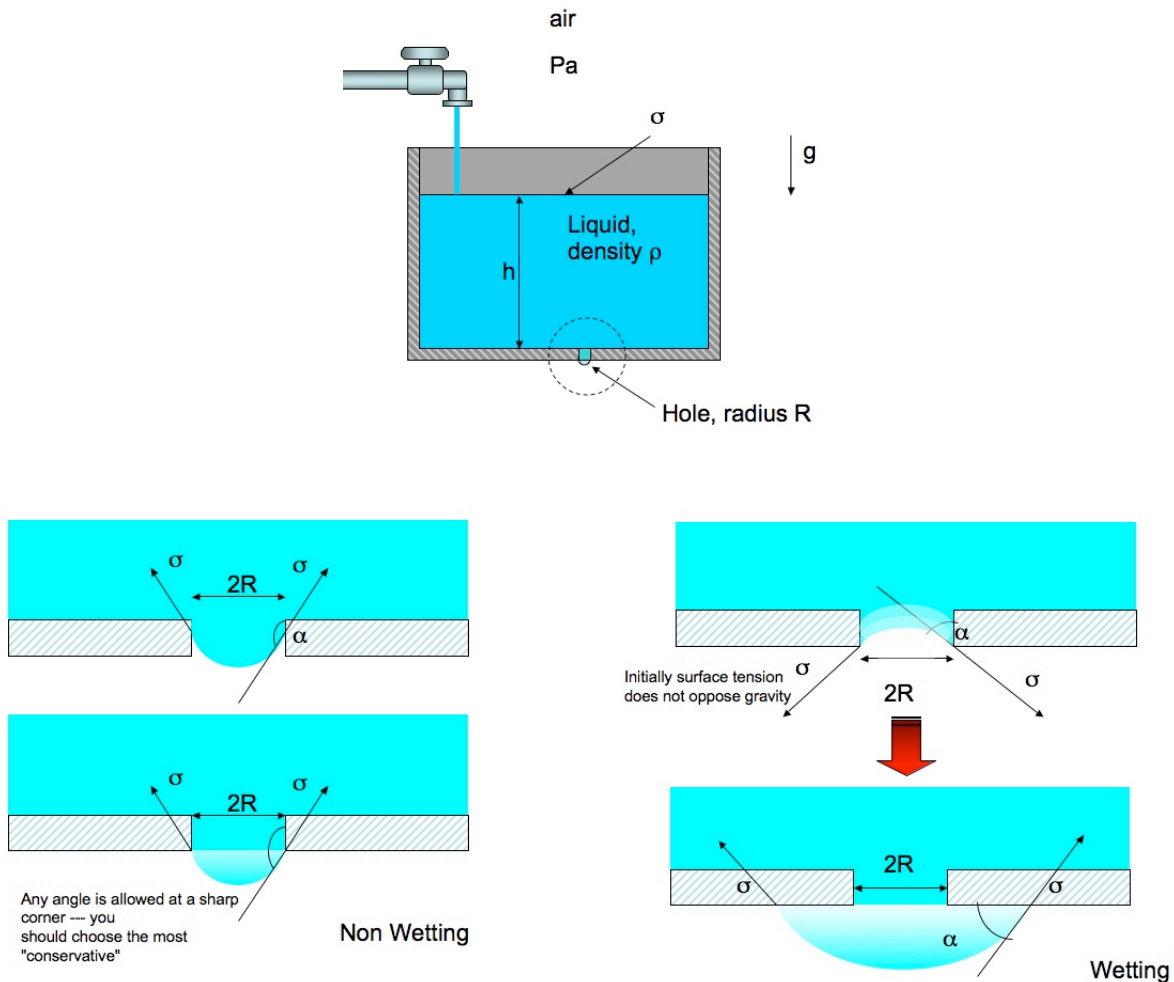
A container is being filled with liquid of density ρ. A small, sharp-edged hole of radius R penetrates the container's bottom. The surface tension between the liquid and the ambient air is σ, and the contact angle for the air/liquid/container combination is α (measured from the wall through the liquid to the interface).

(a) Find the critical liquid depth h_c at which liquid first begins to flow through the hole in the bottom. Assume that $R \ll h$. (Hint Is the expression different depending on whether α is greater or smaller than $\pi/2$?)

(b) Evaluate h_c for the case when the liquid is water at $20°C$, $R = 0.1\,\mathrm{mm}$, $\sigma = 0.07\,\mathrm{N/m}$, and $\alpha = 120°$.

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