Solution to Problem 108G

Will two floating cubes of hydrophobic material attract or repel one another?

As the cubes are brought together, surface tension pulls the level of the fluid between the cubes down relative to the undisturbed fluid outside of the cubes. The height of the depression can be calculated by balancing the vertical component of the surface tension force with the weight of the displaced fluid:

$$2SL\cos\alpha = \rho g h A L$$

$$\Rightarrow h = \frac{2s\cos\alpha}{\rho g A}$$

Another way to think about this is that the pressure at depth h produces an upward force on the meniscus region that is equal to the vertical component of the surface tension when the meniscus is in equilibrium.

Due to the drop in the fluid level between the cubes, there is a force due to a hydrostatic pressure distribution on the outside of the cubes which is unmatched on the inside of the cubes (where the pressure is just atmospheric). This causes the cubes to <u>attract</u> one another.

An estimate of the force due to this distribution would be:

$$\begin{aligned} F &= 2 \times \frac{1}{2}\rho g h^2 L \\ &= \rho g L \left(\frac{2S\cos\alpha}{\rho g A}\right)^2 \\ &= \frac{4S^2 L\cos^2\alpha}{\rho g A^2} \end{aligned}$$