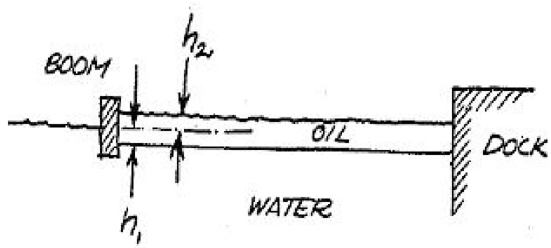
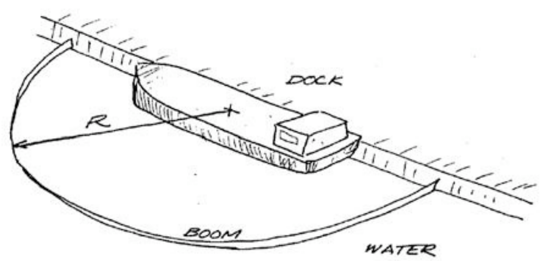
MIT Department of Mechanical Engineering
2.25 Advanced Fluid Mechanics

Problem 1.03

This problem is from "Advanced Fluid Mechanics Problems" by A.H. Shapiro and A.A. Sonin





Oil Spills may occur in ports where oil tankers are loaded. The density of oil, ρ is less than that of water ρ_w, and the two fluids are immiscible, so that when a spill occurs the oil simply spreads out in a layer on top of the water. To contain any possible spills, a semi-circular "oil boom" is deployed at a radius R around the dock where the loading takes place.

The boom is a barrier which floats on the water, its bottom submerged and its top a bit above the water surface, as shown. This barrier prevents the oil from spreading past it, at least if the spill is not too great (see part b).

Suppose a volume V of oil is spilled inside the boom. After sufficient time has elapsed for the situation to reach static conditions, calculate, in terms of ρ_0, ρ_w, R, V and g,

- (a) the depth h_1 of the bottom surface and the elevation h_2 of the top surface of the contained oil relative to the water surface outside the boom;
- (b) the components of force parallel to and transverse to the dock exerted by one of the moored boom ends on the dock.

