# Homework 1: Hydrostatic Fluids

## PHY250 - Fall 2021

## Exercise 1[1]

A narrow, U-shaped glass tube with open ends is filled with 25.0 *cm* of oil (of specific denisty 0.80) and 25.0 *cm* of water on opposite sides, with a barrier separating the liquids. (a) Assume that the two liquids do not mix, and find the final heights of the columns of liquid in each side of the tube after the barrier is removed. (b) For the following cases, arrive at your answer by simple physical reasoning, not by calculations: (i) What would be the height on each side if the oil and water had equal densities? (ii) What would the heights be if the oil's density were much less than that of water?
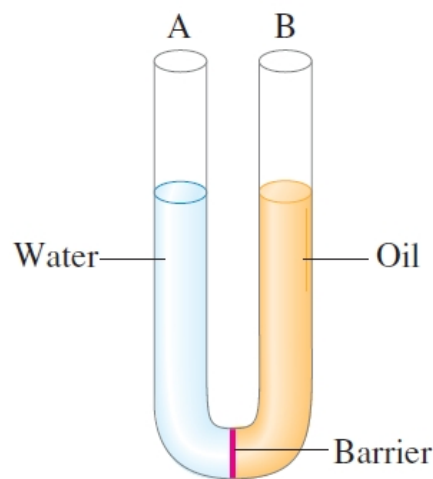


Figure 1: Exercise 1

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[1]All the exercises are taken from chapter 12 of Sears and Zemansky

## Exercise 2

If the force on the tympanic membrane (eardrum) increases by about 1.5 N above the force from atmospheric pressure, the membrane can be damaged. When you go scuba diving in the ocean, below what depth could damage to your eardrum start to occur? The eardrum is typically 8.2 mm in diameter. (Density of seawater: $\rho = 1.03 \times 10^3 \ km/m^3$).

## Exercise 3

A cylindrical disk of wood weighing 45.0 N and having a diameter of 30.0 cm floats on a cylinder of oil of density 0.850 $g/cm^3$. The cylinder of oil is 75.0 cm deep and has a diameter the same as that of the wood. (a) What is the gauge pressure at the top of the oil column? (b) Suppose now that someone puts a weight of 83.0 N on top of the wood, but no oil seeps around the edge of the wood. What is the change in pressure at (i) the bottom of the oil and (ii) halfway down in the oil?
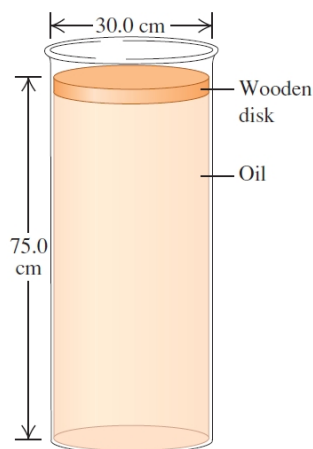


Figure 2: Exercise 3

## Exercise 4

(a) As you can tell by watching them in an aquarium, fish are able to remain at any depth in water with no effort. What does this ability tell you about their density? (b) Fish are able to inflate themselves using a sac (called the swim bladder) located under their spinal column. These sacs can be filled with an oxygen–nitrogen mixture that comes from the blood. If a 2.75-kg fish in freshwater inflates itself and increases its volume by 10%, find the net force that the water exerts on it. (c) What is the net external force on it? Does the fish go up or down when it inflates itself?

# Exercise 5

The upper edge of a gate in a dam runs along the water surface. The gate is 2.00 m high and 4.00 m wide and is hinged along a horizontal line through its center. Calculate the torque about the hinge arising from the force due to the water.
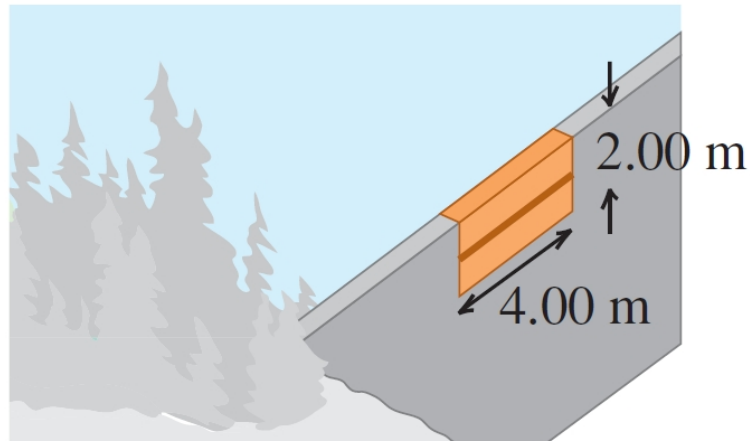


Figure 3: Exercise 5