PHYC10007: Physics for Biomedicine

Tutorial Sheet 4 — *Fluids*

Discussion/Conceptual questions

Last updated: 22/08/2014

1. How do we drink from straws? Is there a height above a glass of water at which drinking from a straw is no longer possible?

2. (a) What happens to the water level in a glass of iced water when the ice cubes melt? Why?
(b)Does the local gravitational field strength affect whether a solid object floats or sinks in a liquid?
(c) A gold bar sits in the bottom of a dinghy on a lake. If the bar is thrown into the lake, what is the effect on the water level in the lake?
(d) A block of wood is held at the bottom of a bucket of water. When it is released, the block rises to the water surface, increasing its gravitational potential energy. Where does this energy come from?

3. How is it that a boat made entirely of steel can float on water, which has a much lower density?

4. The *body average density measurement* can be used to estimate the *body fat index (BF),* i.e. the percentage of fat, for example:

$$BF = \frac{4.57}{\rho} - 4.142$$

where ρ is the body density. Describe how you would measure the density of a human adult.

Problem-solving questions

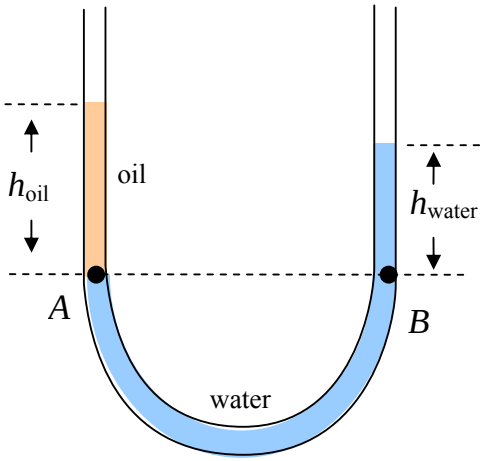
5. The blood pressure at the brain is less than the blood pressure at the heart. Estimate the difference between these blood pressures if the height difference is 0.4 m. The density of blood is 1060 kg/m^3.

6. If a person floats in the Dead Sea, about 1/3 of their body is above the water line. If the density of the human body is about 0.98 g/cm^3 what is the density of the water in the Dead Sea? Why is it greater than 1.0 g/cm^3?

7. Consider a solid cube of steel floating in liquid mercury at a temperature T. Write an expression for the volume fraction of steel above the mercury level when the densities are ρ_{steel} and ρ_{Hg}.

8. Two students, holidaying on the Murray River, decide to row their tin boat across the river to pick up a supply of beer from the bottle shop on the other side. If the boat has dimensions of 1m by 3m and depth 0.5m, estimate the number of bottles they can carry before the boat will start sinking. Assume ρ(water) = 1000 kg/m^3.

9. A U-tube has some water in it. Some oil is added to one arm, and the final situation is as shown in the diagram.



The oil-water interface is at A. The point B in the water is at the same height as A. The oil column has height h_{oil} above A and the water column height h_{water} above B.

a) How are the pressures at A and B related?

b) Show that the density of oil ρ_{oil} and ρ_{water} are related by $\dfrac{\rho_{\text{oil}}}{\rho_{\text{water}}} = \dfrac{h_{\text{water}}}{h_{\text{oil}}}$.