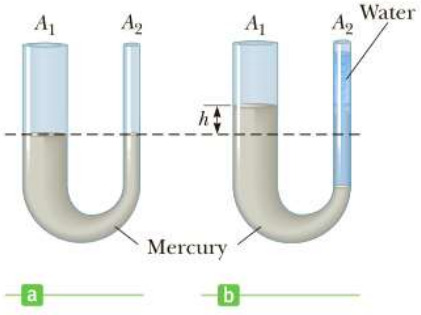
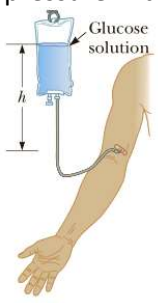
PHY 1015 Tutorial 9 - Mechanical Properties of Materials

1. Calculate the pressure 150 m below the surface of the sea. The density of sea water is 1.026 g/cm^3
2. Tension in piano wire. A 1.60-m-long steel piano wire has a diameter of 0.20 cm. How great is the tension in the wire if it stretches 0.25 cm when tightened?
3. A 15-cm-long tendon was found to stretch 3.7 mm by a force of 13.4 N. The tendon was approximately round with an average diameter of 8.5 mm. Calculate Young's modulus of this tendon.
4. Estimate the net force exerted on your eardrum due to the water above when you are swimming at the bottom of a pool that is 5.0 m deep. The pressure inside the eardrum is atmospheric. [5N, Because a force on the eardrum of this magnitude is uncomfortable, swimmers often "pop their ears" by swallowing or expanding their jaws while underwater, an action that pushes air from the lungs into the middle ear. Using this technique equalizes the pressure on the two sides of the eardrum and relieves the discomfort]
5. In a car lift used in a service station, compressed air exerts a force on a small piston of circular cross section having a radius of r_1 = 5.00 cm. This pressure is transmitted by an incompressible liquid to a second piston of radius r_2 =15.0 cm. (a) What force must the compressed air exert on the small piston in order to lift a car weighing 13 300 N? Neglect the weights of the pistons. (b) What air pressure will produce a force of that magnitude?[1480N, 1.88x10^{5}Pa]
6. Calculate the absolute pressure at the bottom of a freshwater lake at a depth of 27.5 m. Assume the density of the water is 1.00 x10^3 kg/m 3 and the air above is at a pressure of 101.3 kPa. (b) What force is exerted by the water on the window of an underwater vehicle at this depth if the window is circular and has a diameter of 35.0 cm?
7. Mercury is poured into a U-tube as shown. The left arm of the tube has cross-sectional area A_1 of 10.0 cm^2, and the right arm has a cross-sectional area A_2 of 5.00 cm^2 . One hundred grams of water are then poured into the right arm. (a) Determine the length of the water column in the right arm of the U-tube. (b) Given that the density of mercury is 13.6 g/cm^3 , what distance h does the mercury rise in the left arm.



8. A collapsible plastic bag contains a glucose solution. If the average gauge pressure in the vein is 1.33x 10^3 Pa, what must be the minimum height h of the bag to infuse glucose into the vein? Assume the specific gravity of the solution is 1.02



9. The average human has a density of 945 kg/m^3 after inhaling and 1 020 kg/m^3 after exhaling. (a) Without making any swimming movements, what percentage of the human body would be above the surface in the Dead Sea (a body of water with a density of about 1 230 kg/m^3) in each of these cases? (b) Given that bone and muscle are denser than fat, what physical characteristics differentiate "sinkers" (those who tend to sink in water) from "floaters" (those who readily float)?

10. A sample of an unknown material appears to weigh 300. N in air and 200. N when immersed in alcohol of specific gravity 0.700. What are (a) the volume and (b) the density of the material?
11. A small ferryboat is 4.00 m wide and 6.00 m long. When a loaded truck pulls onto it, the boat sinks an additional 4.00 cm into the river. What is the weight of the truck?
12. Assume that a 50-kg runner trips and falls on his extended hand. If the bones of one arm absorb all the kinetic energy (neglecting the energy of the fall), what is the minimum speed of the runner that will cause a fracture of the arm bone? Assume that the length of arm is 1 m and that the area of the bone is 4 cm.
13. Bone has a Young's modulus of 18x 10^9 Pa. Under compression, it can withstand a stress of about 160 x 10^6 Pa before breaking. Assume that a femur (thigh bone) is 0.50 m long, and calculate the amount of compression this bone can withstand before breaking.

A tutorial on Fluids in motion will be posted later.