Ch10 Q2. Consider what happens when you push both a pin and the blunt end of a pen against your skin with the same force. Decide what determines whether your skin is cut—the net force applied to it or the pressure.

Clearly the pressure. Of course, forces are what really cause motion or breakage, but the force experienced by a couple of cells will be much greater for a high pressure as opposed to low pressure.

Ch10 Q6. A submerged can of Coke will sink, but a can of Diet Coke will float. Explain.

The Diet Coke is less dense than water while the Coke is denser.

Ch10 P5. A bottle has a mass of 35.00 g when empty and 98.44 g when filled with water. When filled with another fluid, the mass is 89.22 g. What is the specific gravity of this other fluid?

We have the mass of water is 63.44g and the mass of the unknown fluid is 54.22g. Specific gravity is defined as

$$\mathrm{SG}_f = \frac{\rho_f}{\rho_{\mathrm{H_2O}}}$$

for fluid f. Since they have the same volume, we may just take a ratio of the masses as long as they have the same units. Thus,

$$\begin{aligned}\mathrm{SG}_{\mathrm{oil}} &= \frac{54.22\mathrm{g}}{63.44\mathrm{g}} \\ &= 0.8547.\end{aligned}$$

Ch10 P18. Water and then oil (which don't mix) are pouted into a U-shaped tube, open at both ends. They come to equilibrium as shown Fig.10–50. What is the density of the oil?

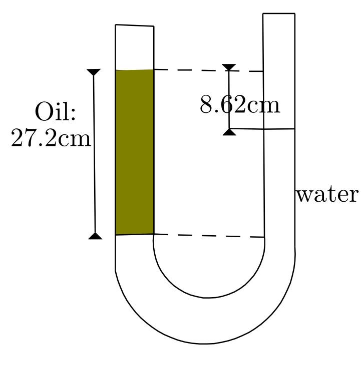

Figure 1. Recreation of Fig. 10–50.

First, using the fact that pressure is the same at interfaces, we have that the pressure at the top of the oil is 1 atm, as is the pressure at the surface of the water. Moreover, the pressure at the oil-water interface is the same in both fluids. Thus,

$$P_{\mathrm{oil}}(h = .272\mathrm{m}) = 101325\mathrm{Pa} + 1000\mathrm{kg/m^3}\, g(.272\mathrm{m})$$

for the first fact. However, since the fluid's pressure at equilibrium only depends on depth, we have that the pressure at the water-oil interface is the water pressure at $h = 27.2\text{cm} - 8.62\text{cm} = 18.6\text{cm}$. Thus,

$$\begin{aligned}
P_{\text{oil}}(h = .272\text{m}) &= 101325\text{Pa} + \rho_{\text{oil}}\, g(.272\text{m}) \\
&= P_{\text{water}}(h = .186\text{m}) \\
&= 101325\text{Pa} + 1000\text{kg/m}^3\, g(.186\text{m}) \\
\Rightarrow \rho_{\text{oil}}\, g(.272\text{m}) &= 1000\text{kg/m}^3\, g(.186\text{m}) \\
\Rightarrow \rho_{\text{oil}}(.272\text{m}) &= 1000\text{kg/m}^3\,(.186\text{m}) \\
\Rightarrow \rho_{\text{oil}} &= 1000\left(\frac{.186}{.272}\right)\text{kg/m}^3 \\
&= 683\text{kg/m}^3.
\end{aligned}$$

Ch10 P24. A geolist finds that a Moon rock whose mass is 9.28 kg has an apparent mas of 6.18 kg when submerged in water. What is the density of the rock?

We have that underwater,

$$ma = V\rho_{\text{water}} g - V\rho g.$$

If we tether a rope to the rock, then, the tension in the string divided by g gives the "apparent mass"

$$\begin{aligned}
0 &= V\rho_{\text{water}} g - V\rho g + T \\
\Rightarrow T &= V\rho g - V\rho_{\text{water}} g \\
&= m_{\text{app}} g \\
\Rightarrow m_{\text{app}} &= V\rho - V\rho_{\text{water}} \\
&= m - m_{\text{water}}.
\end{aligned}$$

Thus, we have that

$$\begin{aligned}
\frac{m}{m_{\text{water}}} &= \frac{V\rho}{V\rho\text{water}} \\
&= \frac{\rho}{\rho\text{water}} \\
\Rightarrow \rho &= \rho_{\text{water}} \frac{m}{m_{\text{water}}} \\
&= \rho_{\text{water}} \frac{m}{m - m_{\text{app}}} \\
&= 2990\text{kg/m}^3.
\end{aligned}$$

Ch10 P30. A scuba driver and her gear displace a volume of 69.6 L and a total mass of a 72.8 kg. (a) What is the buoyant force on the driver in seawater? (b) Will the diver sink of float?

69.9 liters is

$$69.6\text{L}\frac{1\,\text{m}^3}{1000\,\text{L}} = .0696\,\text{m}^3.$$

Her average density is then,

$$\rho = \frac{72.8\,\text{kg}}{.0696\text{m}^3} = 1050\,\text{kg/m}^3.$$

She is only slightly denser than sea water.

a) The bouyant force on her is then

$$\begin{aligned} m_{\text{water}}g &= 0.0696\text{m}^3 1025\text{kg/m}^3 g \\ &= 69.9\text{kg}g \\ &= 699\,\text{N}. \end{aligned}$$

b) She is slightly denser, so she will sink, although very gradually such that she can still swim.

Ch10 P35. A 0.48–kg piece of wood floats in water but is found to sink in alcohol (SG=0.79), in which it has an apparent mass of 0.047 kg. What is the SG of the wood?

Nothing changes from problem 24, we still have that

$$\begin{aligned} \text{sg}_{\text{wood}} &= \frac{m_{\text{wood}}}{m_{\text{wood}} - m_{\text{app}}} \\ &= \frac{0.48\,\text{kg}}{0.48\,\text{kg}{-}0.047\,\text{kg}} \\ &= 1.1 \end{aligned}$$

which is with respect to oil. Thus,

$$1.1 = \frac{\rho_{\text{wood}}}{\rho_{\text{EtOH}}}$$

For the SG with respect to water,

$$\begin{aligned} \text{SG} &= \frac{\rho_{\text{wood}}}{\rho_{\text{EtOH}}}\frac{\rho_{\text{CH}_2\text{OH}}}{\rho_{\text{water}}} \\ &= 1.1 \cdot 0.79 \\ &= 0.88. \end{aligned}$$

Ch10 P38. How many helium-filled balloons would it take to lift a person? Assume the person has a mass of 72 kg and that each helium-filled balloon is spherical with a diameter of 33 cm.

Given a volume of helium V with density 0.179 kg/m^3, and that air has a density of 1.29 kg/m^3, the system of balloon and person system, assuming we neglect the buoyancy force on the human,

$$ma = V\rho_{\text{air}}\,g - V\rho_{\text{He}}g - 72\text{kg}g.$$

If we want to just lift him, then $a = 0$:

$$\begin{aligned} 0 &= V\rho_{\text{air}}\,g - V\rho_{\text{He}}g - 72\text{kg}g. \\ \Rightarrow 72\text{kg} &= V\rho_{\text{air}} - V\rho_{\text{He}} \\ \Rightarrow V &= \frac{72\text{kg}}{\rho_{\text{air}} - \rho_{\text{He}}} \\ &= 64.8\text{m}^3. \end{aligned}$$

Each balloon has a volume of

$$\begin{aligned} V_{1-\text{balloon}} &= \frac{4}{3}\pi(.33\text{m})^3 \\ &= 0.0188\text{m}^3. \end{aligned}$$

Therefore, we have that this takes

$$64.8\text{m}^3/0.0188\text{m}^3 \;=\; 3400 \text{ balloons.}$$

which is certainly a lot more than Up would have you believe.

Ch10 P40. A 3.65–kg block of wood (SG=0.50) floats on water. What minimum mass of lead, hung from the wood by a string, will caue the block to sink?

Consider lead tethered to the block. We have that, ignoring the mass of the tether, for the block

$$3.65\text{kg}\, a \;=\; m_{\text{water}-\text{wood}} g - 3.65\text{kg}\, g - T.$$

For the lead piece,

$$m_{\text{Pb}} a \;=\; T + m_{\text{water}-\text{pb}} g - m_{\text{Pb}} g.$$

For just having the thing sink, $a = 0$. Thus,

$$\begin{aligned} T &= m_{\text{Pb}} g - m_{\text{water}-\text{pb}} g \\ \Rightarrow m_{\text{Pb}} g - m_{\text{water}-\text{pb}} g &= m_{\text{water}-\text{wood}} g - 3.65\text{kg}\, g \\ \Rightarrow V_{\text{Pb}} \rho_{\text{Pb}} - V_{\text{ Pb}} \rho_{\text{water}} &= V_{\text{ wood}} \rho_{\text{water}} - 3.65\text{kg}\,. \end{aligned}$$

We have that

$$\begin{aligned} V_{\text{wood}} &= \frac{3.65\text{kg}}{\rho_{\text{wood}}} \\ &= \frac{3.65\text{kg}}{0.5\rho_{\text{water}}}. \end{aligned}$$

Thus,

$$\begin{aligned} \Rightarrow V_{\text{Pb}}(\rho_{\text{Pb}} - \rho_{\text{water}}) &= \frac{3.65\text{kg}}{0.5\rho_{\text{water}}}\rho_{\text{water}} - 3.65\text{kg} \\ &= \frac{3.65\text{kg}}{0.5} - 3.65\text{kg} \\ \Rightarrow V_{\text{Pb}} &= \frac{\frac{3.65\text{kg}}{0.5} - 3.65\text{kg}}{\rho_{\text{Pb}} - \rho_{\text{water}}} \\ \Rightarrow m_{\text{Pb}} &= \frac{\frac{3.65\text{kg}}{0.5} - 3.65\text{kg}}{\rho_{\text{Pb}} - \rho_{\text{water}}}\rho_{\text{Pb}} \\ &= 3.65\text{kg}\frac{2-1}{1 - \frac{\rho_{\text{water}}}{\rho_{\text{Pb}}}} \\ &= 3.65\text{kg}\frac{1}{1 - \frac{1000}{113400}} \\ &= 4.00\text{kg}. \end{aligned}$$

Hardly much more lead than the wood.