1. The specific gravity of gasoline is 0.72. What is the density of gasoline?

\[ \rho_w := \frac{62.3 \text{ lb}}{\text{ft}^3}, \quad \rho_{\text{gas}} := 0.72 \cdot \rho_w \]

\[ \rho_{\text{gas}} = 718.524 \text{ kg/m}^3 \]

\[ \rho_{\text{gas}} = 44.856 \text{ lb/ft}^3 \]

\[ \rho_{\text{gas}} = 718.524 \text{ gm/L} \]

2. Assuming a Newtonian Fluid, you have one data point relating shear rate to shear stress.

If a shear rate of 2s\(^{-1}\) creates a shear stress of 1360 Pa, approximate the viscosity, \(\mu\).

\[ \sigma := 2 \cdot \frac{1}{s} \]

\[ \tau := 1360 \text{ Pa} \]

\[ \mu := \frac{\tau}{\sigma} \]

\[ \mu = 680 \text{ kg/m/s} \]

\[ \mu = 456.939 \text{ lb/ft/s} \]

3. Consider a block of wood that is exactly a cube with side dimension 1 foot.

When placed in water, it floats and just the top surface is exposed to the atmosphere.

The remainder of the block is under water. Estimate the average density of the block.

The weight of the wood is equal to the buoyant force, which is in turn equal to the weight of the two fluids displaced. However, in this case, no "air" is displaced, so we are looking at just one fluid, water.

\[ V_{\text{wood}} \rho_{\text{wood}} \cdot g = V_{\text{water}} \rho_{\text{water}} \cdot g + V_{\text{air}} \rho_{\text{air}} \cdot g = V_{\text{water}} \rho_{\text{water}} \cdot g \]

Or:

\[ V_{\text{wood}} \rho_{\text{wood}} = V_{\text{water}} \rho_{\text{water}} \]

Since the volume of the wood is exactly that of the displaced water, the density are equal.

\[ \rho_{\text{wood}} := \frac{62.3 \text{ lb}}{\text{ft}^3} \]

1. A research submarine is designed to operate 3 km below the ocean surface.

The interior pressure is 1 atm.

a. What is the pressure (net) on the window in inches of Hg?

b. What is the total "pressure" (force) on the 15-cm-diameter window?

For part a, we are looking at 3000m head of water. The 1 atmosphere interior pressure counteracts the atmospheric pressure.

\[ \text{SG}_{\text{sw}} := 1.03 \quad m_{\text{of water}} := \text{SG}_{\text{sw}} \cdot \frac{1}{10.33} \cdot \text{atm} \]

\[ P := 3000 \cdot m_{\text{of water}} \quad P = 299.1 \text{ atm} \quad P = 4396 \text{ psi} \quad P = 8950 \text{ in}_{\text{Hg}} \]

For part b:

\[ F_{\text{total}} := \frac{\pi \cdot (15 \text{-cm})^2}{4} \cdot P \quad F_{\text{total}} = 5.356 \times 10^5 \text{ N} \quad F_{\text{total}} = 1.204 \times 10^5 \text{ lbf} \]
2. A suspension of very fine sand (quartz) particles in water is used to separate bituminous coal from denser particles of rock. If the desired density of the suspension is 1500 kg/m³, what is the weight fraction of sand that should be used?

\[
\rho_{\text{suspension}} := 1500 \text{ kg/m}^3 \quad \rho_{\text{suspension}} = \frac{m_{\text{sand}} + m_{\text{water}}}{\left(\frac{m_{\text{sand}}}{\rho_{\text{sand}}} + \frac{m_{\text{water}}}{\rho_{\text{water}}}\right)}
\]

\[
m_{\text{sand}} \frac{\rho_{\text{suspension}}}{\rho_{\text{sand}}} + m_{\text{water}} \frac{\rho_{\text{suspension}}}{\rho_{\text{water}}} = m_{\text{sand}} + m_{\text{water}}
\]

But:
\[
\rho_{\text{water}} := 998 \text{ kg/m}^3 \quad \rho_{\text{sand}} := 2.6 \cdot \rho_{\text{water}} \quad \rho_{\text{sand}} = 2595 \text{ kg/m}^3
\]

Assume a basis of 100 kg of suspension:
\[
m_{\text{water}} = 100 \text{ kg} - m_{\text{sand}} \quad m_{\text{sand}} + m_{\text{water}} = 100 \text{ kg}
\]

\[
m_{\text{sand}} \frac{\rho_{\text{suspension}}}{\rho_{\text{sand}}} + (100 \text{ kg} - m_{\text{sand}}) \frac{\rho_{\text{suspension}}}{\rho_{\text{water}}} = 100 \text{ kg}
\]

\[
m_{\text{sand}} \left(\frac{\rho_{\text{suspension}}}{\rho_{\text{sand}}} - \frac{\rho_{\text{suspension}}}{\rho_{\text{water}}}\right) = 100 \text{ kg} \cdot \left(1 - \frac{\rho_{\text{suspension}}}{\rho_{\text{water}}}\right)
\]

\[
m_{\text{sand}} := 100 \text{ kg} \cdot \left(1 - \frac{\rho_{\text{suspension}}}{\rho_{\text{water}}}\right) \left(\frac{\rho_{\text{suspension}}}{\rho_{\text{sand}}} - \frac{\rho_{\text{suspension}}}{\rho_{\text{water}}}\right)^{-1}
\]

\[
m_{\text{sand}} = 54.383 \text{ kg} \quad \text{or: } 54.4\% \text{ sand}
\]
3. The bottom "band" of a grain bin is 2 feet high and 1 cm thick and has a tensile strength of 10,000 psia. The diameter of the bin will be 20 feet. The bottom band is secured (bolted) to a thin metal floor and 4 inches of cement is poured for the permanent floor. Unfortunately, the bin ruptured as almost 1 foot of concrete was inadvertently poured onto the bin floor. What do you think (and why) was the cause of the breach, the bottom ring, the thin metal floor, or the bolted joint?

$$\sigma_{\text{tensile}} := 10000 \text{ psi} \quad \text{SG}_{\text{cement}} := 1.50$$

$$P := 1 \cdot \text{ft}_{\text{water}} \cdot \text{SG}_{\text{cement}} \quad P = 0.65 \text{ psi} \quad D := 20 \text{ ft}$$

For the given tensile strength, the required thickness for the given geometry and pressure:

$$t := \frac{P \cdot D}{2 \cdot \sigma_{\text{tensile}}} \quad t = 0.02 \text{ cm}$$

The material likely did not rupture.

Since the ground is providing the opposing force upward for the thin metal floor, it is not likely the cause of the breach.

Thus the most likely cause of the breach is the bolted joint.