From Eq. (9.1) we find the mean density of the Earth to be

\[ \rho_e = \frac{M_e}{V_e} = \frac{M_e}{\frac{4\pi}{3} R_e^3} = \frac{3(5.975 \times 10^{24} \text{ kg})}{4\pi(1.274246 \times 10^7 \text{ m}/2)^3} = 5.515 \times 10^3 \text{ kg/m}^3. \]

Now change \( \rho_e \) to \( \rho_n \), the density of nuclear matter, and solve for the corresponding new radius \( R'_e \) from the equation above:

\[ R'_e = \left( \frac{3M_e}{4\pi \rho_n} \right)^{1/3} = \left[ \frac{3(5.975 \times 10^{24} \text{ kg})}{4\pi(2 \times 10^{17} \text{ kg/m}^3)} \right]^{1/3} = 2 \times 10^2 \text{ m}, \]

which is only about one-eighth of a mile.

The molar mass of water is 18 g/mol. Thus the number of water molecules contained in 1.00 g of water is \( \left[ \frac{1.00 \text{ g}}{(18 \text{ g/mol})} \right] \left[ 6.02 \times 10^{23} \text{ /mol} \right] = 3.34 \times 10^{22} \). Since each \( \text{H}_2\text{O} \) molecule contains 3 atoms, the number of atoms in 1.00 g of \( \text{H}_2\text{O} \) is \( 3(3.34 \times 10^{22}) = 1.00 \times 10^{23} \), regardless of whether it is in liquid or solid state.

- mass of a water molecule is 18.0 u, of which 2.0 u, or 2.0 u/18.0 u = 1/9, is hydrogen. Thus weight of hydrogen in 62.4 lb of water is \( \left( \frac{1}{9} \right)(62.4 \text{ lb}) = 6.93 \text{ lb} \), which corresponds to a

\[ \text{mass of } (6.93 \text{ lb})/(0.4536 \text{ kg/lb}) = 3.14 \text{ kg}. \]

On the one hand, when the fluid level is at height \( h \) above the bottom of the tank, the fluid surface assumes a circular area of radius \( r = \frac{1}{2}h \). The volume of the water in the tank at that moment is \( V = \frac{1}{3} \pi r^2 h = \frac{1}{12} \pi h^3 \). The time rate of change of \( V \) is then

\[ \frac{dV}{dt} = \frac{d}{dt} \left( \frac{1}{12} \pi h^3 \right) = \frac{1}{4} \pi h^2 \left( \frac{dh}{dt} \right). \]

On the other hand, we know that the volume of the water changes because water is being poured into the tank at the rate of \( dm/dt = \mu \), in kg per sec. Since \( V = m/\rho \), we may divide \( \mu \) by \( \rho \), the density of water, to obtain the rate at which the volume of the water changes due to the addition of the water:

\[ \frac{dV}{dt} = \frac{d(m/\rho)}{dt} = \frac{1}{\rho} \frac{dm}{dt} = \frac{\mu}{\rho}. \]

Equate the two expressions above for \( dV/dt \) to obtain \( \frac{1}{4} \pi h^2 (dh/dt) = \mu/\rho \), or

\[ \frac{dh}{dt} = \frac{4\mu}{\pi h^2 \rho}. \]

Use Eq. (9.4): \( P_i = \rho gh \). Here \( P_i = 400 \text{ kPa} \) and \( \rho = 1.000 \times 10^3 \text{ kg/m}^3 \), so the height of the water column is

\[ h = \frac{P_i}{\rho g} = \frac{400 \times 10^3 \text{ N/m}^2}{(1.000 \times 10^3 \text{ kg/m}^3)(9.81 \text{ m/s}^2)} = 40.8 \text{ m}. \]