Solution: Given $\gamma_{gasoline} = 0.68(9790) = 6657\ N/m^3$, compute the pressure when "full":

$$p_{full} = \gamma_{gasoline}(\text{full height}) = (6657\ N/m^3)(0.30\ m) = 1997\ Pa$$

Set this pressure equal to 2 cm of water plus "Y" centimeters of gasoline:

$$p_{full} = 1997 = 9790(0.02\ m) + 6657Y, \quad \text{or} \quad Y \approx 0.2706\ m = 27.06\ cm$$

Therefore the air gap $h = 30\ cm - 2\ cm(\text{water}) - 27.06\ cm(\text{gasoline}) \approx$ **0.94 cm** *Ans.*

2.23 In Fig. P2.23 both fluids are at 20°C. If surface tension effects are negligible, what is the density of the oil, in kg/m³?

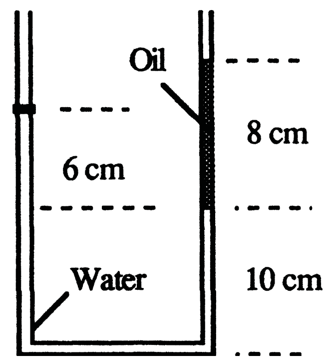

Fig. P2.23

Solution: Move around the U-tube from left atmosphere to right atmosphere:

$$p_a + (9790\ N/m^3)(0.06\ m) - \gamma_{oil}(0.08\ m) = p_a,$$

solve for $\gamma_{oil} \approx 7343\ N/m^3$,

or: $\rho_{oil} = 7343/9.81 \approx$ **748 kg/m³** *Ans.*

2.24 In Prob. 1.2 we made a crude integration of atmospheric density from Table A.6 and found that the atmospheric mass is approximately *m* ≈ 6.08E18 kg. Can this result be used to estimate sea-level pressure? Can sea-level pressure be used to estimate *m*?

Solution: Yes, atmospheric pressure is essentially a result of the weight of the air above. Therefore the air weight divided by the surface area of the earth equals sea-level pressure:

$$p_{sea\text{-}level} = \frac{W_{air}}{A_{earth}} = \frac{m_{air}g}{4\pi R_{earth}^2} \approx \frac{(6.08E18\ kg)(9.81\ m/s^2)}{4\pi(6.377E6\ m)^2} \approx \mathbf{117000\ Pa} \quad \textit{Ans.}$$

This is a little off, thus our mass estimate must have been a little off. If global average sea-level pressure is actually 101350 Pa, then the mass of atmospheric air must be more nearly

$$m_{air} = \frac{A_{earth}p_{sea\text{-}level}}{g} \approx \frac{4\pi(6.377E6\ m)^2(101350\ Pa)}{9.81\ m/s^2} \approx \mathbf{5.28E18\ kg} \quad \textit{Ans.}$$
