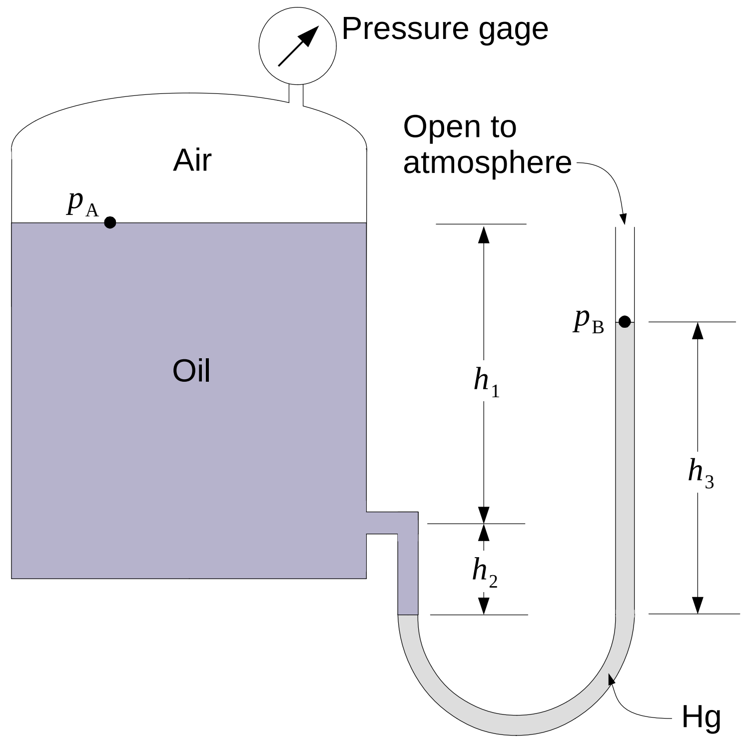
The general procedure for manometer problems consists of starting at one end "making your way" through to the other end. You start at one location and when you go to a greater depth the pressure increases (think of a scuba diver), so you "add". Similarly, when you rise towards the surface above you the pressure decreases, so you "subtract". Also, when you move across horizontally within the same fluid the pressure is unchanged.

For the problem at hand we start at the air–oil interface in the tank (call this location "A") and proceed towards the open end (location "B"), where the pressure is zero (gage). So, at the air–oil interface, the pressure is:

$$p_A \, ;$$



from there you "dive" down inside the tank to the oil–mercury interface; in other words, you increase the vertical depth by h_1+h_2 , so you add pressure to what you had before:

p_A becomes: $p_A+\rho_{oil}\cdot g\cdot(h_1+h_2)$

Now, from the oil–mercury interface you can "jump" horizontally to the location in the other leg of the manometer (i.e., the location from where the height h_3 is measured). You don't add or subtract because the pressure here is the same as in the oil–mercury interface. From here you travel upwards, thus decreasing your vertical depth. So, you subtract pressure from what you had before:

$$p_A+\rho_{oil}\cdot g\cdot(h_1+h_2)-\rho_{Hg}\cdot g\cdot(h_3)$$

Since we have worked our way through to location "B", the expression above has be equal to p_B :

$$p_A+\rho_{oil}\cdot g\cdot(h_1+h_2)-\rho_{Hg}\cdot g\cdot(h_3)=p_B$$

Now, solve for p_A :

$$p_A=\rho_{Hg}\cdot g\cdot(h_3)-\rho_{oil}\cdot g\cdot(h_1+h_2) \, ,$$

because $p_B = 0\,\text{psig}$. Since we are given values for the specific gravity of the oil and mercury, we insert those in the expression above:

$$p_A = SG_{Hg} \cdot \rho_{H_2O} \cdot g \cdot (h_3) - SG_{oil} \cdot \rho_{H_2O} \cdot g \cdot (h_1 + h_2)$$

Now, insert numerical values and as always, keep track of units:

$$p_A = 13.6 \cdot 62.4 \frac{\text{lbm}}{\text{ft}^3} \cdot 32.2 \frac{\text{ft}}{\text{s}^2} \cdot 9\,\text{in} \cdot \left| \frac{1\,\text{ft}}{12\,\text{in}} \right| - 0.9 \cdot 62.4 \frac{\text{lbm}}{\text{ft}^3} \cdot 32.2 \frac{\text{ft}}{\text{s}^2} \cdot (36\,\text{in} + 6\,\text{in}) \cdot \left| \frac{1\,\text{ft}}{12\,\text{in}} \right|$$

$$p_A = 14{,}165 \frac{\text{lbm} \cdot \text{ft/s}^2}{\text{ft}^2}$$

Now clean up the units a little bit (we need pound-force in the numerator and inches squared in the denominator, to get psi):

$$p_A = 14{,}165 \frac{\text{lbm} \cdot \text{ft/s}^2}{\text{ft}^2} \cdot \left| \frac{1\,\text{lbf}}{32.2\,\text{lbm} \cdot \text{ft/s}^2} \right| \cdot \left| \frac{1\,\text{ft}^2}{144\,\text{in}^2} \right| = 3.05\,\text{psig}$$

$$p_A = 3.05\,\text{psig}$$