

33.33 To partially empty an above-ground swimming pool on a calm day, a siphon is set up with one end of a garden hose submerged below the surface of the water, and the other end at ground level. The highest point is where the hose is positioned over the side of the pool, 18in above the surface of the water. Water is flowing out of the hose at 3gpm. The inside diameter of the hose is $\frac{5}{8}$ in. What is the pressure inside the siphon at the highest point?

- A. 3psia
- B. 8psia
- C. 14psia
- D. 32psia

Consider the surface of the stationary pool water as the datum from which any changes in height shall be referenced, and let this be State 1. Consider the highest point in the hose as State 2.

Calculate the velocity of water flowing through the hose.

$$v_2 = \frac{Q}{A}$$

$$v_2 = \frac{\left(3 \frac{\text{gal}}{\text{min}}\right) \left(\frac{1 \text{ft}^3}{7.48 \text{gal}}\right) \left(\frac{1 \text{min}}{60 \text{s}}\right)}{\frac{\pi}{4} \left(\frac{\frac{5}{8} \text{in}}{12 \frac{\text{in}}{\text{ft}}}\right)^2} = 3.14 \frac{\text{ft}}{\text{s}}$$

Write the **Bernoulli Equation** and set States 1 and 2 equal.

$$\frac{P_1}{\gamma} + \frac{v_1^2}{2g} + z_1 = \frac{P_2}{\gamma} + \frac{v_2^2}{2g} + z_2$$

There is no velocity at State 1, so $v_1 = 0$. The height at State 1 is zero because the datum was set at this location. Therefore, $z_1 = 0$. The pressure at State 1 is atmospheric pressure. $P_1 = 14.7 \text{psia}$. Use the rule of thumb for water to convert pressure units of *psi* to *ft* by multiplying by $2.31 \frac{\text{ft}}{\text{psi}}$ to obtain $\sim 34 \text{ft}$ for P_1 . (This can also be done formally by dividing by the specific weight of water and converting from in^2 to ft^2 . The rule of thumb saves time.)

On the right side, P_2 is unknown, v_2 has been established, and z_2 is given. Substitute and solve for P_2 .

$$(14.7 \text{psi}) \left(2.31 \frac{\text{ft}}{\text{psi}}\right) + 0 + 0 = \frac{P_2}{\gamma} + \frac{\left(3.14 \frac{\text{ft}}{\text{s}}\right)^2}{2 \left(32.2 \frac{\text{ft}}{\text{s}^2}\right)} + 1.5 \text{ft}$$

$$\frac{P_2}{\gamma} = 32.3 \text{ft}$$

Use the rule of thumb again and divide by $2.31 \frac{ft}{psi}$ to obtain the final units of *psi*. Alternatively, take the formal approach and multiply by the specific weight and convert square feet to square inches once again.

$$P_2 = \frac{32.3ft}{2.31 \frac{ft}{psi}} = 14psi$$

Answer C