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1.34 A closed tank having a volume of 2 ft^3 is filled with 0.30 lb of a gas. A pressure gage attached to the tank reads 12 psi when the gas temperature is 80 °F. There is some question as to whether the gas in the tank is oxygen or helium. Which do you think it is? Explain how you arrived at your answer.

Density of gas in tank $\rho = \dfrac{\text{weight}}{g \times \text{volume}} = \dfrac{0.30\ \text{lb}}{\left(32.2 \dfrac{\text{ft}}{\text{s}^2}\right)(2\ \text{ft}^3)}$

$= 4.66 \times 10^{-3} \dfrac{\text{slugs}}{\text{ft}^3}$

Since $\rho = \dfrac{p}{RT}$ with $p = (12 + 14.7)$ psia

(atmospheric pressure assumed to be $\approx$ 14.7 psia)

and with $T = (80°\text{F} + 460)°\text{R}$ it follows that

$$\rho = \frac{\left(26.7 \dfrac{\text{lb}}{\text{in.}^2}\right)\left(144 \dfrac{\text{in.}^2}{\text{ft}^2}\right)}{R\,(540°\text{R})} = \frac{7.12}{R} \frac{\text{slugs}}{\text{ft}^3} \qquad (1)$$

From Table 1.7 $R = 1.554 \times 10^3$ for oxygen

and $R = 1.242 \times 10^4 \dfrac{\text{ft} \cdot \text{lb}}{\text{slug} \cdot °\text{R}}$ for helium.

Thus, from Eq. (1) if the gas is oxygen

$$\rho = \frac{7.12}{1.554 \times 10^3} \frac{\text{slugs}}{\text{ft}^3} = 4.58 \times 10^{-3} \frac{\text{slugs}}{\text{ft}^3}$$

and for helium

$$\rho = \frac{7.12}{1.242 \times 10^4} = 5.73 \times 10^{-4} \frac{\text{slugs}}{\text{ft}^3}$$

A comparison of these values with the actual density of the gas in the tank indicates that the gas must be <u>oxygen</u>.