31.3 What is the density of propane at $77°F$ and atmospheric pressure?

A. $0.003 \frac{lb}{ft^3}$

B. $0.02 \frac{lb}{ft^3}$

C. $0.1 \frac{lb}{ft^3}$

D. $60 \frac{lb}{ft^3}$

Treat propane as an Ideal Gas and use the ideal gas law:

$$PV = mRT$$

Divide both sides by volume, V:

$$P = \frac{mRT}{V}$$

Note density is mass per unit volume, $\rho = \frac{m}{V}$:

$$P = \rho RT$$

Rearrange for density:

$$\rho = \frac{P}{RT}$$

Lookup the specific gas constant for propane in the Properties of Ideal Gases table: $R_{propane} = 35.04 \frac{ft \cdot lb_f}{lb_m \cdot R°}$

Substitute and solve for density, being mindful of unit conversions. Make sure to use absolute temperature i.e. Rankine degrees.

$$\rho = \frac{P}{RT} = \frac{\left(14.7 \frac{lb_f}{in^2}\right)\left(\frac{144 in^2}{1 ft^2}\right)}{\left(35.04 \frac{ft \cdot lb_f}{lb_m \cdot R°}\right)(77 + 460R)} = 0.11 \frac{lb_m}{ft^3}$$

Answer C