1.3) The pressure and temperature at a certain point in an air flow are 130 kPa and 30°C, respectively. Find the air density at this point in $\mathrm{kg/m^3}$ and $\mathrm{lbm/ft^3}$.

Solution:

Given $p = 130\,\mathrm{kPa} = 130 \times 10^3\,\mathrm{Pa}$, $T = 30^\circ\mathrm{C} = 30 + 273 = 303\,\mathrm{K}$.

The density can be calculated using ideal gas law as,

$$\boxed{\rho = \frac{p}{RT} = \frac{130 \times 10^3}{287 \times 303} = 1.495\,\mathrm{kg/m^3}}\,.$$

The density in $\mathrm{lbm/ft^3}$ can be calculated using the following conversions $1\,\mathrm{kg} = 2.2046\,\mathrm{lbm}$, $1\,\mathrm{m} = 3.2808\,\mathrm{ft}$. Therefore in $\mathrm{lbm/ft^3}$,

$$\rho = 1.495\,\mathrm{kg/m^3} = 1.495 \times 2.2046/3.2808^3\,\mathrm{lbm/ft^3}$$

$$\boxed{\rho = 0.09333\,\mathrm{lbm/ft^3}}\,.$$