What is the density (in Kg/m³) of nitrogen gas (molecular mass = 28 u) at a pressure of 2.0 atm and a temperature of 310 K?

\[ PV = nRT \quad n = \#\text{mole} \]

\[ PV = NkT \quad N = \#\text{particles} \]

\[ P = m/v \quad n/v \]

\[ PV = nRT \rightarrow n/v = \frac{P}{RT} \]

\[ P = 2.0 \text{ atm} \left( \frac{1.013 \times 10^5 \text{ Pa}}{1 \text{ atm}} \right) = 2.026 \times 10^5 \text{ Pa} \]

\[ R = 8.31 \text{ J/mol.k} \]

\[ T = 310 \text{ K} \]

\[ n/v = \frac{P}{RT} = \frac{(2.026 \times 10^5 \text{ Pa})}{(8.31 \text{ J/mol.k})(310 \text{ K})} = \frac{78.6 \text{ mol}}{m^3} \]

\[ \frac{n}{v} = 78.6 \text{ mol/m}^3 \]

The mass per mole (in g/mol) of any substance has the same numerical value as the molecular mass in u.

molecular mass = 28 u

\[ \downarrow \text{mass per mol} = 28 \text{ g/mol} \]
\( \frac{N}{V} = 78.6 \text{ mol/m}^3 \left( \frac{28 \text{ g}}{\text{ mol}} \right) = 2200.8 \text{ g/m}^3 \)

\( P = 2200.8 \text{ g/m}^3 \left( \frac{1 \text{ Kg}}{10^3 \text{ g}} \right) = 2.2 \text{ Kg/m}^3 \)

\( P = 2.2 \text{ Kg/m}^3 \)