① GIVEN

* Rigid tank
  - » $V_{tank} = 15\ m^3$
  - » separated into 2 sections by membrane each filled w/ $N_2(g)$
  - » section A has $\rho_A = 1.6\ kg/m^3$, vol $= V_A$, P_A
  - » section B $m_B = 6\ kg$, vol $= V_B$, P_B
  - » after membrane punctured $\rho_{tank} = 1.8\ kg/m^3$
  - » M = molar mass of nitrogen 14.006

FIND

Initial density (kg/m^3) of $N_2(g)$ @ section B

EQUATION

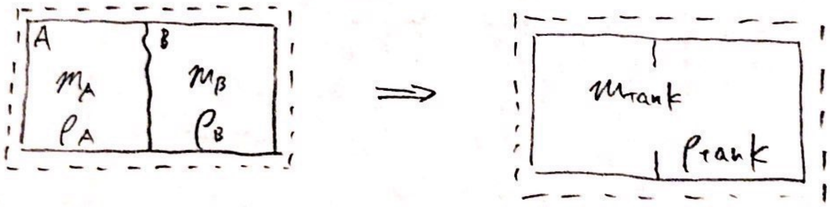
$$\rho = \frac{m}{V}$$

ASSUMPTION

gas is ideal gas. Quasiequilibrium.
• closed system.

EFD

sys. tank



SOLN

initially : $\rho_A = \dfrac{m_A}{V_A}$ ... ①, $\rho_B = \dfrac{m_B}{V_B}$ ... ②

after : $\rho_{tank} = \dfrac{m_{tank}}{V_{tank}}$ ... ③

$\because\ m_{tank} = m_A + m_B$

③ $\Rightarrow$ $\rho_{tank} = \dfrac{m_A + m_B}{V_{tank}}$

$$m_A = \rho_{tank} V_{tank} - m_B = \left(\frac{1.8\ kg}{m^3}\right)(15\ m^3) - 6\ kg = 21\ kg$$

$$\therefore\ V_A = \frac{m_A}{\rho_A} = (21\ kg)\left(\frac{m^3}{1.6\ kg}\right) = 13.125\ m^3$$

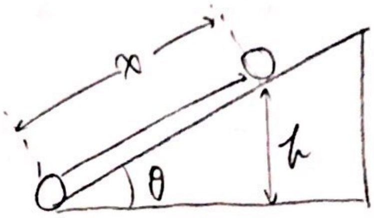
$$V_B = 15 - 13.125 = 1.875\ m^3$$

$$\rho_B = \frac{m_B}{V_B} = (6\ kg)\left(\frac{1}{1.875\ m^3}\right) = \boxed{3.20\ kg/m^3}$$

(ii)

GIVEN

* A body at rest
  - >> accelerated to $v = 200\ \mathrm{m/s}$ along inclined surface $\theta = 45°$ $(\frac{\pi}{4})$ relative to horizontal.
  - >> travels $x = 10\ \mathrm{m}$
  - >> work done $W = 200\ \mathrm{kJ} = 2.00 \times 10^5\ \mathrm{J}$
  - >> $g = 9.81\ \mathrm{m/s^2}$



FIND

mass (kg) of body

EQUATION

Potential EN : $U = mgh$

Kinetic EN : $K = \frac{1}{2}mv^2$

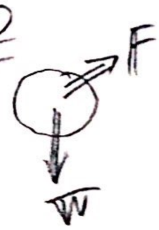
conservation of EN

$$W = K + U$$

ASSUMPTION

no friction, and other energy losses

FBD



SOLN

$$\text{(height) } h = x\sin\theta = 10\,\mathrm{m} \cdot \frac{\sqrt{2}}{2} = 5\sqrt{2}\ \mathrm{m}$$

$$W = mgh + \frac{1}{2}mv^2$$

$$m\left(gh + \frac{v^2}{2}\right) = W$$

$$m = \frac{W}{gh + \frac{v^2}{2}}$$

$$= \frac{2.00 \times 10^5\ \mathrm{J}}{\left(\frac{9.81\,\mathrm{m}}{\mathrm{s}^2}\right)(5\sqrt{2}\ \mathrm{m}) + \left(\frac{200^2\,\mathrm{m}^2}{2\,\mathrm{s}^2}\right)} \simeq 9.965\ \mathrm{kg}$$

$$\simeq \boxed{9.97\ \mathrm{kg}}$$