CANKAYA UNIVERSITY
FACULTY OF ENGINEERING AND ARCHITECTURE
MECHANICAL ENGINEERING DEPARTMENT
ME 211 THERMODYNAMICS I
CHAPTER 1
EXAMPLE SOLUTIONS
Fall 2017

14.)

A tank has two rooms separated by a membrane. Room A has 1.5 kg air and volume 0.5 m^3, room B has 0.75 m^3 air with density 0.8 kg/m^3. The membrane is broken and the air comes to a uniform state. Find the final density of the air.

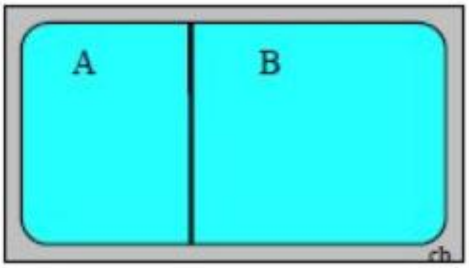
Solution:

Density is mass per unit volume

$$m = m_A + m_B = m_A + \rho_B V_B = 1.5 + 0.8 \times 0.75 = 2.1 \text{ kg}$$

$$V = V_A + V_B = 0.5 + 0.75 = 1.25 \text{ m}^3$$

$$\rho = \frac{m}{V} = \frac{2.1}{1.25} = \mathbf{1.68 \text{ kg/m}^3}$$



15)

A vertical hydraulic cylinder has a 125-mm diameter piston with hydraulic fluid inside the cylinder and an ambient pressure of 1 bar. Assuming standard gravity, find the piston mass that will create a pressure inside of 1500 kPa.

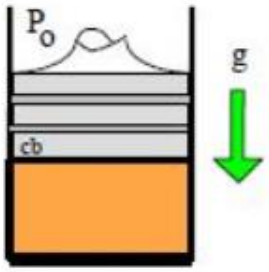
Solution:

Force balance:

$$F\uparrow = PA = F\downarrow = P_0 A + m_p g;$$

$$P_0 = 1 \text{ bar} = 100 \text{ kPa}$$

$$A = (\pi/4)\, D^2 = (\pi/4) \times 0.125^2 = 0.01227 \text{ m}^2$$



$$m_p = (P - P_0)\frac{A}{g} = (1500 - 100) \times 1000 \times \frac{0.01227}{9.80665} = \mathbf{1752 \text{ kg}}$$

16)

A piston/cylinder with cross sectional area of 0.01 m^2 has a piston mass of 100 kg resting on the stops, as shown in Fig. P1.40. With an outside atmospheric pressure of 100 kPa, what should the water pressure be to lift the piston?

Solution:

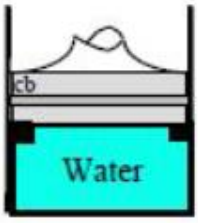
The force acting down on the piston comes from gravitation and the outside atmospheric pressure acting over the top surface.

Force balance: $F\uparrow = F\downarrow = PA = m_p g + P_0 A$

Now solve for P (divide by 1000 to convert to kPa for 2nd term)

$$P = P_0 + \frac{m_p g}{A} = 100\ \text{kPa} + \frac{100 \times 9.80665}{0.01 \times 1000}\ \text{kPa}$$

$$= 100\ \text{kPa} + 98.07\ \text{kPa} = \mathbf{198\ kPa}$$



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