

$$MW_{da} = (2)(14)(.79) + (2)(16)(.21) \approx 29 \frac{lb}{mol}$$

Determining the number of moles of water vapor and dry air.

$$N_{H_2O} = \frac{0.055lb}{18 \frac{lb}{mol}} = 0.00305mol$$

$$N_{da} = \frac{1lb}{29 \frac{lb}{mol}} = 0.03448mol$$

Find the mole fraction of water vapor.

$$x_{H_2O} = \frac{N_{H_2O}}{N_{H_2O} + N_{da}} = \frac{0.00305mol}{0.00305mol + 0.03448mol} = .081$$

The ratio of the partial pressure of water vapor to the total pressure is the same as the ratio of the number of moles of water vapor to the total number of moles i.e. the mole fraction. (Note: This holds true for any mixture of gases. The contribution of any one gas in the mixture to the total pressure - its partial pressure - is equal to its mole fraction!)

$$\frac{p_w}{p_t} = x_{H_2O}$$

$$p_w = (x_{H_2O})(p_t) = (.081)(14.7psia) = 1.19psia$$

**Answer C**

**45.24 A 2500ft<sup>2</sup> conference center with 14ft ceilings is maintained at 72°F and 50% relative humidity. What is the total mass of water vapor in the air?**

- A. 15lb
- B. 22lb
- C. 140lb
- D. 290lb

Find the total volume of the room by multiplying the area and the height.

$$V = (2500ft^2)(14ft) = 35,000ft^3$$

Find the humidity ratio and specific volume for the room conditions using the **Psychrometric Chart**.

$$T = 72^\circ F$$

$$\phi = 50\%$$

$$\omega = 0.0084 \frac{lb_w}{lb_{da}}$$

$$v = 13.6 \frac{ft^3}{lb_{da}}$$

Recall the definition of the **humidity ratio** as described under **Psychrometric Properties**. Rearrange to solve for the mass of water.

$$\omega = \frac{m_w}{m_{da}}$$

$$m_w = (m_{da}) (\omega)$$

The mass of air can be expressed as density times volume, or volume over specific volume.

$$m_{da} = \rho V = \frac{V}{v} = \frac{35,000 ft^3}{13.6 \frac{ft^3}{lb_{da}}} = 2574 lb_{da}$$

Determine the mass of water.

$$m_w = (m_{da}) (\omega) = (2574 lb_{da}) \left( 0.0084 \frac{lb_w}{lb_{da}} \right) = 21.6 lb_w$$

**Answer B**

**45.25 Condenser water returns to a cooling tower at  $95^\circ F$  and leaves at  $85^\circ F$ . The outside conditions are  $84^\circ F$  and 60% relative humidity. What is the cooling tower effectiveness?**

- A. 9%
- B. 46%
- C. 54%
- D. 91%

To find the **Cooling Tower** effectiveness, start by using the **Psychrometric Chart** to determine the wet bulb temperature of the outdoor conditions.

$$T_{db} = 84^\circ F$$

$$\phi = 60\%$$

$$T_{wb} = 73.1^\circ F$$

Cooling tower effectiveness is defined by the equation below where range and approach are defined in terms of the entering and leaving water temperatures and the wet bulb temperature as shown.