$$\omega_3 = (.1)\left(.0172\frac{lb_{H2O}}{lb_{da}}\right) + (.9)\left(.0096\frac{lb_{H2O}}{lb_{da}}\right) = .01036\frac{lb_{H2O}}{lb_{da}}$$

Follow the psychrometric chart horizonally to the left from ω_3 to the saturation curve to read the corresponding dew point temperature.

$$T_{DP,3} \approx 58°F$$

Answer B

47.12 $2000cfm$ of outside air at $95°F$ dry bulb and $78°F$ wet bulb is cooled to $68°F$ and 60% relative humidity. What quantity of latent heat is removed?

A. $60,000\frac{Btu}{hr}$

B. $70,000\frac{Btu}{hr}$

C. $80,000\frac{Btu}{hr}$

D. $90,000\frac{Btu}{hr}$

Let state 1 be the entering air conditions and state 2 be the leaving air conditions. Use the Psychrometric Chart to find the humidity ratio for both states.

$$T_{1,db} = 95°F$$

$$T_{1,wb} = 78°F$$

$$\omega_1 = 0.0169\frac{lb_{h2o}}{lb_{da}}$$

$$T_2 = 68°F$$

$$\phi_2 = 60\%$$

$$\omega_2 = 0.0088\frac{lb_{h2o}}{lb_{da}}$$

Even though this problem is about calculating the latent heat removed from the air, it is appropriate to use the Latent Heat Gain rule of thumb formula provided the smaller humidity ratio is subtracted from the larger humidity ratio such that $\Delta\omega$ has a positive value. As long as the correct units are used for all inputs, q_l will be specified in the desired units, $\frac{Btu}{hr}$.

$$q_l = 4840Q_s\Delta\omega = 4840\,(2000)\,(0.0169 - 0.0088) = 78,408\frac{Btu}{hr}$$

Answer C

47.13 What is the equivalent diameter of a $18in \times 24in$ rectangular duct?

A. $20in$

B. $21in$

C. $22in$

D. $23in$

Use the formula under Rectangular Ducts to find the circular equivalent of a rectangular duct with sides lengths a and b. Substitute into the equation the known side lengths in in and the final result will be determined in in as well. Assignment of a and b is arbitrary as both addition and multiplication are commutative.

$$D_e = \frac{1.30\,(ab)^{0.625}}{(a+b)^{0.25}}$$

$$D_e = \frac{1.30\,(18 \cdot 24)^{0.625}}{(18+24)^{0.25}} = \frac{1.3\,(432)^{0.625}}{(42)^{0.25}} = 22.7in$$

Answer D

47.14 An unoccupied space has $10KW$ of computer equipment and lighting and a moisture load of $12\frac{lb}{hr}$ of water vapor. What is the sensible heat ratio?

A. 0.25

B. 0.34

C. 0.75

D. 2.93

Use the formula for the Sensible Heat Ratio. The total heat gain is the sum of the sensible load and latent load.

$$SHR = \frac{sensible\,heat\,gain}{total\,heat\,gain} = \frac{\dot{Q}_S}{\dot{Q}_S + \dot{Q}_L}$$

The sensible load is composed of the computer equipment and lighting. Convert the units of KW to $\frac{Btu}{hr}$.

$$\dot{Q}_S = (10KW)\left(3412\frac{Btu}{hr \cdot KW}\right) = 34,120\frac{Btu}{hr}$$

The latent load (i.e. moisture load) is a function of the mass flow rate of water vapor being added to the air and the latent heat of vaporation, h_{fg}, of that water vapor, which depends on temperature and pressure. Since no temperature or pressure information is given, assume standard