

Now state 3 is fully defined since the relative humidity was given:

$$\phi_3 = 50\%$$

Look up the enthalpy at state 3 on the psychrometric chart:

$$h_3 = 26.2 \frac{Btu}{lb}$$

Substitute and solve the original formula for the total heat gain:

$$Q_t = 4.5cfm\Delta h = 4.5cfm(h_3 - h_1)$$

$$Q_t = 4.5(5000)(26.2 - 13) = 297,000 \frac{Btu}{hr}$$

**Answer D**

**41.8 At 5000ft above sea level a 1ton fan coil unit discharges 54°F dry bulb, 52°F wet bulb supply air, maintaining the space at 74°F and 50% relative humidity. What is the required CFM for the fan?**

- A. 400cfm
- B. 500cfm
- C. 520cfm
- D. 650cfm

If this question were being asked for a fan coil installed at sea level, it would be appropriate to use the typical rules of thumb. However, since the unit is 5000 ft above sea level, it is necessary to look up **heat gain calculations** using **standard air values** in the Reference Handbook where a different constant is used. In this case, rather than the total heat gain formula at sea level,  $Q_t = 4.5cfm\Delta h$ , the constant in the formula will be modified as shown:

$$Q_t = 3.74cfm\Delta h$$

The capacity is given, and the enthalpy of both the supply and return conditions may be looked up using the psychrometric chart for **5000 feet**, as both states are fully defined. Note that using the sea level psychrometric chart would lead to incorrect values.

$$T_{s,db} = 54^\circ F$$

$$T_{s,wb} = 52^\circ F$$

$$h_s = 23.2 \frac{Btu}{lb}$$

$$T_{r,db} = 74^\circ F$$

$$\phi_r = 50\%$$

$$h_r = 29.6 \frac{Btu}{lb}$$

Rearrange the total heat gain formula, substitute, and solve for the cfm. Use the **measurement relationship**:  $1 \text{ ton} = 12,000 \frac{Btu}{hr}$ . Provided the heat gain is in  $\frac{Btu}{hr}$  and the enthalpy is in  $\frac{Btu}{lb}$ , the *cfm* units will work out automatically using this rule of thumb, hence units need not be shown.

$$Q_t = 3.74cfm\Delta h \rightarrow cfm = \frac{Q_t}{3.74\Delta h}$$

$$cfm = \frac{Q_t}{3.74\Delta h} = \frac{Q_t}{3.74(h_r - h_s)} = \frac{12,000}{3.74(29.6 - 23.2)} = 501cfm$$

**Answer B**

**41.9 How much condensate is produced by a 10,000cfm air handling unit supplying 60°F dry bulb, 58°F wet bulb air? The return air conditions are 76°F and 60% relative humidity.**

- A. 0.002gpm
- B. 0.11gpm
- C. 0.16gpm
- D. 1.3gpm

The rate at which condensate is produced is the mass flow rate of water, which depends on the mass flow rate of air and the difference in the humidity ratio between the supply and return air streams. The governing formula can be found in the Reference Handbook by searching **Moist-Air Cooling and Dehumidification**:

$$\dot{m}_w = \dot{m}_a (\omega_1 - \omega_2)$$

Let state 1 refer to the return condition which is expected to have greater moisture content, and state 2 shall refer to the supply condition after moisture removal by the coil. This ensures  $\Delta\omega > 0$ . Otherwise the process would be *humidification* rather than *dehumidification*.

Both states are fully defined. Use the **psychrometric chart** to look up the humidity ratios for each state. Also look up the specific volume for the return condition, state 1, entering the coil.

$$T_{1,db} = 76^\circ F$$

$$\phi_1 = 60\%$$

$$\omega_1 = .0116 \frac{lb_w}{lb_{da}}$$