$$\Delta T_{lm} = \frac{\Delta T_A - \Delta T_B}{ln\left(\frac{\Delta T_A}{\Delta T_B}\right)}$$

$$\Delta T_{lm} = \frac{60°F - 80°F}{ln\left(\frac{60°F}{80°F}\right)} = 69.5°F$$

Answer D

46.31 A heat sink is designed to remove $25W$ from a computer CPU. The ambient air inside the machine is $90°F$ and the surface temperature of the heat sink is not to exceed $140°F$. The combined heat transfer coefficient, including both convection and radiation, is $3\frac{Btu}{hr \cdot ft^2 \cdot °F}$. What is the minimum required surface area for the heat sink?

A. $7in^2$

B. $24in^2$

C. $82in^2$

D. $148in^2$

The overall heat transfer is given by the equation below, where the overall coefficient of heat transfer, U, *includes* both convection and radiation.

$$\dot{Q} = UA\Delta T$$

Solve for the area. Substitute the amount of heat to be removed, the overall heat transfer coefficient, and the temperatures to determine the surface area. Since the area calculation is based on the *largest* allowable temperature differential, the value obtained represents the *minimum* area required to ensure the upper temperature limit is not exceeded. Convert to square inches.

$$A = \frac{\dot{Q}}{U\Delta T} = \frac{(25W)\left(3.412\frac{Btu}{hr \cdot W}\right)}{\left(3\frac{Btu}{hr \cdot ft^2 \cdot °F}\right)(140°F - 90°F)} = 0.57ft^2$$

$$A = 0.57ft^2\left(\frac{12in}{1ft}\right)^2 = 82in^2$$

Answer C

46.32 **$5000 cfm$ of air at $75°F$ db / $68°F$ wb enters a spray chamber using $90°F$ water. The bypass factor for the spray chamber is 0.15. What is the dry bulb temperature of the leaving air?**

A. $69°F$

B. $74°F$

C. $77°F$

D. $88°F$

The spray chamber is heating the air, so the wet bulb temperature of the entering air has no bearing on the problem. If the process was 100% efficient, the air would leave at the same temperature as the water, $90°F$. However, due to the bypass factor, the efficiency of the heating process is only 85%.

$$\eta = 1 - BF = 1 - 0.15 = 0.85$$

Perform a mixing calculation using 85% of the airflow having been heated to $90°F$, and the balance having been unaffected because it bypassed the spray.

$$T_2 = (0.85)(90°F) + (0.15)(75°F) = 87.75°F$$

Alternatively, set up the efficieny as the ratio of the change in dry bulb temperature actually observed compared to the maximum possible delta T if there was no bypass, i.e. 100% efficiency.

$$\eta = \frac{T_2 - T_1}{T_{spray} - T_1}$$

$$0.85 = \frac{T_2 - 75°F}{90°F - 75°F}$$

$$T_2 = 87.75°F$$

Answer D