37.34 **An object with a surface area of $10ft^2$ and a surface temperature of $40°F$ gains $1000\frac{Btu}{hr}$ through a combination of radiation and convection. The ambient temperature as well as the temperature of the surrounding surfaces is $80°F$. The emmissivity is 0.8. What is the convection film coefficient?**

A. $1.7\frac{Btu}{hr \cdot ft^2 \circ F}$

B. $3.1\frac{Btu}{hr \cdot ft^2 \circ F}$

C. $3.8\frac{Btu}{hr \cdot ft^2 \circ F}$

D. $5.6\frac{Btu}{hr \cdot ft^2 \circ F}$

Radiation and Convection are both applicable and together make up the total heat gain.

$$\dot{Q}_t = \dot{Q}_{conv} + \dot{Q}_{rad}$$

$$\dot{Q}_{conv} = hA\Delta T$$

$$\dot{Q}_{rad} = \sigma \varepsilon A \left(T_s^4 - T_\infty^4\right)$$

$$\dot{Q}_t = \dot{Q}_{conv} + \dot{Q}_{rad} = hA\Delta T + \sigma \varepsilon A \left(T_s^4 - T_\infty^4\right)$$

Calculate the heat transfer resulting from radiation. Be sure to use absolute temperatures i.e. degrees Rankine.

$$\dot{Q}_{rad} = \sigma \varepsilon A \left(T_s^4 - T_\infty^4\right)$$

$$\dot{Q}_{rad} = \left(0.1713 \times 10^{-8} \frac{Btu}{hr \cdot ft^2 \circ R}\right) (0.8) \left(10ft^2\right) \left[(540°R)^4 - (500°R)^4\right] = 308.8\frac{Btu}{hr}$$

Subtract the radiation from the total heat gain to determine the heat gain from convection.

$$\dot{Q}_{conv} = \dot{Q}_t - \dot{Q}_{rad} = 1000\frac{Btu}{hr} - 308.8\frac{Btu}{hr} = 691.2\frac{Btu}{hr}$$

Solve for the convection coefficient.

$$\dot{Q}_{conv} = hA\Delta T$$

$$h = \frac{\dot{Q}_{conv}}{A\Delta T} = \frac{\left(691.2\frac{Btu}{hr}\right)}{\left(10ft^2\right)(80°F - 40°F)} = 1.7\frac{Btu}{hr \cdot ft^2 \circ F}$$

Answer A