37.40 **A $25ft$ long hot water pipe with a $3in$ O.D. has an an average surface temperature of $175°F$ in a room with an ambient temperature of $60°F$. The convection coefficient is $2\frac{Btu}{hr \cdot ft^{2} \cdot °F}$. What is the total heat loss from the pipe, assuming all surfaces are considered to be black, and no insulation is used?**

A. $3000\frac{Btu}{hr}$

B. $4500\frac{Btu}{hr}$

C. $7500\frac{Btu}{hr}$

D. $15,000\frac{Btu}{hr}$

Consider both Convection and Radiation. The total heat loss is found by combining the two.

$$\dot{Q}_{combined} = \dot{Q}_{convection} + \dot{Q}_{radiation}$$

Write the formula for convection found by searching Newton's Law of Cooling. The convection coefficient is given. The surface area of the pipe is defined as $A = \pi DL$. The temperatures are known. Substitute and solve for the heat loss due to convection.

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

$$\dot{Q}_{conv} = \left(2\frac{Btu}{hr \cdot ft^{2} \cdot °F}\right)\left[\pi\left(\frac{3}{12}ft\right)(25ft)\right](175°F - 60°F) = 4516\frac{Btu}{hr}$$

Write the formula for radiation. Since all surfaces are black, assume $\varepsilon = 1$. σ is the Stefan-Boltzmann Constant. Surface area is the same as in the convection analysis. Temperatures must be in absolute terms i.e. Rankine.

$$\dot{Q}_{rad} = \varepsilon\sigma A\left(T_1^4 = T_2^4\right)$$

$$\dot{Q}_{rad} = (1)\left(0.1713 \times 10^{-8}\frac{Btu}{hr \cdot ft^{2} \cdot °R^{4}}\right)\left(\left[\pi\left(\frac{3}{12}ft\right)(25ft)\right]\right)\left[(635°R)^4 - (520°R)^4\right] = 3009\frac{Btu}{hr}$$

Solve for the combined heat loss by taking the sum of the heat loss due to convection and radiation.

$$\dot{Q}_{combined} = 4516\frac{Btu}{hr} + 3009\frac{Btu}{hr} = 7525\frac{Btu}{hr}$$

Answer C