36.32 The thermal gradient across the stone wall of an outdoor fireplace is $1000°F$. The stone wall is $10 inches$ thick and has a thermal conductivity of $0.05\frac{Btu \cdot in}{hr \cdot ft^{2} \cdot °F}$. What is the rate of heat transfer per unit area?

A. $5\frac{Btu}{hr \cdot ft^2}$

B. $6\frac{Btu}{hr \cdot ft^2}$

C. $50\frac{Btu}{hr \cdot ft^2}$

D. $60\frac{Btu}{hr \cdot ft^2}$

Look up the formula for Conduction.

$$\dot{Q}_{conduction} = \frac{kA\Delta T}{L}$$

where k is the thermal conductivity of the stone, A is the area of the stone wall, ΔT is the temperature differential i.e. thermal gradient across the stone wall, and L is the thickness of the wall.

Since the problem asks for heat transfer *per unit area*, divide by area on both sides. Substitute and solve for $\dot{q}$.

$$\dot{q} = \frac{\dot{Q}}{A} = \frac{k\Delta T}{L} = \left(\frac{\left(0.05\frac{Btu \cdot in}{hr \cdot ft^{2} \cdot °F}\right)(1000°F)}{10in} \right) = 5\frac{Btu}{hr \cdot ft^2}$$

Answer A