37.8 A heat recovery ventilator is used to pre-heat $30°F$, 40% RH outside air with $75°F$, 50% RH exhaust air. The HRV effectiveness is 60%. What quantity of heat is recovered?

A. $4.3\frac{Btu}{lb}$

B. $6.5\frac{Btu}{lb}$

C. $10.8\frac{Btu}{lb}$

D. $27.1\frac{Btu}{lb}$

Let State 1 refer to the entering outside air condition. Let State 2 refer to the leaving outside air after being heated through the ventilator. Let State 3 refer to the entering return air condition. Ignore the leaving exhaust air as it is not relevant.

Recall the distinction between *heat* recovery and *energy* recovery. Energy recovery devices transmit latent energy in addition to sensible heat. Heat-Recovery devices drive exclusively Sensible Energy Recovery and the humidity need not be considered. Therefore, the effectivenss of a heat recovery ventilator is given by a the ratio of ΔT_{actual} to ΔT_{ideal}. (Energy recovery effectiveness would depend on changes in enthalpy rather than temperature.)

$$\varepsilon = \frac{\Delta T_{actual}}{\Delta T_{ideal}} = \frac{T_2 - 30°F}{75°F - 30°F} = 0.6$$

$$T_2 = 57°F$$

The total heat transfer by the heat recovery device is given by the equation below. Sicne there is no mass flow rate or volume rate given and the problem is asking for the quantity of heat rather than the rate of heat transfer, divide both sides by $\dot{m}$ and solve for q, heat per unit mass. The delta T is the actual increase in temperature experienced by the outside air.

$$\dot{Q} = \dot{m} c_p \Delta T$$

$$\frac{\dot{Q}}{\dot{m}} = q = c_p \Delta T = \left(0.24 \frac{Btu}{lb \cdot °F}\right)(57°F - 30°F) = 6.48 \frac{Btu}{lb}$$

Answer B