

36.13 2000cfm of 55°F conditioned air with 40% relative humidity enters a kitchen where it collects heat and moisture before being extracted as 80°F air with 70% relative humidity. What is the rate of moisture removal from the kitchen?

- A. $1.8 \frac{lb_m}{min}$
- B. $2.4 \frac{lb_m}{min}$
- C. $2.8 \frac{lb_m}{min}$
- D. $3.4 \frac{lb_m}{min}$

Let state 1 be the entering air conditions and state 2 be the leaving air conditions. Use the [Psychrometric Chart](#) to find the humidity ratio for both states. Note the specific volume for the entering air condition.

$$T_1 = 55^\circ F$$

$$\phi_1 = 40\%$$

$$\omega_1 = 0.0037 \frac{lb_{h_2o}}{lb_{da}}$$

$$v_1 = 13.1 \frac{ft^3}{lb_{da}}$$

$$T_2 = 80^\circ F$$

$$\phi_2 = 70\%$$

$$\omega_2 = 0.0155 \frac{lb_{h_2o}}{lb_{da}}$$

Although this problem is about adding moisture to air, the formula found by searching [Moist-Air Cooling and Dehumidification](#) can be used with the expectation that the humidity ratio for the leaving air at state 2 will be greater than that of the entering air at state 1. It is valid to interchange ω_2 and ω_1 to reflect this understanding.

$$\dot{m}_w = \dot{m}_{da} (\omega_2 - \omega_1)$$

The mass flow rate of dry air entering at state 1 can be expressed as volume flow rate times density or volume flow rate divided by specific volume.

$$\dot{m}_{da} = \rho Q = \frac{Q}{v_1} = \frac{2000 \frac{ft^3}{min}}{13.1 \frac{ft^3}{lb_{da}}} = 152.7 \frac{lb_{da}}{min}$$

Determine the mass flow rate of water being added to the air.

$$\dot{m}_w = \left(152.7 \frac{lb_{da}}{min} \right) \left(0.0155 \frac{lb_{h_2o}}{lb_{da}} - 0.0037 \frac{lb_{h_2o}}{lb_{da}} \right) = 1.8 \frac{lb_m}{min}$$

Answer A