17.34. In an effort to stay awake for an all-night study session, a student makes a cup of coffee by first placing a 200-W electric immersion heater in 0.320 kg of water. (a) How much heat must be added to the water to raise its temperature from 20.0°C to 80.0°C? (b) How much time is required? Assume that all of the heater's power goes into heating the water.

Identify: The heat required is $Q = mc\Delta T$. $P = 200 \text{ W} = 200 \text{ J/s}$, which is energy divided by time.

Set Up: For water, $c = 4.19 \times 10^3 \text{ J/kg} \cdot \text{K}$.

Execute:

(a) $Q = mc\Delta T = (0.320 \text{ kg})(4.19 \times 10^3 \text{ J/kg} \cdot \text{K})(60.0 \text{ C°}) = 8.04 \times 10^4 \text{ J}$

(b) $t = \dfrac{8.04 \times 10^4 \text{ J}}{200.0 \text{ J/s}} = 402 \text{ s} = 6.7 \text{ min}$

Evaluate: 0.320 kg of water has volume 0.320 L. The time we calculated in part (b) is consistent with our everyday experience.