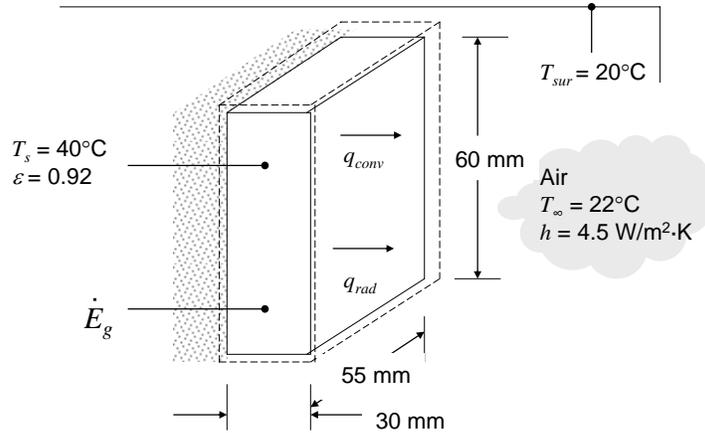


PROBLEM 1.63

KNOWN: Dimensions and emissivity of a cell phone charger. Surface temperature when plugged in. Temperature of air and surroundings. Convection heat transfer coefficient. Cost of electricity.

FIND: Daily cost of leaving the charger plugged in when not in use.

SCHEMATIC:



ASSUMPTIONS: (1) Steady-state conditions, (2) Convection and radiation are from five exposed surfaces of charger, (3) Large surroundings, (4) Negligible heat transfer from back of charger to wall and outlet.

ANALYSIS: At steady-state, an energy balance on the charger gives $\dot{E}_{in} + \dot{E}_g = 0$, where \dot{E}_g represents the conversion from electrical to thermal energy. The exposed area is $A = (60 \text{ mm} \times 55 \text{ mm}) + 2(60 \text{ mm} \times 30 \text{ mm}) + 2(55 \text{ mm} \times 30 \text{ mm}) = 10,200 \text{ mm}^2$. Thus,

$$\begin{aligned} \dot{E}_g &= (q_{conv} + q_{rad}) = hA(T_s - T_\infty) + \varepsilon\sigma A(T_s^4 - T_{sur}^4) \\ &= \left[4.5 \text{ W/m}^2 \cdot \text{K}(40^\circ\text{C} - 22^\circ\text{C}) + 0.92 \times 5.67 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4 \left((313 \text{ K})^4 - (293 \text{ K})^4 \right) \right] \times 6050 \times 10^{-6} \text{ m}^2 \\ &= 2.01 \text{ W} \end{aligned}$$

This is the total rate of electricity used while the charger is plugged in. The daily cost of electricity is

$$\text{Cost} = 2.01 \text{ W} \times \$0.18/\text{kW}\cdot\text{h} \times 1 \text{ kW}/1000 \text{ W} \times 24 \text{ h/day} = \$0.0087/\text{day}$$

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COMMENTS: (1) The radiation and convection heat fluxes are 81 W/m^2 and 116 W/m^2 , respectively. Therefore, both modes of heat transfer are important. (2) The cost of leaving the charger plugged in when not in use is small.