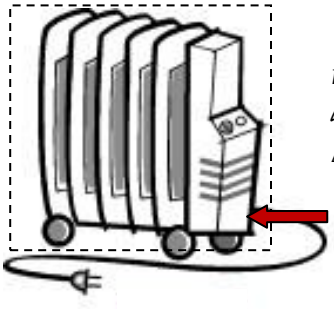
Problem 2.39

An electric heater draws a constant current of 6 amp, with an applied voltage of 220 V, for 24 h. Determine the instantaneous electric power provided to the heater, in kW, and the total amount of energy supplied to the heater by electrical work, in kW·h. If electric power is valued at \$0.08/kW·h, determine the cost of operation for one day.

KNOWN: An electric heater draws a constant current at a specified voltage for a given length of time. The cost of electricity is specified.

FIND: Determine the instantaneous power provided to the heater and the total amount of energy supplied by electrical work. Determine the cost of operation for one day.

SHEMATIC AND GIVEN DATA:



i = 6 amp
$\mathcal{E}$ = 220 V
Δt = 10 h

ENGINEERING MODEL: The current and voltage are constant.

ANALYSIS: The constant power *input* to the heater is given by Eq. 2.21

$$\dot{W}_{\text{in}} = \mathcal{E} I = (220\text{ V})(6\text{ amp})\left|\frac{1\text{ W/amp}}{1\text{ V}}\right|\left|\frac{1\text{ kW}}{10^3\text{W}}\right| = 1.320\text{ kW} \longleftarrow$$

Thus, the total energy *input* is

$$W_{\text{in}} = \int_{t_1}^{t_2} \dot{W}_{\text{in}}\,dt = \dot{W}_{\text{in}}\Delta t = (1.320\text{ kW})(24\text{ h}) = 31.68\text{ kW}\cdot\text{h} \longleftarrow$$

Using the specified cost of electricity

Cost per day = (31.68 kW·h) (\$0.08/kW·h) = \$2.53 ⟵