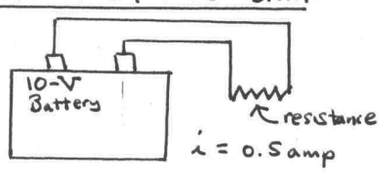
PROBLEM 2.37

KNOWN: Operating data are given for a 10-V battery providing current to a resistance.

FIND: Determine the resistance, in ohms, and the amount of energy transfer by work, in kJ.

SCHEMATIC & GIVEN DATA:



ANALYSIS:

$$\text{Resistance} = \frac{\text{Voltage}}{\text{Current}} = \frac{10\ \text{volts}}{0.5\text{amp}} \left| \frac{1\ \text{ohm}}{1\ \text{volt/amp}} \right|$$

$$= 20\ \text{ohm} \longleftarrow$$

With Eq. 2.21 applied to the battery, which is discharging,

$$\dot{W} = (\text{voltage})(\text{current}) = (10\text{volt})(0.5\text{amp}) \left| \frac{1\ \text{watt/amp}}{1\ \text{volt}} \right|$$

$$= 5\ \text{watt}$$

Then, for 30 minutes of operation,

$$W = \int \dot{W} dt = (5\ \text{watt})(30\text{min.}) \left| \frac{60\text{s}}{1\text{min}} \right| \left| \frac{1\ \text{J/s}}{1\ \text{watt}} \right| \left| \frac{1\text{kJ}}{10^3\text{J}} \right| = 9\ \text{kJ} \longleftarrow$$

($\dot{W}$: constant)

PROBLEM 2.38

KNOWN: An expression for the power developed by an automobile engine in terms of torque and rotational speed is given.

FIND: For power, in hp, torque, in ft·lbf, and rotational speed, in RPM, evaluate the value and units of the constant appearing in the given expression.

ANALYSIS: The given expression is $\dot{W} = \mathcal{T}\omega / C$. When $\dot{W}$ is in hp, $\mathcal{T}$ is in ft·lbf, and ω is in RPM, by inspection the units of C are $\left[\frac{(\text{ft·lbf})(\text{rev/min})}{\text{hp}} \right]$ ←

Beginning with $\dot{W} = \mathcal{T}\omega$, Eq. 2.20, and applying unit conversion factors for the product $\mathcal{T}\omega$, we get

$$\dot{W} = \mathcal{T}(\text{ft·lbf})\,\omega\left(\frac{\text{rev}}{\text{min}}\right) \left| \frac{2\pi\ \text{rad}}{1\ \text{rev}} \right| \left| \frac{1\ \text{min}}{60\text{s}} \right| \left| \frac{1\ \text{hp}}{550\ \text{ft·lbf/s}} \right|$$

($\dot{W}$: in hp)

$$= \mathcal{T}(\text{ft·lbf})\,\omega\left(\frac{\text{rev}}{\text{min}}\right) \left[\frac{1\ \text{hp}}{5252\ (\text{ft·lbf})(\text{rev/min})} \right]$$

$$\therefore \quad \dot{W} = \frac{\tau(\text{ft·lbf})\ \omega\left(\frac{\text{rev}}{\text{min}}\right)}{C}$$

($\dot{W}$: in hp)

where

$$C = 5252\ \frac{(\text{ft·lbf})(\text{rev/min})}{\text{hp}} \longleftarrow$$