

6. (a) The energy transferred is

$$U = Pt = \frac{\mathcal{E}^2 t}{r + R} = \frac{(2.0 \text{ V})^2 (2.0 \text{ min})(60 \text{ s/min})}{1.0 \Omega + 5.0 \Omega} = 80 \text{ J} .$$

- (b) The amount of thermal energy generated is

$$U' = i^2 R t = \left( \frac{\mathcal{E}}{r + R} \right)^2 R t = \left( \frac{2.0 \text{ V}}{1.0 \Omega + 5.0 \Omega} \right)^2 (5.0 \Omega)(2.0 \text{ min})(60 \text{ s/min}) = 67 \text{ J} .$$

- (c) The difference between  $U$  and  $U'$ , which is equal to 13 J, is the thermal energy that is generated in the battery due to its internal resistance.