Electrical Energy Applied to Heating Water
Electrical Immersion Coil Heater

http://michaelbluejay.com/electricity/howmuch.html

Place the immersion into an empty soda can filled about ¾ full of water (ALWAYS DO THIS FIRST, before plugging it in as there is potential for SEVERE EYE INJURY if the coil is plugged in without being immersed in water!)

Plug it in for a minute or two, then unplug it without removing it from the water.

Observe.

Design and outline an experiment that will allow you to measure the amount of heat energy (in J) released and the power consumed (in W) by the immersion coil heater over a specified amount of time. Conduct the experiment, record values, perform the necessary calculations, and summarize your results:

There are actually two different ways to determine the energy and power outputs of the immersion coil heater. To determine energy (from the previous experiment):

$$\mathbf{Q = [m\ c\ \Delta t\ ]_{water} + [\ m\ c\ \Delta t\ ]_{aluminum\ can}}$$

Power (in watts) = Q (expressed in J) / time (sec)

Using an insulator for the can (a "koozie") can reduce the heat lost to the surroundings. SEPUP's *Science and Sustainability* text actually incorporates aluminum can insulator design as an exploration activity, defining minimum heat lost and/or heat gained over time as the quality criterion. Size limitations are also defined for the challenge.

The other method for determining energy imparted and power consumed is to use the electrical data imprinted on the device. Most electrical devices have some combination of *power (or "wattage"), voltage (typically expressed as a value between 110 and 130 volts AC), and current (or amperage, measured in amperes or "amps").*

If "wattage" is provided, it's easy. The power output in watts is a direct read, and to calculate energy you merely multiply the wattage by the time (in seconds) that the device is plugged in and turned on.

If "amperage" and "voltage" are given, the calculation that provides "wattage" is:

Power (W) = voltage (V) x amperage (A)

Amperage is related to the time rate of electrical charge flow. One ampere is defined as the movement of one "coulomb" of charge through a conductor per second.

By applying **both** methods, you may be able to compare the answers and consider "efficiency." Comparisons among other electrical heating methods can be conducted (immersion coil vs. microwave vs. electric stove vs. ???)

Knowledge of the electrical values for an AC device allows the calculation of energy consumption of the device. Electrical energy usage is typically expressed in "kilowatt-hours" which can be calculated by expressing the wattage in kilowatts (divide watts by 1000) and by multiplying this value by the number of hours that the device is used. Electric bills typically refer to "kilowatt-hours per month" to define the energy consumed during one month. Finally, if you know the cost of electricity in "dollars per kWh" an expense calculation can be performed.