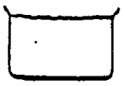
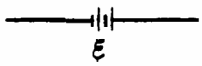
1977B4.

Suppose that you are provided with the following apparatus:

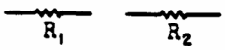
An insulated container of negligible heat capacity containing 100 grams of water at 25°C



A battery of emf $\mathcal{E}$ and negligible internal resistance



Two heating elements, each of unknown resistance, which can be immersed in the water



An ammeter of negligible resistance

A voltmeter of very high resistance

Wires of negligible resistance

a. In the space below draw a diagram, using the symbols described above, to show how you should connect these components to heat the water as rapidly as possible. The meters should be connected so that from the two meter readings alone you could determine at what rate the water is being heated.

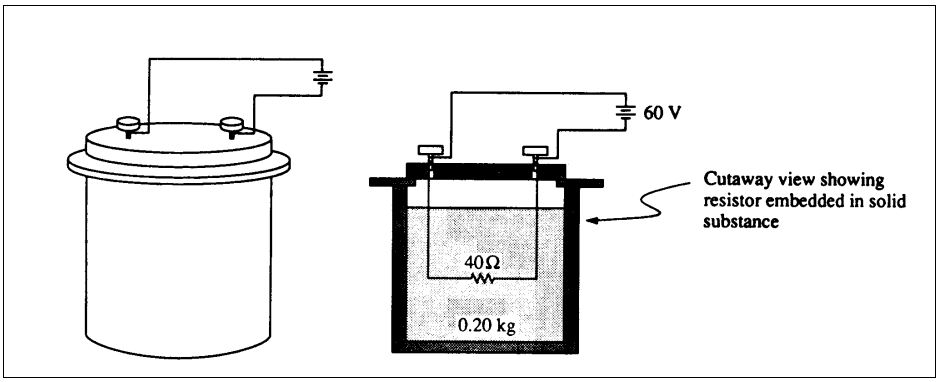
b. Suppose the emf ε of the battery is 50 volts and the current through the battery is 5 amperes. Assume the specific heat of the water is 4 joules per gram per Celsius degree, and the heat of vaporization is 2,200 joules per gram. Calculate the number of seconds required for all the water to boil away.

1984B3. A heating coil is placed in a thermally insulated tank of negligible heat capacity. The tank contains 0.1 kilogram of water and 0.01 kilogram of ice, both initially at a temperature of 0° C. The resistance of the coil is 25 ohms, independent of temperature, and there is a current of 2 amperes in the coil. Calculate each of the following quantities.

a. The heat transferred to the water and ice by the heating coil in time t.

b. The time t_1 necessary to melt all the ice. (The latent heat of fusion of ice is 3.34×10^5 joules per kilogram.)

c. The additional time t_2 necessary to bring the water to a boil. (The specific heat of water is 4.19×10^3 joules per kilogram Kelvin.)



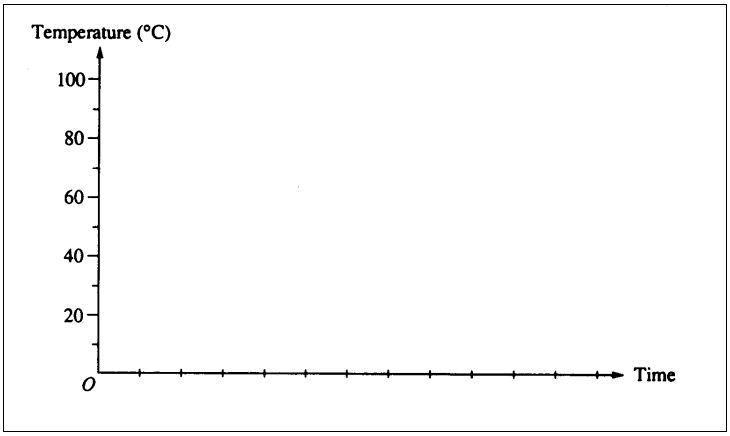
1992B3. A portion of an electric circuit connected to a 40-ohm resistor is embedded in 0.20 kilogram of a solid substance in a calorimeter. The external portion of the circuit is connected to a 60-volt power supply, as shown above.

a. Calculate the current in the resistor.

b. Calculate the rate at which heat is generated in the resistor.

c. Assuming that all of the heat generated by the resistor is absorbed by the solid substance, and that it takes 4 minutes to raise the temperature of the substance from 20°C to 80°C, calculate the specific heat of the substance.

d. At 80°C the substance begins to melt. The heat of fusion of the substance is 1.35×10^5 joules per kilogram. How long after the temperature reaches 80°C will it take to melt all of the substance?



e. Draw a graph of the heating curve for the substance on the axes below, showing the temperature as a function of time until all of the solid has melted. Be sure to put numbers and units on the time scale.