There are two analogous physical scenarios that might help you understand the concept of voltage, current, and resistance. The first analogy is flowing water through a pipe. We place a large reservoir of water in a tower, connect the water through a pipe, and attach a faucet at the bottom of the pipe, see Figure 3.2. In this case pressure is analogous to voltage, water flow is analogous to current, and fluid resistance of the faucet is analogous to electrical resistance. Notice that water pressure is defined as the potential to cause water to flow, and it is measured between two places. Pressure has a polarity and water flow has a direction. If the faucet is turned all the way off, its resistance is infinite, and no water flows. If the faucet is turned all the way on, its resistance is not zero, but some finite amount. As we turn the faucet we are varying the fluid resistance. The fluid resistance will determine the amount of flow:

$$Flow = Pressure/Resistance$$

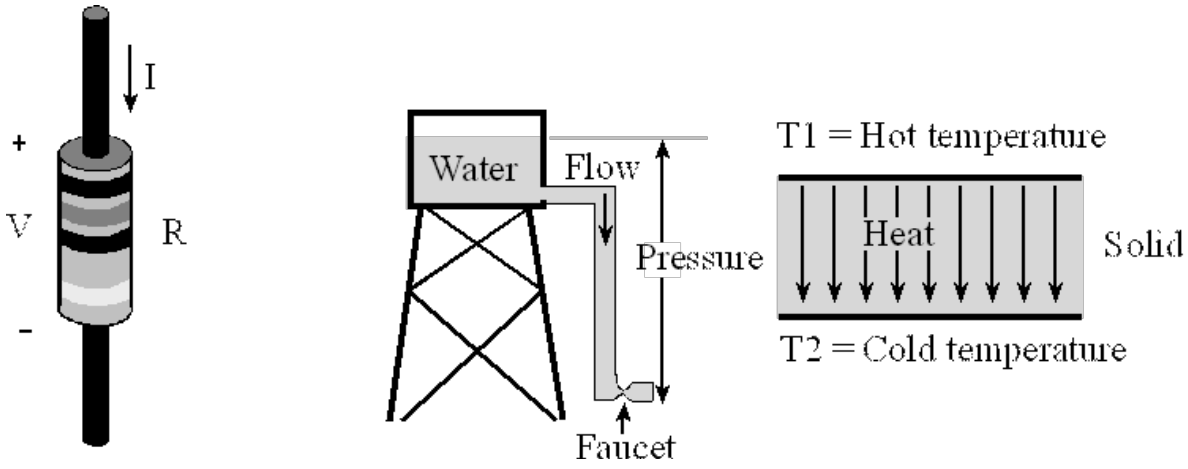

Figure 3.2. Three analogous physical systems demonstrating Ohm's Law.

CHECKPOINT 3.4

If pressure is measured in Newtons/m^2 (Pascal) and flow measured in m^3/sec, what are the units of fluid resistance?

Hide Answer

Resistance is effort over flow = Newtons/m^2/ (m^3/sec) = Newtons-sec/m^5.

A second analogy is heat flow across a solid. If we generate a temperature gradient across a solid, heat will flow from the hot side to the cold side (right side of Figure 3.2). This solid could be a glass window on a house or the wall of your coffee

cup. In this case temperature gradient is analogous to voltage, heat flow is analogous to current, and thermal resistance of the solid is analogous to electrical resistance. Notice that potential is defined as the temperature difference between two places. Heat flow also has a direction. If the coffee cup is made from metal, its thermal resistance is low, lots of heat will flow, and the coffee cools off quickly. If the coffee cup is made of Styrofoam, its resistance is high, little heat will flow, and the coffee remains hot for a long time. The temperature difference divided by the thermal resistance will determine the amount of flow:

$$Flow = (T1-T2)/Resistance$$

CHECKPOINT 3.5

If heat flow is measured in watts (Joules/sec) and temperature measured in ^{o}C, what are the units of thermal resistance?

Hide Answer

Resistance is effort over flow = ^{0}C/ watts.