23.E.16 Most of the energy becomes heat.

23.E.19 (a) A wire of half the length has half the resistance. The new resistance is 5 Ohms.
(b) Doubling the wire over doubles the cross sectional area. This halves the resistance. We’ve also halved the length as before, so we have only a fourth of the original resistance. The new resistance is 2.5 Ohms.

23.E.20 \( I = \frac{V}{R} \), so changing \( V \) and \( R \) by a common factor doesn’t affect \( I \). The factor cancels. \( I \) is the same in both cases.

23.E.21 Look at the above equation for the current. The resistance is the same in both cases, but \( V \) changes. You get a larger current with the larger voltage.

23.E.26 \( P = I^2 R \). Greater power comes from greater resistance. There is more resistance in the high beam filament.

23.E.28 Resistance adds in series, \( R_{eq} = R_1 + R_2 + \ldots \), so this gives an equivalent resistance larger than any of the individual resistances.

23.E.29 This one has to be in parallel. To see this you can try some numbers in the equivalent resistance formula, \( \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots \), or just think about how the bigger a number is, the smaller its inverse. \( \frac{1}{R_{eq}} \) is bigger than any of the individual \( \frac{1}{R} \)’s, so \( R_{eq} \) is smaller than any of the individual \( R \)’s. Or if you like the water analogy, you added another pipe, of course it gets easier to pump water through!

23.E.38 They are brighter in parallel. In series, the voltage drop through each bulb is only half the voltage that is supplied by the battery. In parallel, the potential difference across each bulb is equal to the battery voltage. Bigger voltage means bigger current means bigger power means more light. The battery runs out faster if more power is extracted (a battery stores a certain amount of energy).

23.E.39 Whenever current goes through a resistor, heat is given off. Light bulbs are designed to give off light also, but it takes a certain amount of energy (or effective temperature) for this to happen. These bulbs are below the threshold at which visible light is emitted, but they do emit in the infrared.
23.E.40 We can apply the concepts of 23.E.38 to this problem. The voltage drop across C is the same as the drop for A and B combined. (This is a small extension of the first rule for parallel circuits on page 451 of Hewitt.) The potential difference across A is then half of that for C, and B gives the other half. This means that A and B are equally bright and C is brighter than the other two. As for current, we know that it is proportional to voltage (for identical bulbs/resistors), so twice as much current goes through C as goes through A or B. If A is unscrewed, presumably B will no longer get any current (circuit went through A), and will go out. Unscrewing C would not change A or B.

23.E.49 Greater power means greater resistance. The 100W bulb has the greater resistance. With all else equal, a thicker filament has less resistance. The 60W bulb has the thicker filament.

23.P.1 \[ I = \frac{P}{V} = \frac{60W}{120V} = 0.5A \]

23.P.3 \[ I = \frac{P}{V} = \frac{1200W}{120V} = 10A \]
\[ R = \frac{V}{I} = \frac{120V}{10A} = 12 \]

23.P.5 We’re given the number of cents per kilowatt-hour. If we multiply by the number of kilowatts and the hours, we’ll have the cents. For dollars, divide by 100:

\[ 100W = 0.1kW, \text{ 1 week = 168 hours.} \]

Price in dollars = (15¢/kWh)(0.1kW)(168h)(1/100) = $2.52

23.P.7 \[ P = IV = (9A)(110V) = 990W \]
This is the number of Joules of heat generated in a second. \[ P = (990J/s)(60s/min) = 59400J/min, \text{ so 59,400 J are generated in a minute.} \]