25-45. I'll answer these questions first assuming the light bulbs are ohmic, i.e., R is constant. This is incorrect (but I imagine as the authors intend): In lab 6 you will directly measure R for bulbs and find it is not constant and in fact $I \propto V^{.6}$ (approximately). So I'll also provide more realistic (but still approximate) answers based on that experimental relationship.

(a) $R = V^2/P = 220^2/100 = 484\ \Omega$. At 120 V: $P = V^2/R = 120^2/484 = 29.8$ W.

(b) In Europe the bulb would draw: $I = P/V = 100/220 = .455$ A, whereas here it will draw $I = P/V = 29.8/120 = .248$ A

Using the more correct result $I \propto V^{.6}$, we have $I = .455 \cdot (V/220)^{.6}$ (You can see that I've made the proportionality constant reproduce the European current at the European voltage). In this country: $I = .455 \cdot (120/220)^{.6} = 0.316$ A, and hence a power $P = IV = .316 \cdot 120 = 37.9$ W.

25-77. (a) I'm not sure what this question is asking. Clearly if you are following code, wire diameter controls I_{max}; line voltage and power are used to determine I. If they are asking what physical considerations went into deciding what I_{max} should go into the table, I'll note that if one were limiting power dissipated in the wires (i.e., I^2R) we would conclude $I_{\text{max}} \propto$ dia, where as if limiting power per surface area of the wire (i.e., $I^2R/(\pi \text{ dia } \ell)$, power per area can be related to surface temperature) you would conclude $I_{\text{max}} \propto \text{dia}^{3/2}$. The numbers in the table correspond to $I_{\text{max}} \propto \text{dia}^{1.3}$

(b) $I = 4200/120 = 35$ A, so 8-gauge would do.

(c) Resistivity of copper can be found in Table 25.1: $\rho = 1.72 \times 10^{-8}\ \Omega \cdot \text{m}$. The resistance of 42 m of 8-gauge wire would be:

$$R = \frac{\rho \ell}{\frac{1}{4}\pi \text{ dia}^2} = \frac{1.72 \times 10^{-8} \cdot 42}{\frac{1}{4}\pi(.326 \times 10^{-2})^2} = 0.08655\ \Omega$$

So the power dissipated would be: $P = I^2R = 35^2 \cdot 0.08655 = 106.0$ W,

(d)

$$R = \frac{\rho \ell}{\frac{1}{4}\pi \text{ dia}^2} = \frac{1.72 \times 10^{-8} \cdot 42}{\frac{1}{4}\pi(.412 \times 10^{-2})^2} = 0.0542\ \Omega$$

So the power dissipated would be: $P = I^2R = 35^2 \cdot 0.0542 = 66.4$ W. The power saved is 39.4 W, and the energy saved over 365 12-hour days is: $39.4 \cdot 365 \cdot 12 = 1.73 \times 10^5$ W · hr. This energy costs: $1.73 \times 10^2 \cdot .11 = \$19.08$. FYI: the price difference between these cables is about $50.

12. (old exam)

A. Bulbs are in parallel across a 120 V source.

B. $P = V^2/R \Rightarrow R = V^2/P = 120^2/60 = 240\ \Omega$

C. For one bulb: $I = P/V = 0.5$ A; for all twelve: $12 \times 0.5 = 6$ A.

D. Total energy: $12 \times 60 \times 4 = 2880$ W · hr; cost: $2.88 \times 5 = 14.4$¢