1. **10 points.** An 11.0 W compact fluorescent bulb is designed to produce the same illumination as a conventional 40.0 W incandescent bulb. Assuming a cost of $0.0800/kWh for electrical power, how much money does the user of the fluorescent bulb save over 100 hr of use?

2. **5 points.** If the voltage at the terminals of an automobile battery drops from 12.3 to 9.8 V when a 0.5 Ω resistor is connected across the battery, what is the internal resistance?

3. **15 points.** In the circuit below, if $R_0$ is given, what value must the $R_1$ have for the equivalent resistance between the two terminals $a$ and $b$ to be $R_0$?

   ![Circuit Diagram](image)

4. **10 points.** An aluminum wire with a cross-sectional area of $4.00 \times 10^{-6} \text{ m}^2$ carries a current of 5.00 A. Find the drift speed of the electrons in the wire. The density of aluminum is 2.70 g/cm$^3$; assume each Al atom provides a single electron for conduction. *Hint: how many atoms per unit volume are there? How many charges per unit volume does this imply?*

5. **15 points.** A regular tetrahedron is a pyramid with a triangular base. Six 14.0 Ω resistors are placed along its six edges, with junctions at its four vertices. A 9.0 V battery is connected to any two of the vertices. (a) Find the equivalent resistance of the tetrahedron between these vertices. (b) Find the current in the battery.

6. **5 points.** A conductor of uniform radius 1.2 cm carries a current of 3.0 A produced by an electric field of 120 V/m. What is the resistivity of the material?

7. **5 points.** A common 1.5 V “D” cell battery can supply about 0.100 A of current for about 100 h, hence its capacity rating of 10000 mA·h. How high could you lift yourself with one “D” cell battery powering a 50% efficient winch? Note that your mass in kg can be found by dividing your weight in pounds by 2.2.
8. 10 points. If the current carried by a conductor is doubled, what happens to the (a) charge carrier density? (b) Current density? (c) Electron drift velocity? (d) Average time between collisions?

9. 15 points. The value of an unknown resistor is to be determined with an ammeter and voltmeter, as shown below. The ammeter has an internal resistance of 0.500Ω, and the voltmeter has an internal resistance of 20.kΩ. Within what range of actual values of $R$ will the measured values be correct to within 5% if the measurement is made using the circuit shown in (a) and (b)?

10. 10 points. All of the resistors in the figure below are equal, and have a value $R$. What is the equivalent resistance between the end points?