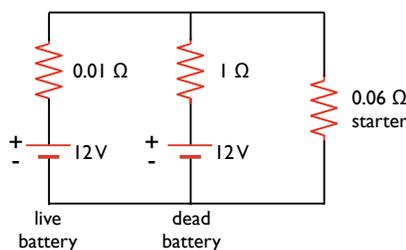


## Problem Set 5: dc Circuits

### Instructions:

- Answer all questions below. Show your work for full credit.
- Due before 5pm, 18 Feb 2008
- Problem sets may be turned in *via* email or hard copy
- Hard copies may be left in Dr. LeClair's mailbox (Gallalee 206) or office (Bevill 228)
- You may collaborate, but everyone must turn in their own work

- 1. 5 points.** Are the two headlights of a car wired in series or in parallel? How can you tell?
- 2. 5 points.** What advantage might there be in using two identical resistors in parallel connected in series with another identical parallel pair, rather than just using a single resistor?
- 3. 15 points.** An electric heater is rated at 1500 W, a toaster at 750 W, and an electric grill at 1000 W. The three appliances are connected to a common 120 V household circuit. **(a)** How much current does each draw? **(b)** Is a circuit with a 25 A circuit breaker sufficient in this situation? Explain your answer.
- 4. 15 points.** A dead battery is charged by connecting it to the live battery of another car with jumper cables (see below). Determine the current in the starter and in the dead battery.



- 5. 20 points.** A group of students on spring break manages to reach a deserted island in their wrecked sailboat. They splash ashore with fuel, a European gasoline-powered 240 V generator, a box of North American 100 W, 120 V lightbulbs, a 500 W 120 V hot pot, lamp sockets, and some insulated wire. While waiting to be rescued they decide to use the generator to operate some bulbs.
  - (a)** Draw a diagram of a circuit they can use, containing the minimum number of lightbulbs with 120 V across each bulb, and no higher output.
  - (b)** One student catches a fish and wants to cook it in the hot pot. Draw a diagram of a circuit containing the hot pot and the minimum number of lightbulbs with 120 V across each device, and not more. Find the current in the generator and its power output.

**6. 15 points.** Two resistors  $R_1$  and  $R_2$  are in parallel with each other. Together they carry total current  $I$ . **(a)** Determine the current in each resistor. **(b)** Prove that this division of the total current  $I$  between the two resistors results in less power delivered to the combination than any other division. It is a general principle that current in a direct current circuit distributes itself so that the total power delivered to the circuit is a minimum.

**7. 5 points.** A fully charged capacitor stores energy  $U_0$ . How much energy remains when its charge has decreased to half its original value?

**8. 5 points.** A capacitor in an  $RC$  circuit is charged to 60% of its maximum value in 0.900 s. What is the time constant of the circuit?

**9. 10 points.** A capacitor of value  $C$  is discharged through a resistor of value  $R$ . **(a)** After how many time constants is the charge on the capacitor one fourth of its initial value? **(b)** After how many time constants is the *energy* at one fourth of its initial value?

**10. 5 points.** Two resistors connected in series have an equivalent resistance of  $690\ \Omega$ . When they are connected in parallel, their equivalent resistance is  $150\ \Omega$ . Find the resistance of each resistor.