On electrical power

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Problem 10 is not original. Problem 9 owes a debt to G. Polya.

Warm-up problems

1. Write down three formulas for the power in an electrical component. Remember to include what the usual units are and what each symbol means. When is each useful?

2. Link the following terms with their units.

   (a) current
   (b) e.m.f.
   (c) p.d.
   (d) resistance
   (e) charge
   (f) energy
   (g) power

   i. joule
   ii. coulomb
   iii. watt
   iv. volt
   v. ohm
   vi. ampere
   vii. volt

3. Why does a lamp change more electrical energy per second into heat and light than the wires connecting it to the supply? Use the term *resistance* in your answer.

Regular problems

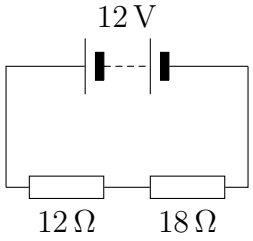
4. (a) What is the power of a lamp rated at 12 V 2 A?
   (b) How much energy is radiated per second from a 6 V 0.5 A lightbulb?
   (c) A lightbulb is labelled 12 V 36 W. When used on a 12 V supply,
      i. what current will it take?
      ii. what is its resistance?

5. (a) Why are thick wires rather than thin wires used to carry high currents?
   (b) Will a lamp with a thick filament draw more current or less current (if screwed into a mains socket) than a lamp with a thin filament?

6. (a) What is the electrical power dissipated in a 100 Ω resistor carrying a current of 50 mA?

(b) Would a 0.5 W rating be suitable for a 10 kΩ resistor through which a current of 10 mA flows? If it is not, what rating would be suitable?

7. A 12 Ω and 18 Ω resistor are connected in series with a 12 V battery.



(a) What is the current drawn from the battery?

(b) What is the power dissipated in the 12 Ω resistor?

(c) Which of the two resistors dissipates the greater power?

(d) The two resistors are now connected to the battery in parallel. What is the new (i) current and (ii) drawn from the battery, and (iii) which of the two resistors now dissipates the greatest power?

8. Should a kettle element have a lower or higher resistance in order to boil the water more quickly? Justify your answer.

Extension problems

9. Question 7 was what is known as a problem "in numbers". You should have found that the resistor which used greater power in series was the less powerful one in parallel. Look back at your solution to that problem and see whether

(a) Can you now see this result *at a glance*? Why does it arise (what is the main criterion in series and parallel?)

(b) Can you turn the problem into a problem "in letters"? [*Use unambiguous and easy to remember notation, e.g.* R_L *and* R_H *rather than* R_1 *and* R_2.]

(c) Can you make a *visual proof* of the result?

10. Downstairs in a house are three identical on-off switches. One of them controls the lamp in the attic. The puzzle is to work out which switch controls the lamp.

The rules are as follows. You are allowed to manipulate the switches all you like, and then you are allowed only one trip to the attic. How do you do it?