On current electricity

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Warm-up problems

1. What are the units of charge, current, voltage and resistance? Express each of these units in SI base units.
2. What are the other two alternative names for *voltage*? Give the equation linking voltage, energy and charge.
3. Give the equations linking
   (a) current to charge and time,
   (b) resistance to current and voltage.

Regular problems

4. Why are *electrons*, rather than *protons*, the principal charge carriers in a metal wire?
5. (a) What is the current in a circuit if the charge passing each point is (i) 10 C in 2 s, (ii) 20 C in 40 s, (iii) 240 C in 2 minute?
   (b) If the current through a lamp is 5 A, what charge passes in (i) 1 s, (ii) 10 s, (iii) 1 minute?
6. The voltage across a lamp is 12 V. How much electrical energy is changed into heat and light when
   (a) a charge of 1 C passes through it,
   (b) a charge of 5 C passes through it,
   (c) a current of 2 A passes through it for 10 s?
7. (a) What is the voltage across a 220 Ω resistor when a current of 3 mA flows through it?
   (b) The voltage across a 2.7 kΩ resistor is 5.4 V. What current flows?
   (c) Calculate the resistance of a resistor if a voltage of 9 V causes a current of 1.5 mA to flow through is.
   (d) A current of 0.4 mA flows through a 10 kΩ resistor. What is the voltage across its ends?
8. (a) If the voltage across a circuit is held constant while the resistance doubles, what change occurs in the current?

(b) If the resistance across a circuit halves while the voltage increases by a factor of three, what change occurs in the current?

9. (a) What is the combined resistance of the following resistors connected in parallel: 220 Ω, 100 Ω, 470 Ω?

   (b) Calculate the the combined value of the following resistors connected in series: 33 kΩ, 18 kΩ, 4.7 kΩ. If a battery supplies a current of 215 µA through the resistors when they are connected to it, what is the battery voltage?

Extension problems

10. A 10 kΩ and a 6 kΩ resistor are connected in series. If both resistors have a manufacturing tolerance of ±10 %, what, approximately, are the maximum and minimum values of resistance we should expect to measure across the combination?

11. In the following infinite network of 1 Ω resistors, what is the resistance (as measured by an ohmmeter) between A and B?