Coulomb's Law (reminder)

Two electric charges, q_1 and q_2 , at distance r, act onto each other with electrostatic force given by **Coulomb's law**:

$$F = k\frac{q_1 q_2}{r^2} \qquad k = 9 \cdot 10^9 \ \frac{Nm^2}{C^2}$$

SI unit of electric charge is 1 **Coulomb** (1C). Charges can be positive and negative. Charges of the same sign repel, while the opposite ones attract each other.

1 Coulomb is a very large charge. Two charges 1C each at distance 1m from each other repel with the force F approximately equal to the weight of a billion kilogram mass.

A number of atoms in a penny coin is about 10^{22} and the total number of electrons is of the order of 10^{24}. The charge of each electron is -1.6×10^{-19} C. If one could possibly separate electrons from nuclei in a single penny one would get the electric charge of the order of 100,000 C. This separation is hardly possible because of the huge attraction force between opposite charges.

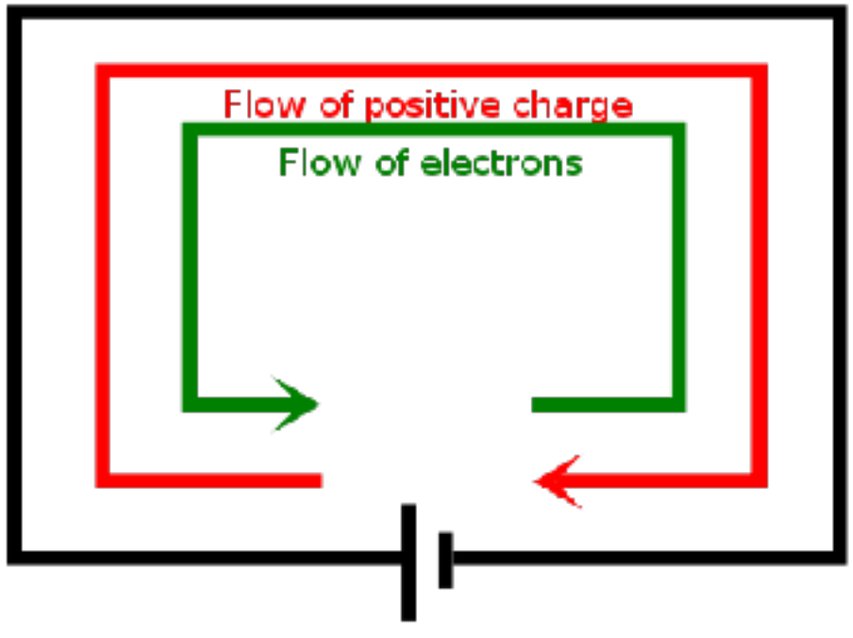
Electric Current

When electric charges move we say that there is an electric current. More precisely: **Electric Current** (represented by letter **I**) is the total charge flowing through a given cross section of the wire in 1 sec. Current is measured in **Amperes [A]** (Coulomb per second) : **1A=1C/s**.

$$I = \frac{\Delta Q}{\Delta t}$$

$$\text{Current} = \frac{\text{Charge}}{\text{Time}}$$

In most cases the current is the flow of electrons (negative charges), but the convention is to assume that current is the motion of positive charges. When electrons are moving to the right, it is the same as positive charge (and current) is moving to the left. Therefore, the current is flowing from '+' to '-' terminal of a battery.



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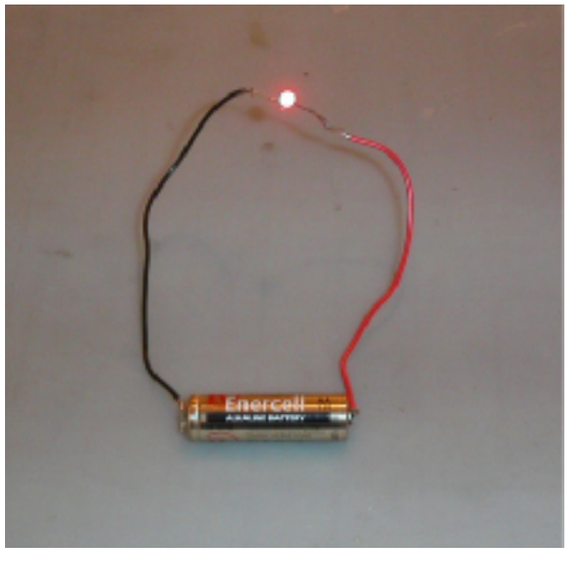
Physics 0

Homework

Problem 1

The brightest phase of a lightning bolt lasts approximately 1 millisecond (1ms, “milli” stands for 1/1000). During that time, a charge of approximately 10 C moves between the cloud and the ground. Estimate the typical electric current during this event.

Problem 2



A good “AA” battery can “pump” a total charge of about 7000 C through an electric circuit, until it dies. Consider an electric circuit made of a single battery and a single LED (light-emitting diode) shown in the picture. The current in LED is 20 mA (mA=milliampere). How long will the battery last?