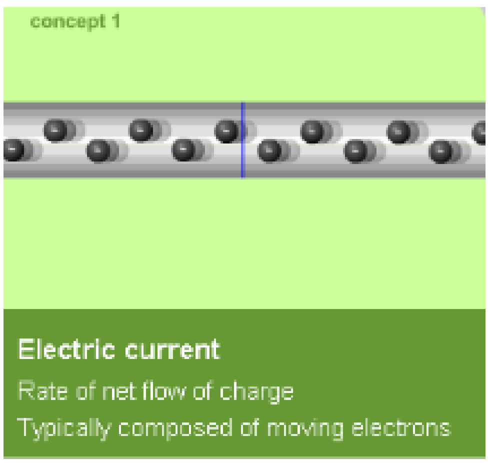
Electric current: Amount of net charge passing through a surface per second.

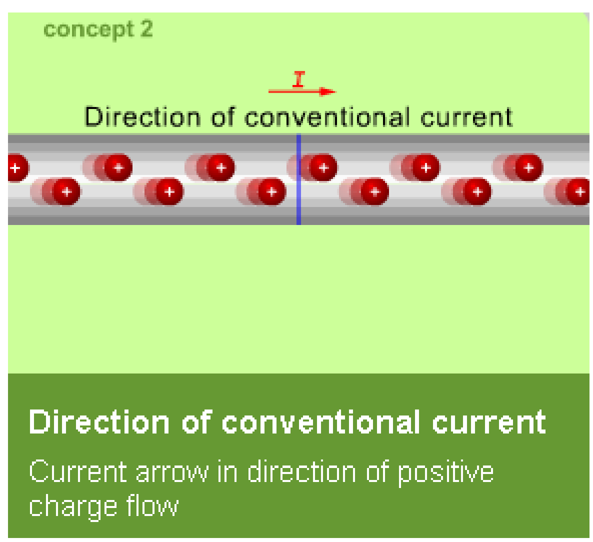
Current is the rate at which net charge passes through a hypothetical surface, the number of coulombs of charge per second. As a practical matter, currents are often measured as they pass through a wire, so we use this configuration to explain currents in the illustrations to the right. In this section, we focus solely on the current, not its cause.

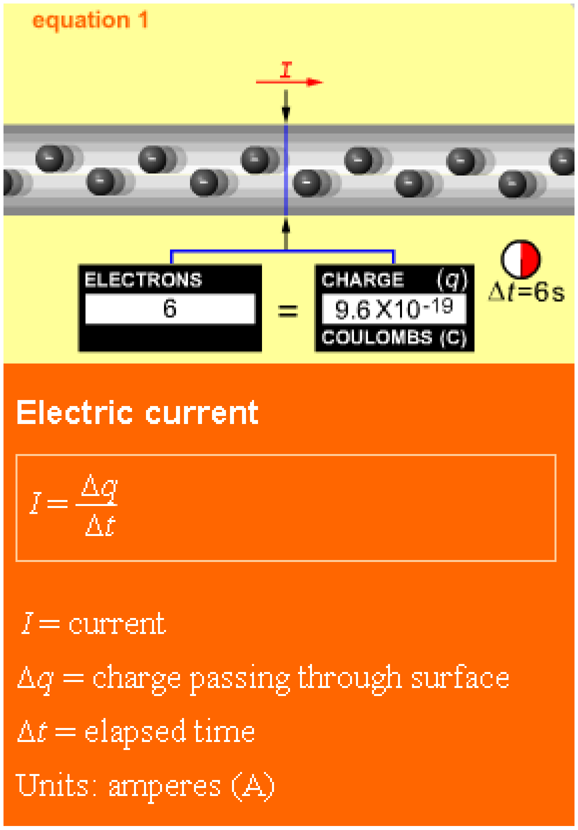


To measure the amount of current, we can place an imaginary surface across the wire shown in Concept 1 and count the net number of electrons moving through it each second. The electrons we show are the *charge carriers*, the charges that make up the current. In this example, they are moving from right to left.

Counting the electrons as they pass by is a useful start, but electric current is charge per second, so we need to multiply by the charge of an electron. An electron has a charge of -1.6×10^{-19} C, so if there are five electrons flowing by every second, the electric current is 8.0×10^{-19} coulombs per second. For reasons discussed below, the flow of current here is considered positive.

When electrical current was first discovered, it was thought that protons moved instead of electrons. This created a false convention that has continued through the ages. The direction of current is thought of as if it was the protons moving, not the electrons. So the direction of current is the opposite direction of the way the electrons move.





The equation in Equation 1 states that current is the net charge passing through a surface divided by time. The *ampere* (A) is the unit for electric current. It is named after the French scientist André-Marie Ampère. One ampere equals one coulomb per second. A coulomb of charge is equivalent to 6.2×10^{18} electrons, so one ampere equals that number of electrons passing through every second. The letter I represents current.

Using water as an analogy may help you understand electric currents. The rate of water flow is measured in several settings. You may have seen water flow ratings for shower heads. Newer shower heads allow a water flow of nine liters per minute, about half the rate of flow of older models. Boaters also keep a close eye on water flow. For a particular river, a rafter might measure how much water is flowing, in cubic feet per second, to judge whether it is safe to run the rapids.

Similarly, the rate of flow of electrons can be measured. Many electrons move in the currents used in household devices. About 2.5×10^{18} electrons pass through the light bulb in a typical household flashlight every second, which is 0.4 amperes.

Current is a scalar quantity. It states the rate of flow of charge, not the direction of the flow of charge. Again, think of water. Liters per second tells you how much water is flowing, but not in which direction. Often, it is important to know the direction of an electric current: which way the charge is flowing. Confusingly, the arrow used to indicate a current's direction points opposite the way you might expect. It does not point in the direction that electrons flow. Instead, it points the way positive charges would be flowing if they were the charges moving in an electric current. This is shown in Concept 2. The arrow indicates the direction of what is called *conventional current*, the direction in which positive charge carriers creating the current would move. The flow of electrons discussed above would be described as a positive current flowing to the right, not a negative current flowing to the left.

Why is typical electric current shown as though positive charge carriers flow, even if they do not? Scientists began studying electric currents before they knew about electrons and protons. One of the early explorers of electricity, Benjamin Franklin, established the convention that the current points in the direction of positive charge flow. More than a hundred years later, when the scientist Edwin Hall determined that current is actually the movement of negative charge carriers (electrons), the positive charge flow convention had already been established, and it remains in place to this day.

In basic configurations like the segment of conducting wire shown to the right, electric current is stated as a positive quantity and its direction is indicated with an arrow. In other circumstances, such as alternating current circuits where the direction of current flow changes constantly, signs can be used to indicate the direction of current.

Questions:

1) What are the units of current?
2) If electrons are flowing to the right, in what direction is the current?
3) What is the symbol for current?
4) If 6 electrons flow past in 6 seconds, what is the current? (this is the example in equation 1)