Charge and Current

Say we have a conductor (e.g., wire) with I=1 Ampere of current flowing through it.

Q: *What does this mean, **physically** ?*

A: Current I simply describes the **rate** at which **net** charge passes through the wire cross-sectional surface S. For example, if a **net** charge ΔQ moves across surface S in some small amount of time Δt, we find that:

$$I = \lim_{\Delta t \to 0} \frac{\Delta Q}{\Delta t} = \frac{dQ}{dt}$$

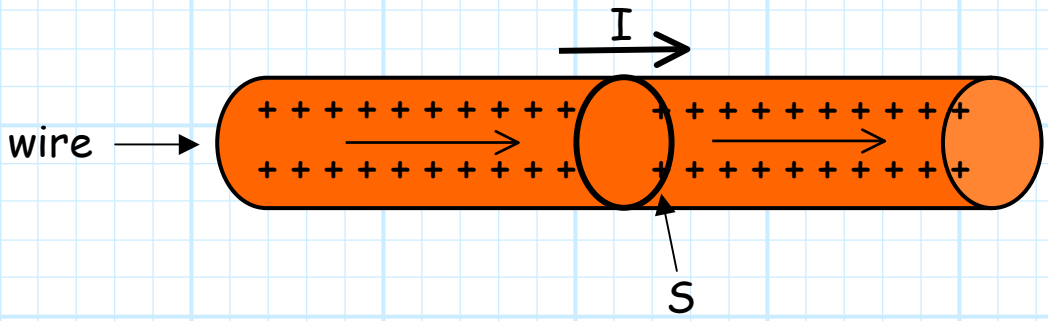
Thus, we find that 1 Amp means **+1.0 Coulomb** of net charge passes by a location on the wire each **second**, with the net charge in this case flowing from left to right.

Q: *The current is **positive**, does this mean that the current is made up of **positive** charge?*

A: **No!** Current generally consists of **both** positively and negatively charged particles.

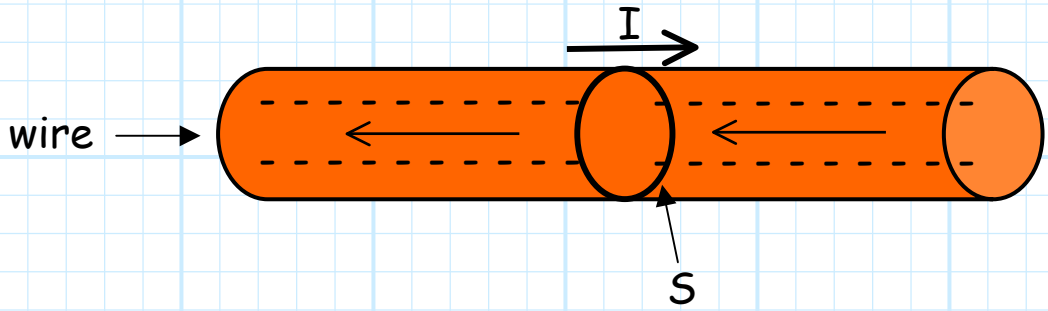
Remember, current is the **net** change in charge with respect to time.

For example, say **positive** charges are moving from **left to right** through the wire:



The current due to these charges is **positive**, as the total net charge on the right side of the surface is **increasing** with time.

That was pretty obvious, but here's the **tricky** part: say **negative** charges are moving from **right to left** through the wire (the **opposite** direction of that above).



Note in this case, the total charge on the right side of S is **again increasing** !

* With the first case, the net charge was increasing because positive charges were entering the right side. For this case, the net charge on the right side is **also** increasing, but because negative charge is **leaving** the right side !

* For reasons we shall learn about later, if positive charge moves one direction, then negative charge will generally move in the **opposite** direction. Therefore, total current is composed of charges moving in **both** directions:

$$I = I^{+} + I^{-}$$

* Generally speaking, it **does not matter** (in fact we generally cannot tell) whether the particles that form a specific current are negative or positive—all that matters is the **net** change in charge across a surface.