

Discussion of Wolfson Problem 26.60 (question 1 from Practice Problem Set 7)

The question states, “you’re standing under a power line carrying 1.5 kA toward magnetic north.”

Note, there are two important sign conventions utilized here:

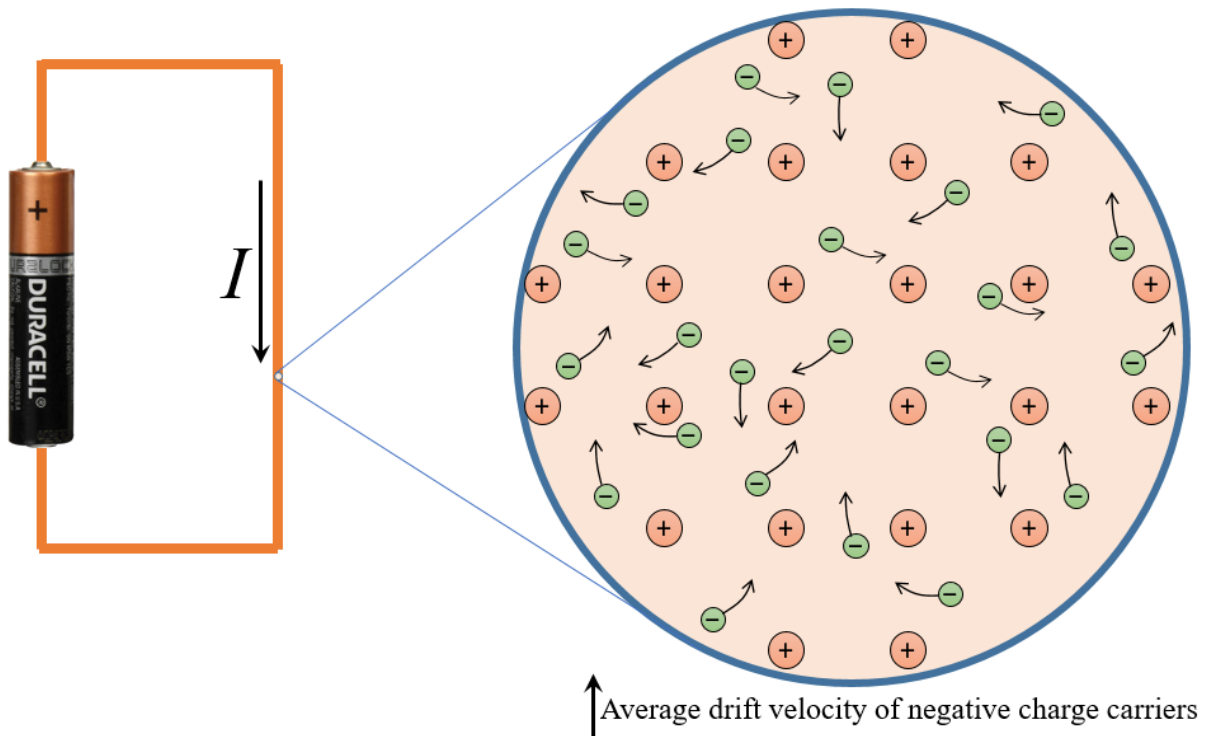
1. Electric current is defined as the flow of **positive** charge.
2. “toward magnetic north” means toward the pole of the Earth that contains the Arctic Ocean, and polar bears.

If you completely understand the two sign conventions above, you may stop reading now. If you are still confused, keep reading and I will explain two common misconceptions.

Misconceptions below

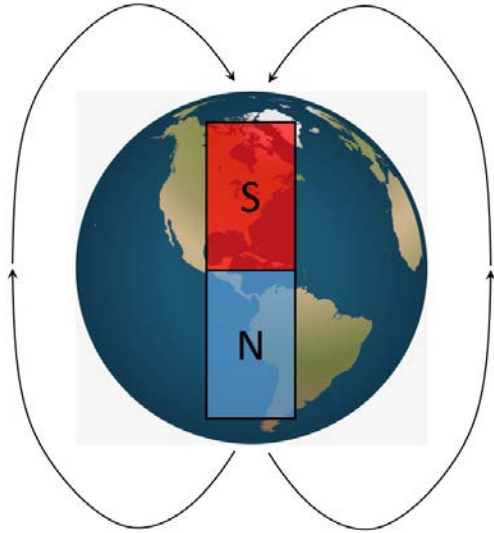
Electric Current Direction

One confusion many students have with the first sign convention is that, for metal wires, the individual charge carriers are electrons. So, if you measure the Hall Effect and keep track of the drift velocity of the individual electrons, you will find this velocity is in the *opposite* direction of the current.



Magnetic Field Direction

One confusion many students have with the second sign convention is that, if you imagine the Earth to contain a giant permanent bar magnet (which it does not), then the “S” side of this internal bar magnet would be up near the North pole.



By definition, the labels on a permanent bar magnet, N and S, stand for “North-seeking” and “South-seeking”. So, if a permanent bar magnet is placed on the surface of the Earth near the equator, and allowed to rotate freely around a vertical axis with no other magnets nearby, it will tend to rotate until the “N” side points North (toward the Arctic Ocean), and the “S” side points South (toward the continent of Antarctica). And, by definition the N-side of a small, isolated, permanent bar magnet naturally rotates until it points in the direction of the magnetic field. The global magnetic field of the Earth is due to an internal electromagnetic dynamo. https://en.wikipedia.org/wiki/Dynamo_theory

A second confusion with regards to the second sign convention is that North Magnetic Pole and the Geographic North Pole are not quite in the same location. Also, there is a third place called the “North Geomagnetic Pole”. They are all in the Arctic, and are explained at https://en.wikipedia.org/wiki/North_Magnetic_Pole. In Canada, isolated compasses out in the wilderness point toward the North Magnetic Pole, and this is what Wolfson means by “toward magnetic north”.

