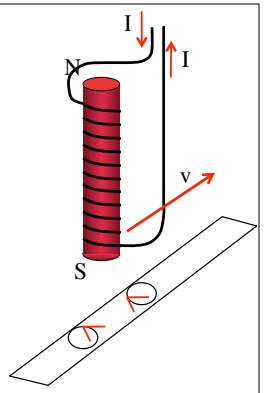
Problem 31.44

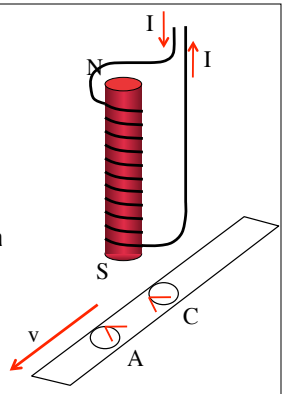
Given the direction of current in the solenoid, and the direction of motion of the solenoid relative to the sheet of metal, which way will the eddy current flow?



As a quick preamble, if you use the right-hand-curl approach on the solenoid, you find that the direction of the magnetic field at either end of the solenoid is correctly presented with the pole nearest the metal sheet being a South Pole. That means the "external" magnetic field through the sheet will be UPWARD.

In my opinion, it is actually easier to see what is happening if we think of the solenoid as stationary and the metal sheet as moving out at us (versus having the metal sheet stationary and the solenoid moving into the page). A sketch on the next page pictures this alternate view.

Once reoriented, the craftiness of this problem becomes evident.

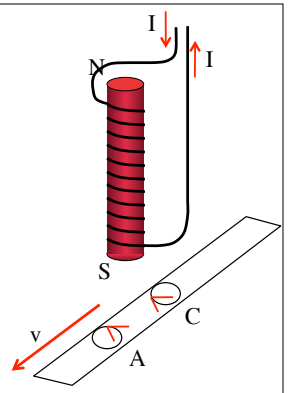


Let's examine the possible eddy current that I've labeled "A" on the sketch.

That section of the sheet has passed by the south pole of the solenoid, so it is experiencing a magnetic flux that is decreasing. A decreasing magnetic flux will motivate an induced current which will generate an induced B-fld that ADDS to the external field. In other words, the B-fld generated by the induced current will be UPWARD. The current required to do that will be counterclockwise, just as the current at "A" is shown. Apparently, A's current is good.

The temptation is to think that if the current at "A" is correct, the one at "C" must be wrong. OH, CONTRARE! The book is being tricky.

How so?



Let's examine the possible eddy current I've labeled "C" on the sketch.

That section of the sheet is just passing into the region where the South Pole of the solenoid is predominant. As such, its magnetic flux is increasing. An increasing magnetic flux will motivate an induced current which will generate an induced B-fld that SUBTRACTS FROM the external field. In other words, the B-fld generated by the induced current will be DOWNWARD. The current required to do that will be clockwise, just as the current at "C" is shown. Apparently, C's current is good, also.

Bottom line: Even though the eddy current swirls are in opposite directions, both of the current sections that interact with the solenoid's South Pole generate a force back into the page, slowing the metal sheet. Cool, eh?