Lesson 21: Lenz's Law

Heinrich Lenz was a German physicist who started studying electromagnetism in the 1830's.

- By using a bit of logic he was able to come up with a method to predict the direction of the current in a coil if it was exposed to a changing magnetic field.
  - We will be drawing these coils as solenoids to make them easier to figure out, but they do not have to be solenoids.

Lenz recognized that there were only two possibilities for the direction of the current in the coil, so he figured out which one was impossible and which must be correct.

The Wrong Way

As the magnet is pushed into the coil of wire, we *assume* that the induced current is flowing as shown by the arrow.

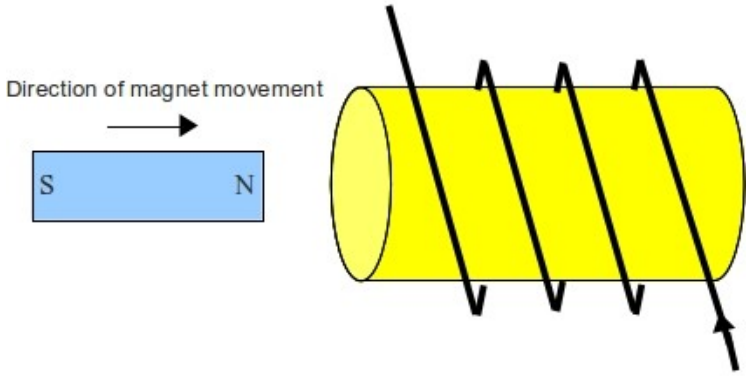


Illustration 1: Current induced in coil.

- If the current flows this way in the coil, we can use the second hand rule to figure out the direction of the magnetic field of the solenoid.

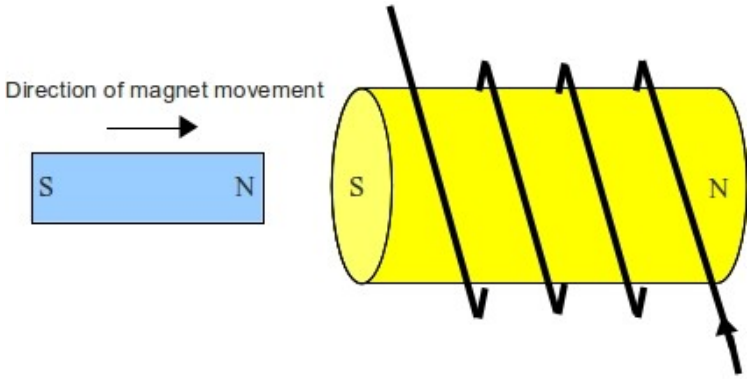


Illustration 2: Showing the magnetic poles induced on the solenoid.

- If this was what really happened, all you would need to do is just start start pushing on the magnet for a moment.
  - The current induced in the coil will create the poles as shown.
  - Since the coil's magnetic field has its south pole near the magnet's north pole, it will start to

pull the magnet in for us.... we don't have to do anything.

- The coil is pulling the magnet in for us, while also making electricity.
- This would be like getting something for nothing, and the universe does not work that way.

The Correct Way

For this one we just assume the direction of the induced current is flowing in the exact opposite direction.

- This will induce a magnetic field in the coil that will also be opposite.

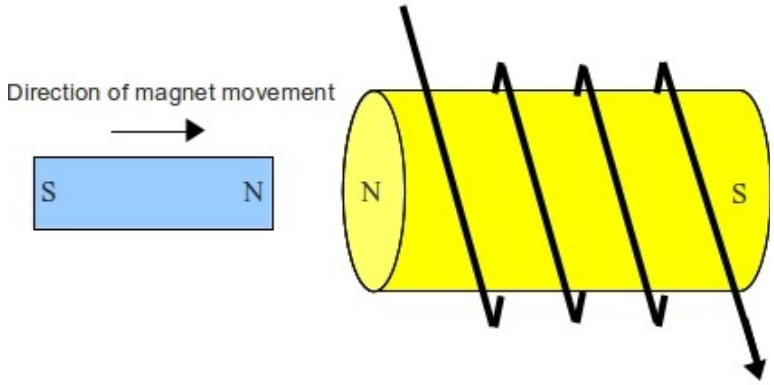
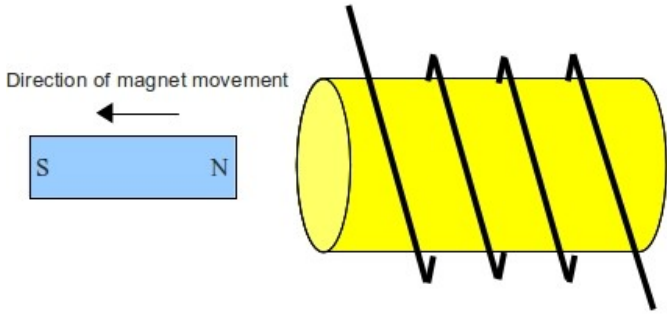


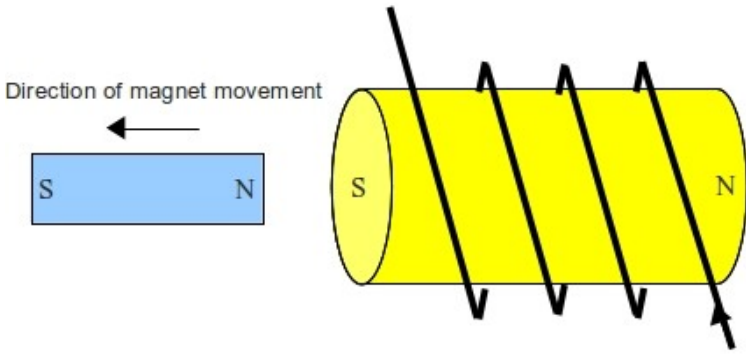
Illustration 3: Induced current in coil is reversed, so the magnetic poles are also reversed.

- Now the north poles are facing each other, so they will repel.
  - This makes it difficult to push the magnet towards the coil.
  - We have to work at it now... we aren't getting something for nothing. The work we do forcing the magnet towards the coil is converted to the electricity induced in the coil.

Example 1: Identify the direction the magnet is being moved to cause the direction of the current shown.



This would be most difficult if the left side of the solenoid was a south pole, since that will try to pull the magnet back to the right while we are trying to move it to the left.
We use the second hand rule to figure out the direction of the current in the wire that results in the poles being aligned this way.



Basically, just always keep in mind that Lenz's Law says that the induced current in the coil creates a magnetic field that makes moving the external magnet difficult to do.

Homework

Review
p622 #1, 4, 5, 7, 12, 15, 19-22, 26