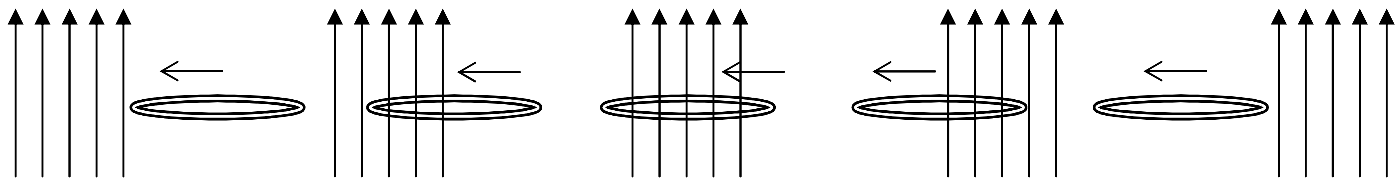
A-day: Due Mon., May 23
B-day: Due Tues, May 24

2011 PreAP Magnetism 5

Lenz's Law states: "*A change of magnetic field causes an induced current whose induced magnetic field that opposes the change.*" Let's see if I can make this clearer.

1. A loop of wire passes thru the magnetic field, moving left, as seen below. Let's pretend that each vertical arrow represents 1 Tesla of magnetic field strength. Since they are pointing up, we'll call B positive. The amount of B in each loop (# of arrows) is notated below each stage of the diagram.



I: $B_{loop} = 0$ T II: $B_{loop} = 3$ T III: $B_{loop} = 5$ T IV: $B_{loop} = 3$ T V: $B_{loop} = 0$ T

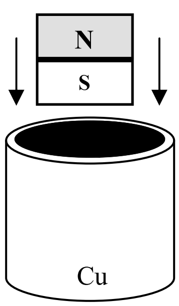
Step A:	$\Delta B_{loop} =$ +3 T	$\Delta B_{loop} =$ _____	$\Delta B_{loop} =$ −2 T	$\Delta B_{loop} =$ _____
Step B:	$B_{induced} =$ + or −	$B_{induced} =$ + or −	$B_{induced} =$ + or −	$B_{induced} =$ + or −
Step C:	$I_{induced} =$ CW or CCW	$I_{induced} =$ CW or CCW	$I_{induced} =$ CW or CCW	$I_{induced} =$ CW or CCW

Step A: Between each of the stages, write the ΔB_{loop} in the given blanks. Two of them are given for you already.

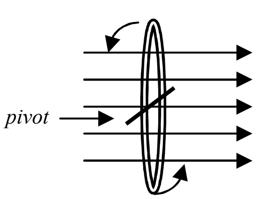
Step B: $B_{induced}$ must always be opposite the change of magnetism in the loop. Two of them, again, have been given for you.

Notice that as the loop passes into the field, the ΔB_{loop} (Stages I—III), the magnetic field is becoming more positive, so the induced field must be negative. As the loop passes out of the field (Stages III-V), the magnetic field is decreasingly positive, so the change is negative. Therefore, the induced magnetic field must be positive, restrengthening the positive B.

Step C: Using the circular right hand rule, use the direction of the induced magnetic field in the loop to determine the direction of the induced current in the loop (as viewed from above). The first one has been given for you.



2. A magnet is dropped into a copper tube.
   A. Is the magnet attracted to the copper tube?
   B. Is the copper a hard or soft magnetic material?
   You know that the magnet drops slowly thru the tube, so there must be a magnetic force opposing gravity.
   C. To keep the magnet from falling, which way must the induced magnet face?
   You should have chosen N facing down, so your thumb faces down with your fingers curled.
   D. To create this magnet which way is the induced current flowing in the tube (*as seen from above*)?



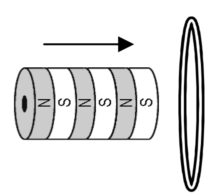
3. A wire loop is rotated CCW in a magnetic field.

A. * When it is vertical, are the ends of the loop moving parallel or perpendicular to the field?

B. Is the emf (induced voltage) a max or a min at this position?

C. As it turns CCW from vertical to horizontal, is B increasing or decreasing in the loop?

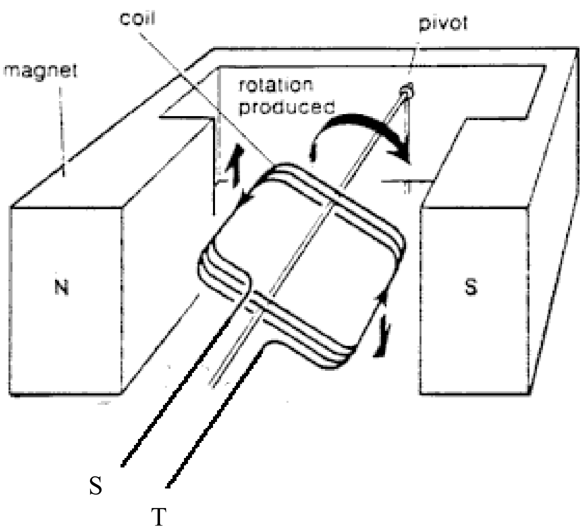
D. From the left, determine the direction of $I_{induced}$ in the loop as it rotates from this position to horizontal.



4. A stack of magnets is moved into a wire loop.

A. To resist the magnet, the loop will make a magnet with the north pointing left or right?

B. From the left, which direction is $I_{induced}$ flowing in the loop?

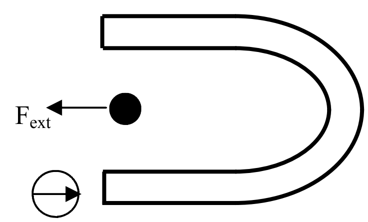


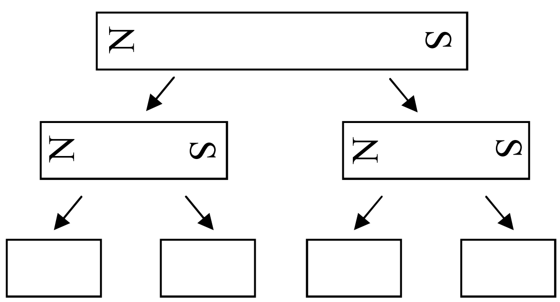
5. The diagram at the left shows a loop of wire moving inside a horseshoe magnet. The loop rotates clockwise around the pivot.
   A. Which direction does the magnetic field point?
   B. When does the rotating loop cut more magnetic field lines, when it is horizontal or vertical?
   C. When does the loop create a stronger emf (voltage), when horizontal or vertical?
   D. Remembering that the wire is your thumb, which side will the induced current flow: out point T or point S? (*You can either use the right hand rule on either side of the loop OR Lenz's Law.*)
   E. During an entire rotation (360º) will the moving loop produce AC or DC voltage (emf)?

   So, the emf be negative during one half of the rotation and positive during the other half.

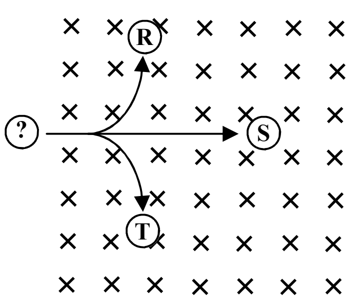
   F. How do the peak magnitudes of the negative and positive emfs compare?

6. A. Use the compass at the left to decide which side is N and S. The wire is pulled to the left by an external force.
   B. Is the magnet moving the wire?
   C. So, what part of the right hand rule (RHR) is the moving wire?
   D. Which direction does the magnetic field point?
   E. Which direction will the magnetic force be in the wire?
   F. Which direction will the induced current be?





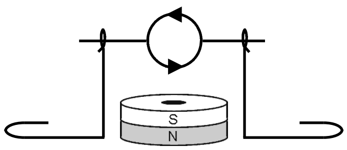
7. A bar magnet is split in half. Each of the two halves is also halved.
   A. Label each of the bars.
   B. So, how small would one of the bars have to be to have just a single North or single South pole?



8. When scientists need to determine the charge of a particle, they project it (shoot it) into a magnetic field, as seen at the left. By watching the path, they can easily determine its charge.
   A. ___ Which path would prove it is negatively charged?
   B. ___ Which path would prove it has no charge?
   C. ___ Which path would prove it is positively charged?

This is one way that scientists can determine the charge of a particle. The picture at the lower left is that of "pair production", when an electron and a positron (an anti-electron) are formed in a nuclear accelerator. (I don't know which is which because I don't know the direction of the magnetic field.) The two particles have equal mass (more mass would be a much larger spiral path), but you can see by the opposite paths that they have opposite charges. The positron is the antimatter particle of an electron.

9. Below is an example of a rudimentary motor. The current in the loop of the motor is turning CCW.

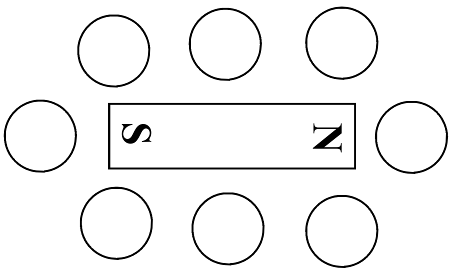


A. Is the north pole of the loop facing out of or into the page?

B. Label front face of the loop as a N or S.

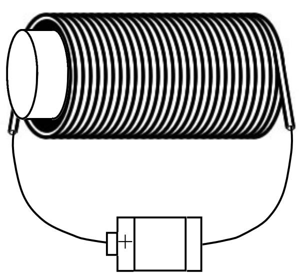
C. The electromagnetic of the loop will interact with the permanent magnet below it. Will the front of the loop rotate up or down?

This is how motors work: electromagnets interact with permanent magnets, causing magnetic forces and motion.



10. A. Magnetic field lines point from ____ to ____.
    B. Draw the magnetic field lines around the top and bottom of the bar magnet.
    C. Realizing that compasses will point tangent to the magnetic field lines, draw the compasses around the bar magnet.

11. A piece of iron (iron core) is placed inside a solenoid, which is connected to a battery, as shown.



A. Since conventional current flows from positive to negative, draw an arrow to show the direction of the current out of the battery.

B. Determine which side of the solenoid is its north pole.

C. Draw the magnetic field lines around the solenoid.

D. What reason would there be for an iron core to be in the solenoid?

E. Is the iron a soft or hard magnetic material?

F. Before the battery is connected, are the magnetic domains in the iron aligned or random?

G. When the battery is connected, are the magnetic domanins in the iron aligned or random?

3A: parallel