

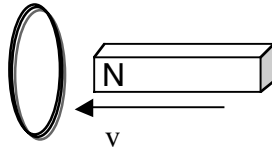
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EMI 5A: WIRE COILS AND MOVING MAGNETS

EMI5A—WBT1: WIRE COILS AND MOVING MAGNETS

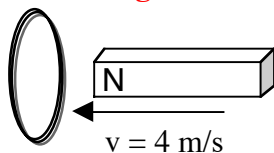
Construct a physical situation involving a permanent magnet and a circular coil of wire in which the magnet repels the coil of wire. Explain fully.

One solution is a magnet approaching the coil as shown below



EMI5A—CCT1: WIRE COILS AND MOVING MAGNETS

With which, if any, of the following students do you agree?



Student A: *“If you suspend a coil of wire from a thread and bring a permanent magnet up to the coil, the coil will swing toward the magnet since wires are metal.”*

Student B: *“If you suspend a coil of wire from a thread and bring a permanent magnet up to the coil, the coil will swing away from the magnet since there will be an induced magnetic field in the coil.”*

Student C: *“If you suspend a coil of wire from a thread and bring a permanent magnet up to the coil, the coil will not move because the magnet cannot exert a force on the coil if there isn’t a current in it.”*

I agree with:

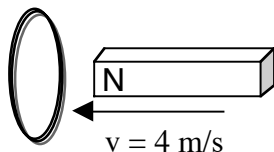
Student A _____ Student B X Student C _____ None _____

Please explain your reasoning fully.

The coil experiences a repulsive force due to the magnetic field of the induced current since the flux is changing as the permanent magnet is getting closer. This repulsion is explained by Lenz’s law.

EMI5A—WWT1: WIRE COILS AND MOVING MAGNETS

What, if anything, is wrong with the following situation? If something is wrong, identify it and explain how to correct it. If nothing is wrong, explain why the situation works the way it does.

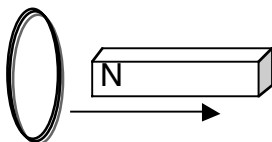


A student says: *“If I hang a circular coil of wire from a thread and then bring a permanent magnet up to the coil, the coil will be repelled by the moving magnet.”*

The statement is correct since the coil experiences a repulsive force. This is due to the magnetic field of the induced current since the flux is changing because the permanent magnet is getting closer. This repulsion is explained by Lenz’s law.

EMI5A—WWT2: WIRE COILS AND MOVING MAGNETS

What, if anything, is wrong with the following situation? If something is wrong, identify it and explain how to correct it. If nothing is wrong, explain why the situation works the way it does.

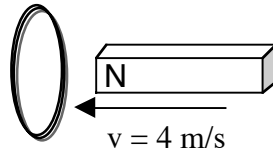


A student says: *“If I pull a permanent magnet out from the center of a hanging circular wire loop, the loop will try to follow the magnet because of the induced magnetic field opposing the change.”*

The statement is correct since the coil experiences an attractive force. This is due to the magnetic field of the induced current since the flux is changing because the permanent magnet is getting farther away. This attraction is explained by Lenz’s law.

EMI5A—TT1: WIRE COILS AND MOVING MAGNETS

Explain what is wrong with the following situation.

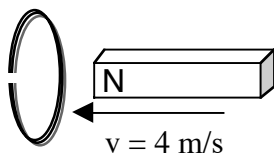


A student says: *“If I bring a permanent magnet up to the center of a circular wire loop that is hanging from a thread, the loop will swing toward the magnet because the induced magnetic field will oppose the field of the magnet, and the two fields will attract.”*

The loop will swing away from the magnet moving in, not toward the magnet.

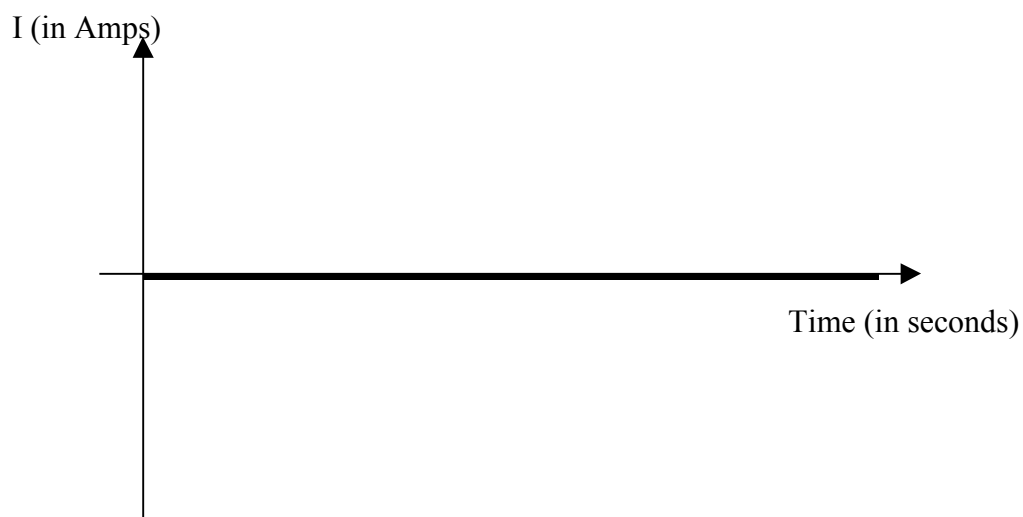
EMI5A—CRT1: WIRE COILS AND MOVING MAGNETS

A circular coil of wire with a small gap is suspended from a thread. A permanent magnet is moved up to the center of the coil.



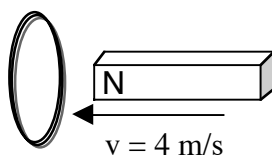
Graph the current in the loop versus time for the interval while the magnet is approaching the coil. Explain fully.

The current will be zero due to the gap in the coil.



EMI5A—LMCT1: WIRE COILS AND MOVING MAGNETS

A circular loop of wire is hung from a thread. Then a permanent magnet is brought up toward the center of the circular loop with the North Pole of the magnet on the side near the loop. The situation is shown in the figure below. The loop of wire swings away from the magnet.



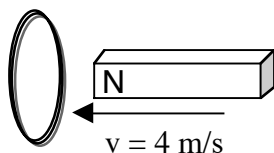
Listed below are a number of changes in this basic situation. (All of these changes are modifications of the basic case above.) **For each, identify how the change will affect the behavior of the loop.** The possible choices for how the change will affect the loop are:

- (a) The loop will swing away from the magnet faster than the base case above.
- (b) The loop will swing away from the magnet slower than the base case above.
- (c) The loop will swing toward the magnet.
- (d) There will be no change in the behavior of the loop.
- (e) The loop will not move in this case.

- 1) The magnet is moved toward the loop twice as fast. _ **A** _
- 2) A small gap is cut in the loop. _ **E** _
- 3) The opposite pole of the magnet is closer to the loop. _ **A** _
- 4) The loop is made of plastic rather than metal. _ **E** _
- 5) The strength of the magnet is doubled. _ **A** _
- 6) The magnet with the North Pole still near the loop is moved away from the loop. _ **C** _
- 7) The speed of the approaching magnet is reduced. _ **B** _

EMI5A—PET1: WIRE COILS AND MOVING MAGNETS

A circular loop of wire is suspended from a thread so that it hangs freely. A permanent bar magnet is moved up toward the center of the wire loop as shown in the figure below.



The North Pole of the magnet is on the side nearer the wire loop. When this is done, the wire loop swings away from the magnet.

If we start with the magnet in the center of the wire loop and quickly pull it out of the loop, what will the loop do and why?

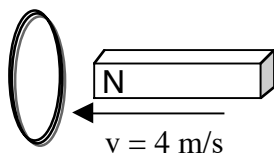
The loop will experience an attractive force due to Lenz's law and swing toward the magnet.

If we move the magnet up to the loop with the South Pole nearer to the loop, what will happen and why?

The loop will experience an repulsive force due to Lenz's law and will swing away.

EMI5A—QRT1: WIRE COILS AND MOVING MAGNETS

A circular loop of wire is suspended from a thread so that it hangs freely. A permanent bar magnet is moved up toward the center of the wire loop as shown in the figure below.



Describe how each of the following changes affects the behavior of this system.

The magnet is moved toward the loop at twice the speed.

The loop will experience a larger repulsive force and thus move more.

A gap is cut in the wire loop.

The loop will not experience any effect due to the magnet.

The opposite pole of the magnet is on the side of the magnet closer to the loop.

The loop will experience the same repulsive force and thus move away at about the same rate.

The North Pole is moved up to the loop from the opposite side from the left in the figure.

The loop will experience the same repulsive force and thus move away at about the same rate.

The strength of the magnet is tripled.

The loop will experience a larger repulsive force and thus move more away.

The magnet is moved away from the loop.

The loop will experience an attractive force and thus move about the same as before but toward the magnet.

EMI5A—CODT1: WIRE COILS AND MOVING MAGNETS

A circular wire loop is hung from a thread and a permanent magnet is brought up to the center of the loop with the North Pole of the magnet on the side near the loop. Students observe that the loop swings away from the magnet. Then the magnet is carefully, and slowly, inserted into the loop so that the North Pole is just within the loop. The students are told that the magnet is going to be pulled out of the loop quickly.

What will the loop do when the magnet is removed? Explain.

It will swing toward the magnet that is pulled out due to interaction between the induced magnet field and the field of the permanent magnet (Lenz's law).