Copper Tube Race

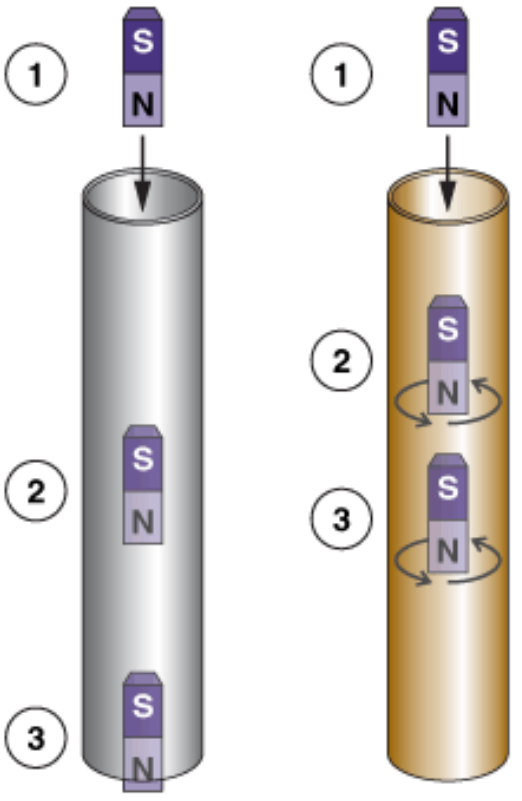
Get a copper tube about 2 feet long and a piece of plastic PVC pile the same size. Get at least 2 round **neodymium** magnets with a diameter just smaller than the opening in the copper tube. I got all of these at a local hardware store. Be sure the magnet is the stronger neodymium magnet. The principal is the same but the effect is not as good with the regular ones.

Step 1. Show the students the two pipes. Show them that neither the plastic or copper tubes attract a magnet. Neither are magnetic. Try not to get the two magnets close to each other. They are very strong and hard to get apart.

Step 2. Have two students each hold one of the pipes in front of them facing another student. The top opening of the pipe should be about chest height. Have them hold the pipe in1 hand and put their second hand below the pipe to catch the magnet when it drops. Have the pipes at the same height and as vertical as possible.

Step 3. Have 1 student hold their magnet over the top opening of the plastic pipe and the other student hold their magnet over the top opening of the copper pipe. At the count of 3 have each student drop **(not throw)** their magnet down the tube. The magnet in the copper tube will take a significantly longer time to fall out the bottom then the same magnet in the plastic.

Do to several time with different students. Let student look down the copper pipe and watch the magnet fall. It is a weird sight to watch and raises the question, **WHY?**



How to Make it More Like a Trick

No matter what you do this is less a trick and more a science demonstration. Almost no student knows the science behind the trick so it is still amazing to most of them. Even when you give a basic explanation it is still interesting to look down the tube and watch the magnet drop at such a slow speed. One internet links on u tube had several million viewers so it is a high interest effect.

I get 1 **neodymium** magnet and put a round dot sticker on the top and bottom. They are the same color and I trim them to fit the top and bottom. I then get several washers that same diameter as the magnet and stack them 5 or 6 high. I use a glue gun to out glue in the middle to stick the washers together and fill the hole. I then put a round dot sticker on the top and bottom that hides the whole.

neodymium magnet with a dot sticker on top and the bottom

A stack of washers the same diameter as the magnet glued together with a dot sticker on top and the bottom

I show show 2 copper tubes with the same size opening and same length. I then show the two objects, 1 is the magnet and the other is the stack of washers. I tell the students that we are going to drop one object down one of the copper tubes and the other smaller object down the other tube.

I show them the small object first and then the larger one. I select 2 students and I ask one which of the 2 objects do they think will drop the fastest. They almost always choose the large stack. I then let that student select the tube they think will be fastest. After they choose I say " I think that tube will be the fastest." I am trying to get them to think of the tube as the factor in speed.

I then have 1 student hold their small object over the top opening of their copper pipe and the other student hold their stack of washers over the top opening of their copper pipe. At the count of 3 have each student drop **(not throw)** their objects down the tube. The magnet will take a significantly longer time to fall out the bottom of it's tube then the stack of washers.

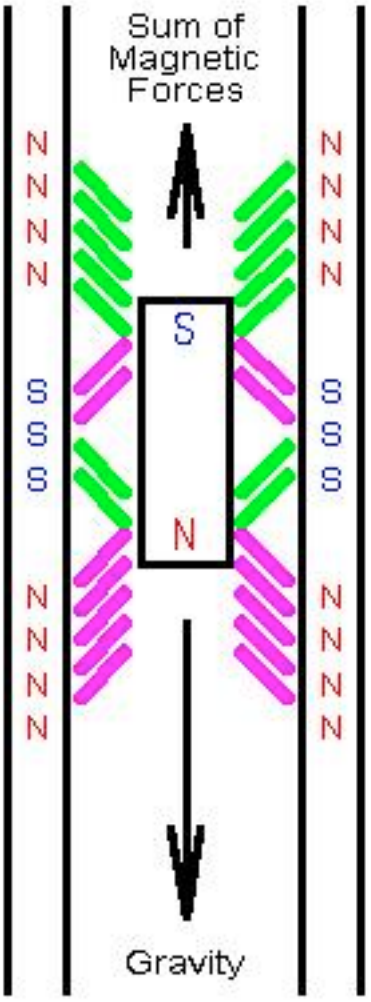
Let student look down the copper pipe and watch the magnet fall. It is a weird sight to watch and raises the question, **WHY?**

Whats Happening

Lenz's Law: Magnet Through a Copper Tube

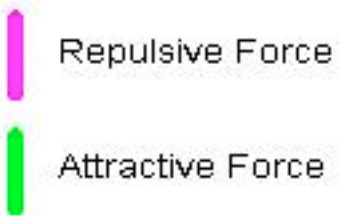
An interesting thing happens when magnets and copper pipes interact, which is strange, because copper isn't magnetic! The effect involves induction. The falling magnet induces a second magnetic field around the copper pipe called an eddy current. This is like an eddy currant by a river bank where you can see the water flowing back up stream. A raft in the eddy current is pushed back upstream This happens with the magnet and the copper pipe. The effect was discovered by a man named Lenz.

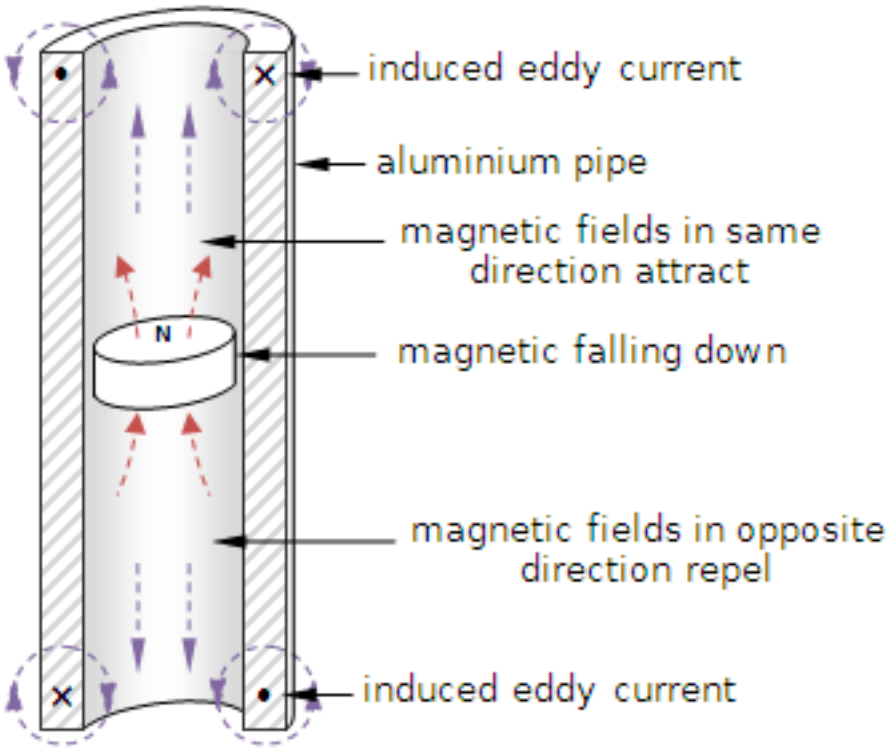
The basic explanation is that when a current is induced in a conductor, a magnetic field is generated that opposes the action that produces the current. The falling magnet induces an eddy current in the copper pipe, which in turn produces a magnetic field. The direction of this current opposes the change in the magnet's field, resulting in the magnet being repelled and thus falling more slowly.



Lenz's Law states that the direction of a magnetic induction effect is to create a force that opposes the cause of the effect. The magnet falling down through the conductor creates an induction effect. The induction creates eddy currents. These currents move in an opposite direction of the magnets movement. These magnetic currents creates a force that oppose the fall.

When the magnet is dropped down a conducting copper pipe it feels a resistive force. This slows up the rate the magnet falls.




induced eddy current
aluminium pipe
magnetic fields in same direction attract
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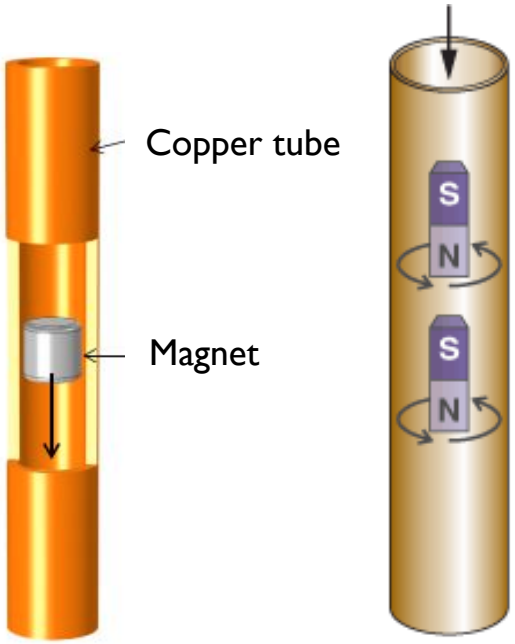
magnetic falling down
magnetic fields in opposite direction repel
induced eddy current


Copper tube
Magnet
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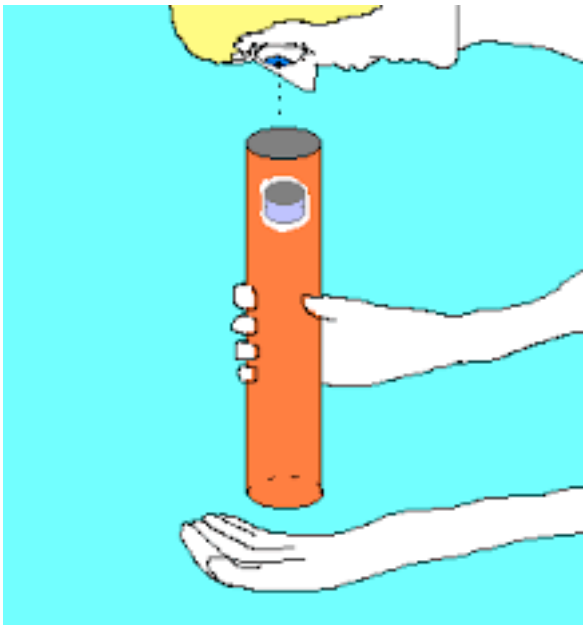
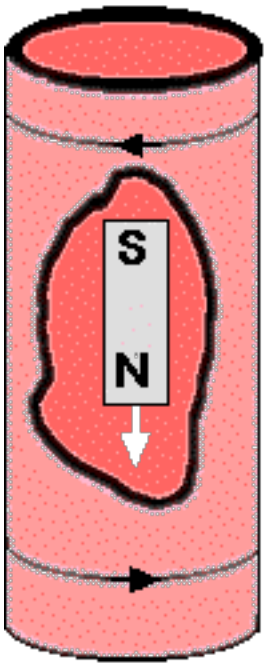
N
S
N

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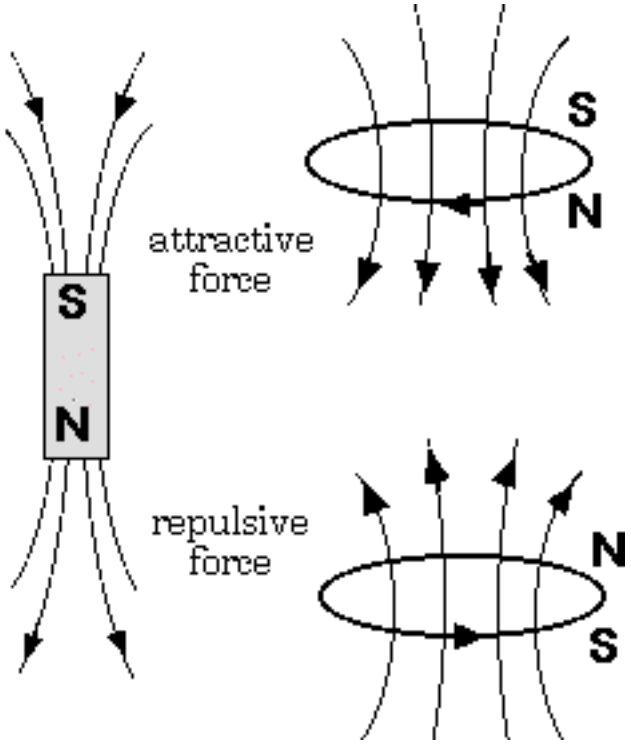
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attractive
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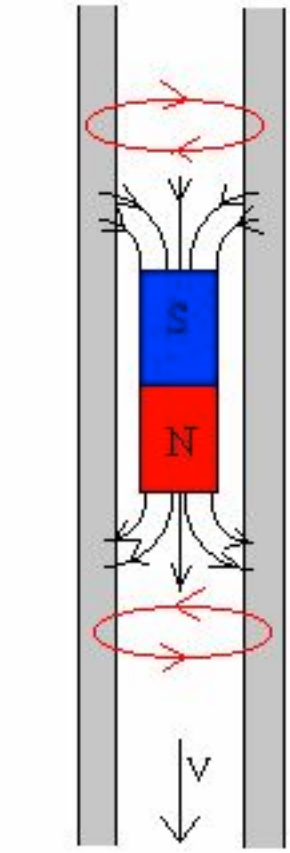
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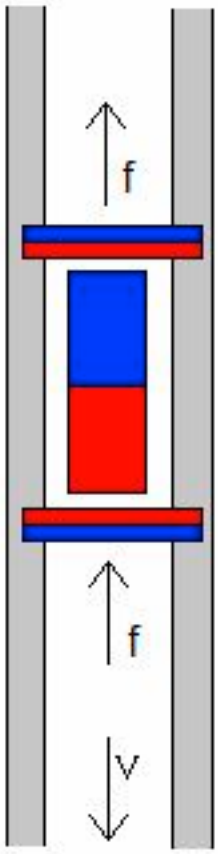
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