The Curiosity Guide

Subject: Magnetism

Investigation: 01

Season 1 Ep. 5 (#105)

Slow Poke Magnet

Description:
Magnetism vs Gravity. Who wins?

Materials:
3/4 inch copper pipe or tube of aluminum foil (24 inches long)
3 small neodymium magnets that fit just inside the copper pipe by diameter
Cushion
3/4 inch PVC tube or plastic conduit (24 inches long)
Stopwatch
Aluminum cookie sheet

Procedure:
1) Hold the magnet 24 inches above the cushion and predict what will happen when the magnet is released
2) Drop the magnet through the plastic tube and time how long it takes to fall through
3) Demonstrate that the magnet does not stick to the copper and discuss that copper is nonmagnetic
4) Drop the magnet through the copper tube and time its travel through the tube
5) Predict what could cause the delayed drop
6) Repeat by dropping both magnets at the same time through the different tubes and notice the differences

My Results:

Explanation:
This phenomenon is known as Lenz's Law. Moving a magnetic field beside a metal that is nonmagnetic causes the electrons in the metal to move in an attempt to eliminate the magnetic field. As the electrons rearrange it stimulates an electric field and a new magnetic field in the copper. The magnet is then attracted to the new field and begins to slow down gravity's effect on it falling through the tube.

Variation with Cookie Sheet:
Place the magnet on the cookie sheet to demonstrate that it is not magnetic. Place the magnet on one side of the cookie sheet and lift it up so that it can slide down. Observe that it does not slide down easily. Again, the magnet's field caused the electrons in the cookie sheet to move causing an electric and magnetic field that attracted the magnet and created resistance.

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Investigation: 02

Season 1 Ep. 5 (#105)

Attraction and Repulsion

Description:
Feel the power of magnets!

Materials:
Variety of magnets
4-5 ceramic ring magnets
Pencil or wooden dowel
Paper clips

Procedure:
1) Gather a variety of magnets
2) Using powerful magnets, feel both the attractive force and repelling force
3) Hold the base of a wooden pencil and stack up several ceramic ring magnets rotating them so that each repels above the next
4) Experiment with the magnets and the number of paper clips they can attract

My Results:

Explanation:
While magnets are used extensively and used for a variety of purposes, they come in many shapes, and are also produced in various combinations of ferrous and nonferrous materials. Materials include ceramic, alnico, which combines aluminum with nickel and cobalt, as well as cobalt, samarium, and neodymium, often referred to as rare earth magnets and are incredibly strong. Magnets will attract to materials such as iron (in the paper clips), cobalt, and nickel.

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Subject: Magnetism

Investigation: 03

Season 1 Ep. 5 (#105)

Chaotic Pendulum

Description:
Make a magnet do strange things.

Materials:
Ring stand
Clamp
7 ceramic ring magnets
String

Procedure:
1) Stack three pairs of magnets with the same pole facing up in a triangle on the base of the ring stand
2) Slide the stacks to form an equidistant triangle with each stack about two inches apart
3) Tie a string around the seventh ring magnet and suspend it from the ring stand so that it can freely swing very closely to the magnets on the base
4) Push the pendulum and observe the motion
5) Experiment by moving the magnet stacks to effect the swing

My Results:

Explanation:
As the magnet pendulum swings its motion is the result of a combination of the first push, gravity, attraction, and repulsion making the predictability of the swing direction difficult to guess. This is referred to as chaotic motion, and by moving the base magnets around the pendulum will alter its complex motion in distinctly unique ways.

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The Curiosity Guide

Subject: Magnetism

Investigation: 04

Season 1 Ep. 5 (#105)

Magnetic Cash

Description:
Did you know money is magnetic?

Materials:
Dollar bill
Strong neodymium magnet

Procedure:
1) Hold one end of the dollar bill
2) Bring the strong neodymium magnet near the other end of the bill and observe
3) Infer that there is a magnetic material in the bill

My Results:

Explanation:
In order to make counterfeiting of United States currency that much more difficult, iron is added to the ink making the ink itself magnetic. Neodymium magnets are exceedingly strong. In addition to neodymium, they also contain, boron, iron and traces of other metals and with their powerful magnetic field they can attract the ink in a dollar bill or the iron in a box of Total cereal.

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The Curiosity Guide

Subject: Magnetism

Investigation: 05

Season 1 Ep. 5 (#105)

Levitating Paper Clip

Description:
Make a paper clip float, and see what makes it fall.

Materials:
Paper cup
Stand to hang the cup
Neodymium magnet
String
Tape
Book

Thin pieces of:
- Wood
- Plastic
- Paper
- Glass
- Cardboard
- Aluminum foil
- Copper
- Steel sheet metal

Procedure:
1) Suspend the cup from a stand with string
2) Place a powerful neodymium magnet inside the cup
3) Tie a second string to the paper clip
4) Attach the clip to the underside of the cup and stretch the sting toward the base of the stand and either tape it or tie it in place so that the clip is levitating in the air drawn to the cup in the magnet with space in between
5) Notice how the magnetic field extends through the cup and the air to attract the clip
6) Using a variety of materials, predict and then test what materials the magnetic field can pass through
7) Save the steel sheet until last
8) Experiment if the field can go through someone's hand or a book

My Results:

Explanation:
The levitating paper clip demonstrates the power of the invisible magnetic field. By placing objects in between the cup and the paper clip, you can see that the magnetic field travels through most materials but will be blocked by the steel sheet. In that case, and when trying any magnetic material, the force is disrupted and the paper clip falls.

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The Curiosity Guide

Subject: Magnetism

Investigation: 06

Season 1 Ep. 5 (#105)

Magnetic Fields

Description:
Make the invisible, visible.

Materials:
4 bar magnets
Iron filings
Small piece of clear plastic, Plexiglas, or glass

Procedure:
1) Lay out the bar magnets in two pairs with one pair having opposing poles near one another and the second pair with like poles facing each other
2) Lay the piece of clear glass on top of the magnets
3) Lightly sprinkle the surface with iron filings to demonstrate the magnetic field

My Results:

Explanation:
As mentioned, each magnet has two poles, a north and a south, with the magnetic field emanating from the north end and circling around to the south. Demonstrating those lines of force with the magnets and iron filings helps understand the concept. When the iron filings are sprinkled near the magnet their domains align with the lines of force encircling the magnet making it clear that those opposite poles therefore have energy stemming from the north end and reentering at the south. Opposite poles attract to one another and similar poles repel. It is also assumed impossible to have a single pole magnet, for even a broken magnet will have two resulting poles.

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Making a Compass

Description:
Make the invisible, visible.

Materials:
4 bar magnets
Iron filings
Small piece of clear plastic, Plexiglas, or glass

Procedure:
1) Lay out the bar magnets in two pairs with one pair having opposing poles near one another and the second pair with like poles facing each other
2) Lay the piece of clear glass on top of the magnets
3) Lightly sprinkle the surface with iron filings to demonstrate the magnetic field

My Results:

Explanation:
As mentioned, each magnet has two poles, a north and a south, with the magnetic field emanating from the north end and circling around to the south. Demonstrating those lines of force with the magnets and iron filings helps understand the concept. When the iron filings are sprinkled near the magnet their domains align with the lines of force encircling the magnet making it clear that those opposite poles therefore have energy stemming from the north end and reentering at the south. Opposite poles attract to one another and similar poles repel. It is also assumed impossible to have a single pole magnet, for even a broken magnet will have two resulting poles.

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The Curiosity Guide

Subject: Magnetism

Investigation: 08

Season 1 Ep. 5 (#105)

Opposing Grapes

Description:
Some things are magnetic, and some are just the opposite.

Materials:
2 grapes
Straw
Push pin
Film canister or plastic spool
Neodymium magnet

Procedure:
1) Carefully press the push pin through the top of the film canister so that to point of the pin protrudes out of the top of the canister
2) Put the lid on the canister with the pin poking up
3) Cut a notch out of one side of the center of the straw (.5 x 1 cm)
4) Skewer the grapes on either end of the straw
5) Carefully perch the straw on the head of the pin within the notch and adjust so that the grapes are relatively balanced and there is little friction on the head of he pin
6) Lift the neodymium magnet and bring it toward one of the grapes
7) Observe that the grape begins to repel
8) Turn the magnet over and bring it near the grape once more
9) Again notice that the grape repels that pole as well
10) Hypothesize as to the cause

My Results:

Explanation:
Diamagnetic material includes metals like lead, gold, copper, silver, bismuth, and nonmetal materials like water and organic materials. In each case these materials will repel away from both poles of a magnet, but because the repulsion is so weak (100,000 times weaker than a magnetic attraction force), it is generally difficult to observe naturally. In this case the water in the grapes is diamagnetic. While ferromagnetic materials have atoms that spin in alignment within their domains leaving a net magnetic field and will readily shift when approached by a magnet, diamagnetic materials have pairs of atoms that spin in opposition eliminating a magnetic field and resist any change in their orbital current. As a result, there is a weak repulsion from the diamagnetic water in the grapes to the introduced magnetic field.

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Making a Magnetic Acclerator

Description:
Your own miniature amusement park ride.

Materials:
12 inch ruler with a groove (to serve as a track)
9 steel balls (5/8" diameter)
4 cube neodymium magnets (1/2" cubes)
Duct tape
Scissors
Target object (not something fragile)
Safety glasses

Procedure:
1) Place the ruler on the table so the groove faces up
2) Put one of the magnets so that it is 2 ▯ inches from the zero end of the ruler
3) Cut a narrow strip of duct tape with the scissors and tape the magnet to the ruler
4) Space the remaining neodymium magnets so that there are 2 1/2 inches between each and secure each to the ruler with tape
5) To the right of each magnet, place two of the steel balls
6) Place target on the floor in front of the ruler
7) Put on safety glasses
8) Hold the ninth ball on the zero end of the track and release
9) Observe the chain reaction and the launch of the final marble
10) Experiment with different placements of the magnets on the ruler, as well as the number of balls used

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(Part 2)

Making a Magnetic Acclerator

My Results:

Explanation:
The transfer of energy through the balls is the first noteworthy observation. The first ball has potential energy between it and the magnet, which converts to kinetic energy when it is released. As each ball strikes the magnet on the left, the energy passes through the magnet and through the ball to its right launching the second ball to the right toward the next magnet in the series with the same input energy (energy conservation). However, with each stage, the velocity of the steel ball increases. This is because each magnet's attraction to the ball adds to the speed that it carried from the first stage. As a result each time the marble is launched to the next magnet, it carries the same input energy then adds kinetic energy from the attracting magnet increasing its velocity with each step. By adding additional magnets in a continual series, greater speeds can be achieved, however, at some point the energy will be so great that it will destroy the magnets. The concept of magnetic acceleration is already used in amusement park rides with a series of electromagnets working in sequence to quickly accelerate passenger cars. There is also interest in harnessing similar technology as a launch system from the moon sending things into space.

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