Math "Magic" Card Trick 1

STEM
DEMO
KIT

Inventory:

1 full deck of cards

Directions:

1) Shuffle a full deck of 52 cards.
2) Deal the cards out into piles.
3) Have a person select three of the piles and turn them over.
4) Have the person select the top card from one of the piles.
5) Perform the rest of the trick and "mathemagically" tell them which card they selected.

Math “Magic” Card Trick 1 - What the heck? – FOR PRESENTERS EYES ONLY

After shuffling the cards, place the top card on the table face up. Unless the card is a King, place other cards on top of the first card, also face up, and count from the first card’s value up to 13. For instance, if you turn up a 9, you would put four cards on top of it face up as you say to yourself 10, 11, 12, 13. Remember that Jacks are worth 11, Queens 12, and Kings 13.

Once the pile is complete, put the next card face up in a new pile. Repeat the same procedure counting up from that card’s value to 13. So, if the second pile starts with a 6, you would put 7 cards on top as you count in your head – 7, 8, 9, … 13. Keep building piles in this way until you get low on cards. If you miscalculate and don’t have enough cards to complete the last pile, just pick it back up.

Now have someone select three piles and turn them over. Collect the remaining piles that are still face up. Have the person then take the top card off one of the piles. They should not show you this card as you are going to figure out the value of it using mathemagic.

Turn over the top cards on the two piles the person did not take. Add these together remembering again the values for a Jack, Queen, and King if necessary. Now, from the cards you have in your hand, count out the number of cards equal to the sum plus another ten. So, if the top two cards are 3 and 8, you would count out 11 + 10 or 21 cards. Then count the remaining cards you still have in your hand and you have the value of the card the person selected. And again, if it is 11 – they have a Jack and so on.

Math “Magic” Card Trick 2

STEM
DEMO
KIT

Inventory:

1 full deck of cards

Directions:

1) Select out just the cards 1-9 from one of the decks.
2) Shuffle the cards and have a person select a card. They should look at the card but not show it to you.
3) Perform the trick and “mathemagically” tell them which card they selected.

Math “Magic” Card Trick 2 - What the heck? – FOR PRESENTERS EYES ONLY

After the person has selected their card, start setting the leftover cards out face up one at a time in different piles. As you see pairs of cards that add up to ten, cover them both with new cards you are laying out face up. When you have placed all the cards out face up, collect the piles that add up to ten. You will have one unpaired card. Subtract the face value of that card from ten and you will know what the value of the card they selected at the beginning. You can also just scan the piles and look for the one that does not have a “buddy” that adds up to ten.

Variations:
1-10 – use the cards 1-10. If a ten turns up on one of the piles immediately cover it with another card face up. If all the piles at the end have a “buddy” that adds up to 10, then the card selected by your participant was a ten. Otherwise, the trick remains the same.

Full Deck – use the entire deck. Instead of covering pairs that add up to 10, cover pairs that add up to 14 with the Jack representing the number 11, Queen 12, and King 13. Everything remains the same as the original trick only now the magic number is 14 and not 10.

Full Deck Version 2 – Use 13 as your magic number and cover Kings immediately. If you can switch back and forth between the two full deck versions of this trick, you can really keep people guessing.

Math "Magic" Card Trick 3

STEM
DEMO
KIT

Inventory:

1 full deck of cards

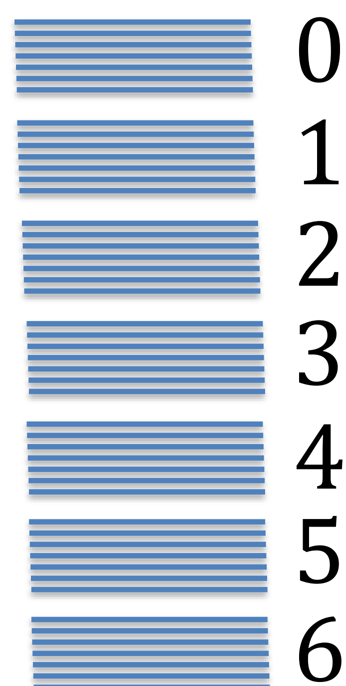
Directions:

1) Remove THREE cards from the deck so you only have 49 cards. It does not matter which three you remove.
2) Shuffle the 49 cards.
3) Have a person select a card from the deck, look at it, remember the card, and then return in anywhere into the deck without you seeing it.
4) Have the person select their favorite number between 1-49.
5) Ask the person to watch for their card as you deal the deck out into 7 piles.
6) Once done, have the person indicate which pile their card is in, then pick up the piles.
7) Repeat the seven piles process again and have the person indicate which pile their card is in.
8) Now, pick up the piles and then count out until you get to the number they selected and VOILA – that is the card they had selected at the beginning.

Math "Magic" Card Trick 3 - What the heck? – FOR PRESENTERS EYES ONLY

After the person has selected and returned a card, which they will remember, and selected a number between 1-49, you have to do a little simple math. Take the number they have selected, subtract ONE and then divide that number by SEVEN. This trick relies on the mathematics of base 7 numbers – NOTE: $7^2 = 49$. So, if the person selected 26 for their number, you would subtract ONE to get 25 and then divide by SEVEN to get a quotient of 3 with a remainder of 4. The remainder (4 in our example) will be important for the first deal. The quotient (3 in our example) will be important in the second deal.

Now, deal out the 49 cards into seven piles face up. Be sure to tell the person to watch for their card so they can tell you at the end which pile it is in, but not before you are done dealing out all the cards. Lay out seven cards face up and then start over covering up the first layer with the next, also face up, until you run out of cards. Ask them which pile their card is in. Now, being sure the pile which contains their card is in the right order is critical. You can work on the showmanship later. The remainder in our example was 4. So, we need the pile they indicated to be in position 4 in the layers indicated to the right. Pick up their pile and turn it over. Then, pick up four piles and turn them over on top of the pile containing their card. The last two piles you will turn over and place on the bottom of the deck.



Repeat dealing out seven piles face up with the person watching for their card. It is really important that you lay out seven piles and then start back at the beginning to cover them up in the same order. Then, have them indicate which pile contains their card. Now, the quotient (3 in our example) is important. Pick up their pile and turn it over. Then, pick up three piles and turn them over on top of the pile containing their card. The last three piles you will turn over and place on the bottom of the deck.

Now, count out cards from the top of the deck face down until you get to 25. The 26th card will be the card they selected at the very beginning – VOILA!

You can also do this trick with 36, 25, or 16 cards using base 6, 5, or 4 respectively. This is an easier way to work students into the full 49 card version. Just adjust the number of piles in each deal to 6, 5, or 4.

Math "Magic" Card Trick 4

STEM
DEMO
KIT

Inventory:

1 full deck of cards

Directions:

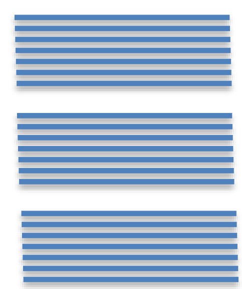
1) Shuffle one of the full decks of 52 cards and count out 27 cards to use for this trick. Place the rest to the side and out of the way.
2) Have a person select a card from the deck of 27, look at it, remember the card, and then return in anywhere into the deck without you seeing it.
3) Have the person select their favorite number between 1-27.
4) Ask the person to watch for their card as you deal the deck out into 3 piles.
5) Once done, have the person indicate which pile their card is in, then pick up the piles.
6) Repeat the three piles process again and have the person indicate which pile their card is in.
7) Once done, have the person indicate which pile their card is in, then pick up the piles.
8) Repeat the three piles process a third time and have the person indicate which pile their card is in.
9) Now, pick up the piles and then count out until you get to the number they selected and VOILA – that is the card they had selected at the beginning.

Math “Magic” Card Trick 4 - What the heck? – FOR PRESENTERS EYES ONLY

After the person has selected and returned a card, which they will remember, and selected a number between 1-27, you have to do a little simple math. Take the number they have selected, subtract ONE and then divide that number by NINE. You will get a quotient and a remainder. Divide the remainder by THREE to get a quotient and a remainder. This trick relies on the mathematics of base 3 numbers – NOTE: $3^3 = 27$. So, if the person selected 16 for their number, you would subtract ONE to get 15 and then divide by NINE to get a quotient of 1 with a remainder of 6. Now, take that remainder (6) and divide by THREE, which give you a quotient of 2 and a remainder of 0. The remainder (0 in our example) will be important for the first deal. The quotient from dividing by THREE (2 in our example) will be important in the second deal. The original quotient from dividing by NINE (1 in our example) will be important in the third deal.

Now, deal out the 27 cards into three piles face up. Be sure to tell the person to watch for their card so they can tell you at the end which pile it is in, but not before you are done dealing out all the cards. When dealing out piles, be sure to lay out three cards face up and then start over covering up the first layer with the next, also face up, until you run out of cards.

Ask them which pile their card is in. Now, being sure the pile which contains their card is in the right order is critical. You can work on the showmanship later. The final remainder in our example was 0. So, we need the pile they indicated to be in position 0 in the layers indicated to the right. Pick up their pile and turn it over. Then, pick up the other two piles, turn them over, and place them below the pile they indicated.



0
1
2

Repeat, dealing out three piles face up with the person watching for their card. It is really important you lay out three piles and then start at the beginning to cover them up in the same order. Then, have the person indicate which pile contains their card. Now, the second quotient when we divided by THREE (2 in our example) is important. Pick up their pile and turn it over. Then, pick up the other two piles, turn them over, and place them on top of the pile they indicated. Repeat dealing out three piles one last time. For the last deal, the quotient from when we divided by NINE is important (1 in our example). So, pick up the pile they indicate and turn it over. Then place one pile on top of it and the other below it.

Now, count out 15 cards face down. The 16^{th} card you can flip face up and it should be the card they selected at the very beginning – VOILA!

You can see this trick demonstrated and explained in detail here: http://bit.ly/Base3CardTrick

Static Levitator

Inventory:

A balloon

Produce Bags

Scissors

Cotton Towel

Directions:

1) Cut a loop off the produce bag that is about an inch wide.
2) Blow up and tie the balloon.
3) Charge both the loop of plastic bag and the balloon using either the cotton towel or your hair.
4) Hold the balloon in one hand and have another person drop the charged plastic bag loop on top of it from about a foot above.
5) Move the balloon around to keep the loop levitating.

EXTENSIONS:

What other objects can you use to levitate the plastic bag loop?

Are there other shapes, besides a loop, that you can levitate?

Source: http://www.stevespanglerscience.com/lab/experiments/static-flyer-flying-bag/

Static Levitator - What the heck?

Rubbing the towel against the balloon and the plastic band transfers a negative charge to both objects. The band floats above the balloon because the like charges repel one another. If you really want to impress someone, just tell them that it's a demonstration of "electrostatic propulsion and the repulsion of like charge." That should do it.

When you rub a balloon on someone's hair the balloon picks up electrons, leaving it negatively charged and the hair positively charged. Because opposite charges attract, bringing the balloon near the hair causes the hair to stand up.

When you bring a charged balloon near pieces of paper, the paper isn't charged so you might expect nothing to happen. But the paper is attracted to the balloon. Why? The negative charge on the balloon repels the electrons in the paper, making them (on average) farther from the balloon's charge than are the positive charges in the paper. Because electrical forces decrease in strength with distance, the attraction between the negatives and positives is stronger than the repulsion between the negatives and negatives. This leads to an overall attraction. The paper is said to have an induced charge. This explanation applies to a charged balloon sticking to a wall and a charged balloon attracting other uncharged objects.

WTH Source: http://www.stevespanglerscience.com/lab/experiments/static-flyer-flying-bag/

Two Circles to a Square

Inventory:

Paper Strips (about 1” x 11”)

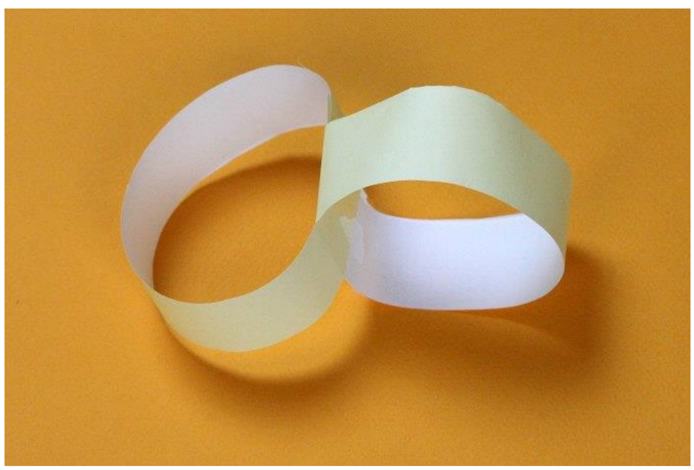
Tape

Scissors

Directions

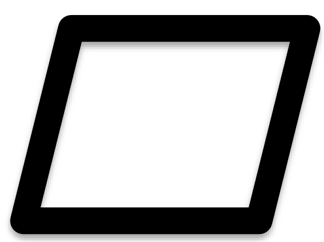
1) Tape two strips of paper together into the two connect loops as shown. Use plenty of tape to secure them.

CHALLENGE: Using only scissors, cut these two circles into a square selfie frame big enough to fit your face into!



BONUS CHALLENGE 1: Can you start with two circles and wind up with a rectangle that is not a square?

BONUS CHALLENGE 2: Can you start with two circles and wind up with a rhombus that is not a square?



Two Circles to a Square - What the heck?

Pinch one circle and start a cut down the middle of it. Open it up and cut around the middle of the entire circle, including through the middle section where the two loops are taped together. Cut the remaining strip of paper down the middle and you have a square!

Notice the CIRCUMFERENCE of the circles became the LENGTH of the sides of the square!

Source: http://www.whatdowedoallday.com/2015/06/geometry-magic.html

Impossible Paper Trick

Inventory:

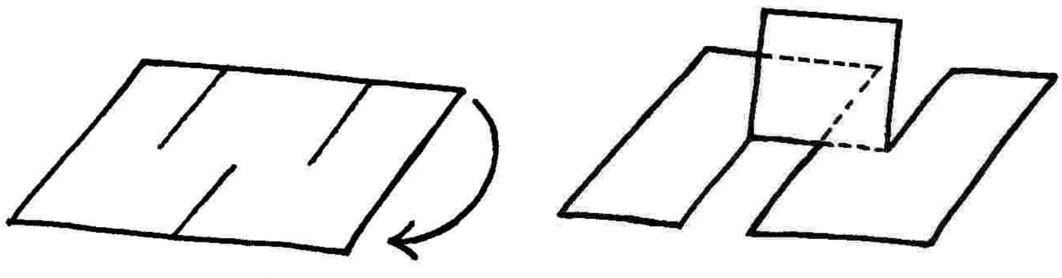
Small Rectangular Pieces (about 1½" x 3")

Scissors

CHALLENGE: Take one small rectangle and make shape on display.

Impossible Paper Trick - What the heck?

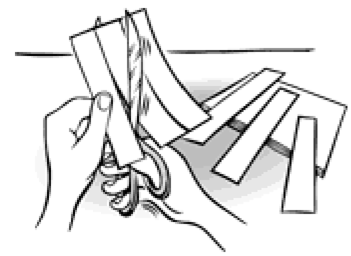
Three cuts, a twist and a couple of folds and you have it!



Source: http://www.businessballs.com/games.htm

Two Looper Airplane

Inventory:



Scissors

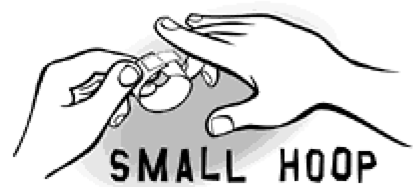
Ruler

3x5 index cards

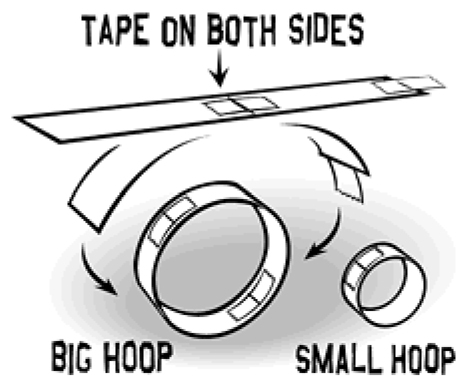
Clear Plastic Tape

Plastic Straws

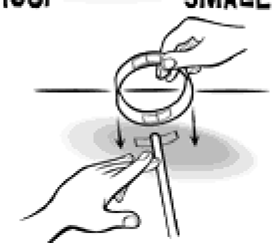
Directions:



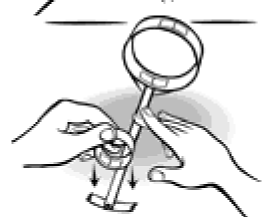
1) Cut an index card the long way into three equal strips.
2) Put a piece of tape on the end of one strip. Curl the paper into a little hoop and tape the ends together.



3) Put the other two strips end to end, so they overlap a little. Tape them together to make one long strip, and put another piece of tape on one end. Curl the strip into a hoop and tape the ends together.
4) Cut off the bendy part of the straw if it has one. Put one end of the straw onto the middle of a strip of tape. Put the big hoop on top of the straw and fold the tape up the sides of the hoop.

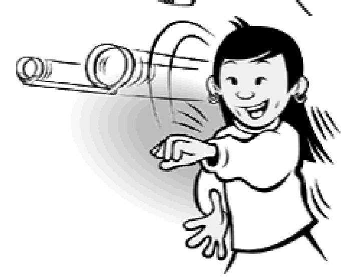


5) Put another strip of tape on the other end of the straw. Press the small hoop very gently onto the tape. Move it around until it lines up with the big hoop, then press the tape down firmly. Your Two Looper Airplane should look like the picture below.



6) Hold the Two Looper in the middle of the straw, with the little hoop in front. Throw it like a javelin and have fun flying!

EXTENSIONS: Add a paper clip to different parts of the plane to see how it affects its flight. Try more hoops, hoops of different sizes, more straws, longer straws, shorter straws, and on and on.



Two Looper Airplane - What the heck?

Can we really call that a plane? It may look weird, but you will discover it flies surprisingly well. The two sizes of hoops help to keep the straw balanced as it flies. The big hoop creates “drag” (or air resistance) which helps keep the straw level while the smaller hoop in at the front keeps your super hooper from turning off course. Some have asked why the plane does not turn over since the hoops are heavier than the straw. Since objects of different weight generally fall at the same speed, the hoop will keep its “upright” position.

Activity Source: https://www.exploratorium.edu/science_explorer/hoopster.html

Explanation Source: https://sciencebob.com/the-incredible-hoop-glider/

Radiometer

STEM
DEMO
KIT

Inventory:

Radiometer

Light source – can lamp with extra light bulb

WARNING – the lamp and light bulb can get VERY hot. Be very careful!

Directions:

1) Place the radiometer in a bright light and observe what happens.
2) Move the radiometer closer to and farther from the light source. If you are using an artificial light source, find ways to partially and completely shield the radiometer from the light source. Observe what happens.
3) CHALLENGE: Can you get the radiometer to spin the other direction while still just sitting on the table in front of the light source?
4) Read the “What the heck?” on the back of this page to learn more about what you observed.

Radiometer - What the heck?

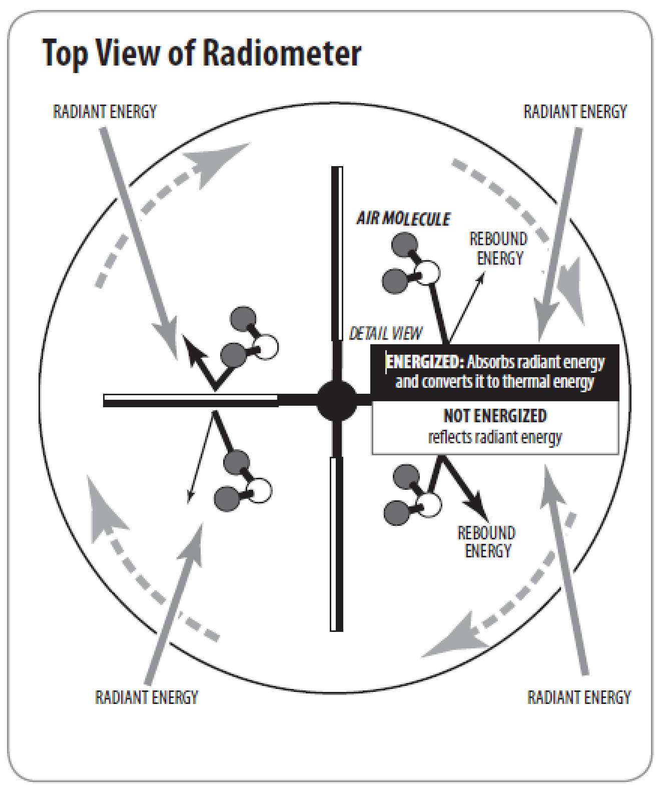
Did you realize light could make things move? In the radiometer investigation, you saw light change into thermal energy, then into motion—radiant energy into thermal energy into kinetic energy.

The radiometer has very little air inside the bulb; it is almost a vacuum. The black and white vanes are balancing on a needle. There is nothing else inside the bulb.

When you put the radiometer in the light, the vanes begin to turn. How is the light making the vanes turn? Black objects get hotter than white objects in the sun. That is why people wear light colored clothes in the summer. A black object absorbs most of the radiant energy that strikes it and reflects only a little. A white object reflects most of the radiant energy that strikes it and absorbs only a little.

When you put the radiometer in the light, the vanes absorb sunlight. The radiant energy is changed into thermal energy. The black side of the vane is absorbing more energy than the white side. When the air molecules hit the black side, they bounce back with more energy than when they hit the white side. The brighter the light, the faster the vanes turn. If both sides of the vanes were the same color, the vanes would never move because the air molecules would be bouncing off the vanes with the same amount of force.

To the right is a picture of the radiometer from the top. When the air molecules hit the white sides of the vanes, they push a little. When the air molecules hit the black sides of the vanes, they push a lot. Since there is more of a push on one side than the other, the vanes begin to turn. The more radiant energy that reaches the radiometer, the more thermal energy is transformed into motion energy, and the faster the vanes spin.



Source: The NEED Project (www.need.org) - Science of Energy Curriculum

Baking Soda and Vinegar

Inventory:

Plastic Ziploc bag

Baking Soda

Vinegar

Measuring cup

Teaspoon

Waste cup

Directions:

1) Use the measuring cup to pour 10 mL of vinegar into an empty plastic bag.
2) Feel the bag to observe the temperature of the vinegar.
3) Carefully pour a level (not heaping) teaspoon of baking soda into the bag and gently mix. (Be careful—the chemical reaction will cause foam to fill the bag.)
4) Wait 30 seconds and feel the bag to observe the temperature again.
5) Dump the contents from the back into the waste cup so the next group can reuse the plastic bag. It does not have to be completely rinsed out.
6) Read the “What the heck?” on the back of this page to learn more about what you observe.

Baking Soda and Vinegar - What the heck?

Chemical reactions occur when you mix two chemicals together to form another chemical. All chemical reactions involve the transfer of thermal energy. Some release or emit energy and some absorb or take in energy.

An exothermic reaction releases or emits energy. *Exo*- means out and *thermal* means heat. Exothermic—the heat goes out, or is released. An endothermic reaction absorbs heat. *Endo*- means in and *thermal* means heat. Endothermic—the heat goes in, or is absorbed.

This experiment was an endothermic reaction—it absorbed, or took in, thermal energy. Combining vinegar and baking soda together made other chemicals: water, carbon dioxide, and sodium acetate.

When you added baking soda to the vinegar you were able to visually see a reaction take place. The temperature of the substance also dropped, which you could tell by feeling the bag.

The mixture felt colder because the reaction was absorbing thermal energy. It was an endothermic reaction. The energy the reaction absorbed from you and its surroundings was stored in the bonds of the new chemical that was formed. The reaction took thermal energy from the mixture and transformed it into stored chemical energy.

Most chemical reactions do not take in thermal energy like the vinegar and baking soda. Most chemical reactions give off thermal energy—they are exothermic.

Source: The NEED Project (www.need.org) - Science of Energy Curriculum

Calcium Chloride and Water

Inventory:

Plastic Ziploc bag

Calcium Chloride ($CaCl_2$)

Water bottle

Measuring Cup

Teaspoon

Waste Cup

Directions:

1) Use the measuring cup to pour 10 mL of water from the water bottle into an empty plastic bag.

2) Feel the bag to observe the temperature of the water.

3) Carefully pour a level (not heaping) teaspoon of calcium chloride into the bag and gently mix.

4) Wait 30 seconds and feel the bag to observe the temperature again.

5) Dump the contents from the back into the waste cup so the next group can reuse the plastic bag. It does not have to be completely rinsed out.

6) Read the “What the heck?” on the back of this page to learn more about what you observe.

Calcium Chloride and Water - What the heck?

Chemical reactions occur when you mix two chemicals together to form another chemical. All chemical reactions involve the transfer of thermal energy. Some release or emit energy and some absorb or take in energy.

An exothermic reaction releases or emits energy. *Exo*- means out and *thermal* means heat. Exothermic—the heat goes out, or is released. An endothermic reaction absorbs heat. *Endo*- means in and *thermal* means heat. Endothermic—the heat goes in, or is absorbed.

This experiment was an exothermic reaction—it released thermal energy that had been stored chemical energy.

When calcium chloride comes into contact with ice or water, it dissolves and the calcium chloride molecules dissociate into calcium and chloride ions. The attraction between the ions and water molecules leads to an overall exothermic process. Since exothermic reactions release thermal energy that had been stored in the chemical bonds of the chemicals reacting, the temperature of the solution should have increased.

A common use for calcium chloride is driveway ice melt. You can buy driveway ice melt at your local hardware store to melt the ice on your driveway during the winter.

Source: The NEED Project (www.need.org) - Science of Energy Curriculum

Nitinol "Live" Wire

Inventory:

STEM
DEMO
KIT

2 live wires

1 clear cup

1 electric tea kettle

2 sets of tongs

Directions:

1) Twist the wire into different shapes, but do not tie it in a knot.
2) CAREFULLY drop the live wire into the hot water. Be sure you are not leaning over the cup! Observe what happens and then remove the wire using the tongs.
3) Now bend the wire in half right at the center so both ends touch. Hold one end in each hand and CAREFULLY lower the bent part of the wire into the water. Observe what you feel.
4) Read the "What the heck?" on the back of this page to learn more about what you observe.

Nitinol "Live" Wire - What the heck?

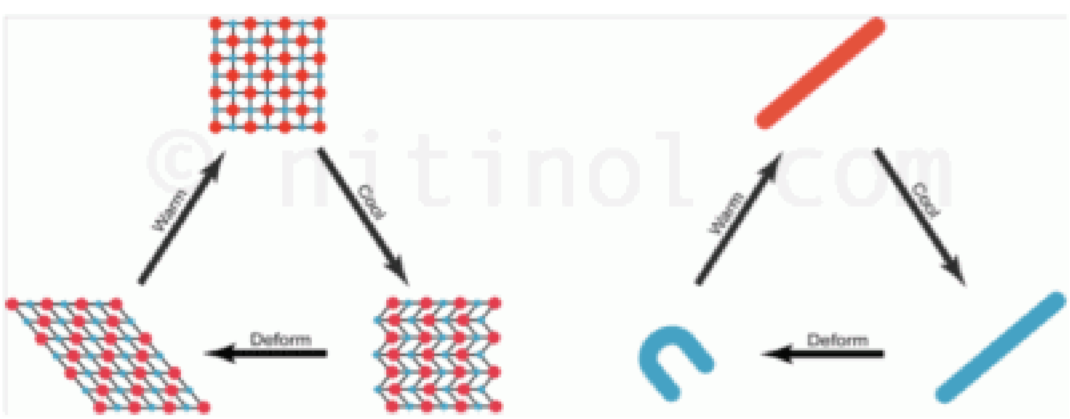
The "live wire" is a nitinol (nī-tĭn-ŏl) wire, made of nickel and titanium that has been treated in a thermal process so that it has a "memory." Most metals stay in whatever shape you put them in, but nitinol is different. Nitinol "remembers" its original shape when it is heated. Nitinol is used in space to move robot arms. It is also used to control the temperature of greenhouses. If the temperature gets too hot, a nitinol spring opens a door to let in air. Dentists use it in braces to straighten teeth. As the wires in your mouth warm, they attempt to return to their original shape, slowly moving your teeth with them.

You were able to bend and twist the original shape of the wire any way you wanted. The thermal energy in the water made the wire return to its original shape. The thermal energy was transformed into kinetic energy.

Source: The NEED Project (www.need.org) - Science of Energy Curriculum

Shape-memory alloys flip back and forth between two solid crystalline forms called Austenite and Martensite. At lower temperatures, they take the form of Martensite, which is relatively soft, plastic, and easy to shape; at a (very specific) higher temperature, they transform into Austenite, which is a harder material and much more difficult to deform. Let's say you have a shape-memory wire and you can bend it into new shapes relatively easily. Inside, it's Martensite and that's why it's easy to deform. No matter how you bend the wire, it stays in its new shape; much like any ordinary wire, it seems to be undergoing a very ordinary plastic deformation. But now for the magic part! Heat it up a little, above its transformation temperature, and it will change into Austenite, with the heat energy you supply rearranging the atoms inside and turning the wire back into its original shape. Now cool it down and it will revert back to Martensite, still in its original shape. If the material is above its transition temperature the whole time, you can deform it but it will spring back to shape as soon as you release the force you're applying.

Source: http://www.explainthatstuff.com/how-shape-memory-works.html



Source: http://www.nitinol.com/nitinoluniversity/reference-library/a-short-orientatio

Magnetized Paperclips

STEM
Demo
Kit

Inventory:

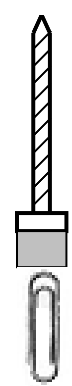
Paper Clips

2 plastic bowls (fill them with water)

2 strong rare earth neodymium magnets (on a washer for safe keeping)

Directions:

1) Fill the bowl up with water.
2) Bend one paper clip into an L shape as shown on the right.
3) Place another paperclip on the end of a neodymium magnet and hold it out straight as shown in the diagram below.
4) Place the magnetized paperclip onto the L shaped paperclip and very gently lower it into the water. Keep it completely parallel to the surface of the water.
5) The paperclip should float thanks to the surface tension of the water. (NOTE: This floating is NOT a result of magnetizing the paperclip.)
6) Now magnetize another paperclip. Do not float this paperclip, rather bring it near either end of the floating paperclip and observe what happens.



ADVANCED OBSERVATION: Did you notice that the floating paperclip points along a south/north line? It actually behave just like a compass – aligning with the Earth's magnetic field!

Magnetized Paperclips - What the heck?

The electrons in every atom are spinning, which causes them to behave like tiny magnets. In a magnet like the small cylindrical magnet you have been using in your explorations, all (or most) of the electron's spins are lined up the same way and are fixed (not able to rotate). Because the electrons in a magnet like the one you are using are fixed and not able to move around, we call it a *permanent magnet*.

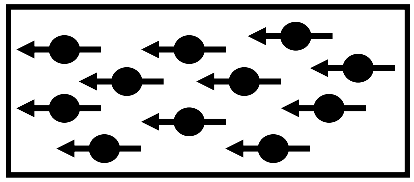


Diagram of a permanent magnet showing its electrons

NOTE: Any material that is not a magnet still has electrons in it but they all point in random directions instead of being lined up the same way.

When you magnetize a paperclip, you are causing the electrons to align and create, at least temporarily, a weak magnet. Over time, the direction of the electrons will once again become random and the paperclip will no longer behave like a magnet.

A Historical Note: The Chinese are generally credited with the discovery of this important navigational tool. There is a debate, based on an artifact found, that perhaps the Olmec people of Central America made the discovery before the Chinese. Using science along with other historic documents and artifacts, historians and scientists are trying to determine the rightful inventors. One fact is agreed upon, this navigational tool has been used since well before 1100 AD.

Star Wars Sound Machine

Inventory:

2 Metal slinky springs

2 Large foam cups

2 Small foam cups

STEM
DEMO
KIT

Directions:

1) Place the slinky on the floor so the coils are all together facing up. Place the large foam cup inside of the slinky coils and press in gently.

2) Lift the cup straight up. The end coils should come up around the center of the cup.

3) Place your hand around a few coils in the cup's middle to hold the slinky in place.

4) Bounce your hand up and down to create longitudinal waves and observe the sound vibrations echoing from the cup.

5) Repeat your hand motions at different heights—low and high—to hear the different sound vibrations and see the longitudinal waves produced. Make observations about changes and differences as you vary the motion of the cup.

6) Remove the large cup and repeat the investigation with the small cup. Make observations about similarities and differences.

Short Science Story (S^3)

The Styrofoam cup acts like sounding board when stuck into the Slinky. The Slinky vibrates when it shakes and hits the floor. The cup is forced to vibrate at this same frequency and because of its large surface area, it amplifies the sound the Slinky was making

Source: The NEED Project (www.need.org) - ??? Curriculum all along.

Star Wars Sound Machine - What the heck?

A slinky can model sound waves traveling through solids, liquids or gases. Each coil represents a molecule of the material. With a push, the coils compress against each other. The compression travels to the other end of the Slinky as a wave. Sound travels through solids, liquids and gases as a compression wave. Energy is transmitted through the coils and travels from source to receiver.

When an object begins to vibrate, the molecules next to it are compressed or pushed together. This compresses molecules further out. When the object moves back, a space in the air is created next to the object. The first molecules of air expand to fill this space, causing molecules further out to expand too. This compression and expansion of the air molecules is called a sound wave.

The Styrofoam cups in this activity act as sounding boards to amplify the vibrations from the slinky.

Source: http://www.smm.org/sound/nocss/activity/2b.htm

World's Simplest Electric Motor

Inventory:

2 Copper wires

2 Neodymium (rare earth) magnets

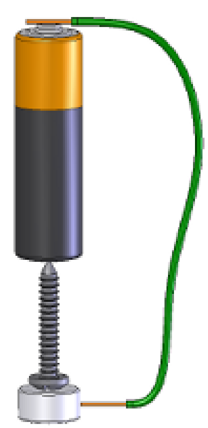
2 Screws

2 D Cell Batteries

STEM
DEMO
KIT

Directions:

1) Center the neodymium magnet on the head of the screw.
2) Hold the battery vertically with the positive (nib) end down.
3) Hang the screw, with the pointed end facing upward, from the nib of the battery. The magnet is strong enough to keep it from falling.
4) With the hand that is holding the battery, use your index finger to hold one end of the wire to the top or negative side of the battery.
5) With your other hand, take the other end of the wire and gently touch it to the side of the magnet. Observe!



OBSERVATION CHALLENGE: What happens when you set up the motor with the negative (flat) end of the battery facing down?

Short Science Story (S^3)

When the circuit is complete and electrons run through the wire, moving electrons create a magnetic field around the wire. This magnetic field pushes or repels the magnetic field of the magnet causing the screw (with very little friction) to spin. Moving electrons create a magnetic field!

World's Simplest Electric Motor - What the heck?

Magnets affect materials in one of three ways, attraction, non-attraction (neutral) and repulsion. In a homopolar motor, the flow of electrons through a wire creates a magnetic field that is in opposition to that of the disc magnet and thus is repulsed by it. This repulsion creates a tangential force called the Lorentz force that is responsible for creating the spinning motion. Dependent on which item is fixed the opposite item will spin. So in one case of this motor, the magnet is fixed and thus the copper wire spins. In another case using the magnet on the head of the screw, the copper wire is fixed and the magnet/screw spin.

Search YouTube for homopolar motor to find all kinds of variations on these designs.

Source: http://www.imagesco.com/magnetism/homopolar-wire-motor.html

You hold the current-carrying wire still, along with the battery, and the magnet and screw spin. This is fairly easy to reproduce, though there are problems with the screw slowly migrating off to the side. This problem can be solved by adding a piece of tape with a hole in it. Another solution is to hit the battery with a chisel or other sharp object to make a small indentation for the screw-point to sit in.

Source: https://www.kjmagnetics.com/blog.asp?p=homopolar-motors

Eddy Current Tube

STEM DEMO KIT

Inventory:

2 copper pipes

1 pvc pipe

2 neodymium (rare-earth) magnets

A few small pebbles

1 magnet holder (a metal ring)

Directions:

1) One person should hold the pvc (white) pipe vertically and off the table a few inches. Another person should hold the copper pipe the same way.
2) Hold the copper pipe vertically and off the table or ground a few inches.
3) Drop small pebbles through the pvc and copper pipes, releasing them at the same time, and observe what happens.
4) Now drop a magnet through the pvc and copper pipes, releasing them at the same time, and observe what happens.
5) Drop two magnets stuck together down the same pipe and make observations about similarities and differences between this experiment and the previous one. (BE CAREFUL – two strong magnets are attracted by a lot of force and can easily pinch you!)
6) Play with different variables and continue to make observations about what is happening.

Short Science Story (S^3) – the electromagnetism side

As the magnet falls through the copper tube, it pushes electrons around the tube creating an electric current. The moving electrons (electric current) create their own magnetic field which repels the falling magnet, slowing it down.

Short Science Story (S^3) – the energy side

The magnet starts with a particular amount of potential energy. Without the copper tube, this energy would be converted into kinetic energy (energy of motion), causing it to speed up as it falls. When the magnet is dropped through the tube, some of the initial potential energy is converted into electrical energy (energy given to the moving electrons). Because some of the magnet's original energy has been given to the moving electrons, it doesn't gain as much kinetic energy and therefore moves slower.

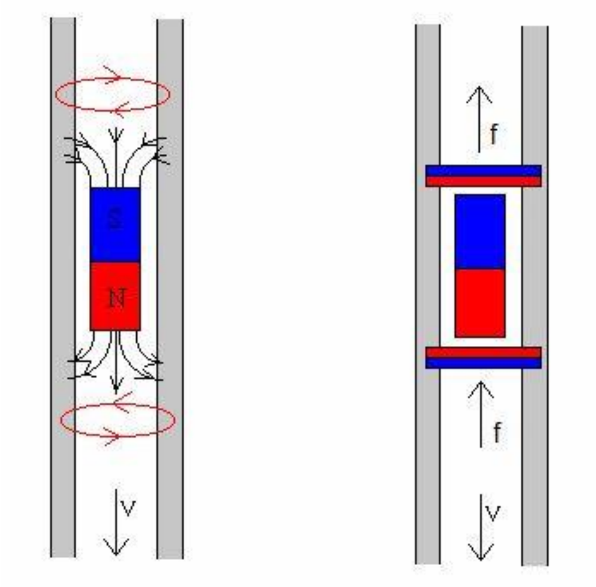
Eddy Current Tube - What the heck?

Eddy currents are an electric phenomenon that is produced when a conductor (metal) passes through a variable magnetic field. The relative movement causes a circulation of electrons, or induced current within the conductor. These circular Eddy currents create electromagnets with magnetic fields that oppose the effect of the applied magnetic field.

The **Eddy currents** and the generated contrary fields will be stronger

- when the applied magnetic field is stronger, or
- with higher conductivity of the conductor, or
- with higher relative speed of movement.

For a practical demonstration of the **Eddy Currents**, cylindrical magnets are used that fall vertically in a copper or aluminum tube. It can be experimentally proven that the force that opposes the weight is proportional to the speed of the magnet. The experience is illustrated in the attached drawing:



Let's suppose that the cylindrical magnet descends with its North pole (color red) in front and its South pole (color blue) behind. On a magnet, the magnetic field lines are outgoing at the North pole and incoming at the South pole.

During the descent of the magnet, the flow from the magnetic field increases in the region near the magnet's North pole. An induced current originates in the tube, **Eddy Current**, which opposes the increased flow, in the direction that is indicated in the first figure.

In the following figure, the equivalency between currents (spirals or solenoids) and magnets is shown, in such a way that the induced current ahead of the North pole equals a magnet of opposing polarity, by which they repel each other. However, the induced current behind the magnet has the same polarity by which they attract each other. Both currents generate a force (f) that stops the falling movement of the magnet.

Source: http://www.regulator-cetrisa.com/eng/magnetism.php?section=foucault

Conservation of Energy Story

The magnet has gravitational potential energy when at the top of the tube. When you drop it outside the tube, the potential energy would be converted into kinetic energy. When you drop it inside the tube, some of the potential energy is converted into electrical energy (the energy required to move the electrons in the conducting tube). Because some of the original energy is converted to the electrical energy while the magnet is falling, it won't have as much kinetic energy when it reaches the bottom of the eddy current tube.

UV Color Changing Materials

Inventory:

STEM
DEMO
KIT

UV sensitive beads on a string

UV sensitive frisbee

2 UV flashlights (extra AAA batteries)

Directions:

1) Turn on the UV flashlights.
2) Hold the flashlights over the beads or Frisbee. Experiment to find the best way to get the beads or Frisbee to change color. If it is daylight, take the Frisbees out into the sunlight.
3) Hold the sunglasses right next to the Frisbee and shine the UV light through the lens. Are the sunglasses good at blocking out UV light? How do you know?
4) Think about how you could use the beads to test the effectiveness of sunscreen or medicine bottles that are supposed to protect pills from UV light.

Short Science Story (S^3)

When the ultraviolet light hits the material of the Frisbee or beads, it causes molecules inside of them to shift and form larger, connected molecules. These larger molecules absorb some of the visible light (subtracting it from the white light illuminating it). This causes the color to change.

UV Color Changing Materials - What the heck?

UV-sensitive beads contain pigments that change color when exposed to ultra-violet light from the sun or certain other UV sources. The electromagnetic radiation needed to affect change is between 360 and 300 nm in wavelength. This includes the high-energy part of UV Type A (400-320 nm) and the low energy part of UV Type B (320-280 nm). Long fluorescent type black lights work well; incandescent black lights and UV-C lamps will not change the color of the beads.

The dye molecules consist of two large, planar, conjugated systems that are orthogonal to one another. No resonance occurs between two orthogonal parts of a molecule. When high energy UV light excites the central carbon atom, the two smaller planar conjugated parts form one large conjugated planar molecule. Initially neither of the two planar conjugated parts of the molecule is large enough to absorb visible light and the dye remains colorless. When excited with UV radiation, the resulting larger planar conjugated molecule absorbs certain wavelengths of visible light resulting in a color. The longer the conjugated chain, the longer the wavelength of light that is absorbed by the molecule. By changing the size of the two conjugated sections of the molecule, different dye colors can be produced. Thermal energy from the surroundings provides the activation energy needed to return the planar form of the molecule back to its lower energy orthogonal colorless structure.

COOL NOTE: Although UV light is needed to excite the molecule to form the high-energy planar structure, heat from the surroundings provides the activation energy to change the molecule back to its colorless structure. If colored beads are placed in liquid nitrogen, they will not have enough activation energy to return to the colorless form.

The UV detecting beads remain one of the least expensive qualitative UV detectors available today. They cycle back and forth thousands of times.

Source: http://www.arborsci.com/Data_Sheets/P3-6500_DS.pdf

Holographic Glasses

Inventory:

STEM
DEMO
KIT

10 animal 3D holographic glasses

String of LED lights

Extension Cord

Directions:

1) Put on a set of 3D holographic glasses.
2) Look at the lights and make observations about what you see.
3) Move closer to and further from the lights to see how it affects the images. NOTE: Some of them change when you move your head up and down in a nodding motion. Try it to see if the glasses you are wearing change.

Short Science Story (S^3)

The holographic glasses have a three-dimensional image imbedded in the lens. When light from a point source enters the glasses, it is refracted allowing the viewer to see the image around each point of light (bulb).

Holographic Glasses - What the heck?

Holographic glasses are specially designed to give points of light a three-dimensional (3-D) prism effect. The term can also be used to describe novelty glasses that have a three-dimensional image embedded in the lens. While originally designed for entertainment purposes, the technology used to create these types of glasses has also been used to develop holographic military goggles.

The main purpose of most holographic glasses is entertainment. The glasses generally have paper or plastic frames and are similar in appearance to 3-D glasses found in many movie theaters. The effects generated by the glasses, though, are more intense and detailed than the types of images generated by 3-D glasses.

Due to the way the lenses in these glasses are designed, normal light displays are viewed as stunning, three-dimensional illusions. For instance, many people enjoy viewing fireworks displays through holographic glasses because of the added vibrant, multidimensional aspects. Similarly, many places that offer seasonal holiday displays may provide guests with holographic glasses to enhance the lights with enchanting prism effects.

Certain novelty glasses with holographic images embedded in the lenses are also called holographic glasses. These products don't necessarily alter the wearer's view of objects. Instead, they provide a comical effect for people looking at the person wearing them. For instance, the lenses of the glasses might contain very realistic images of a woman's eyes, complete with eyelashes and makeup, and when worn by a man, the effect can be quite amusing.

Aside from entertainment, the technology used to create these types of glasses has been used by the military in order to develop certain eyewear and goggles to be worn by soldiers. The holographic capabilities can enhance the wearer's perception and allow computer-generated images to be projected onto the goggles. These aspects can assist military personnel in assessing field conditions and identifying potential hazards and targets.

Holographic technology continues to evolve. When holographic movies and television shows are available, viewers will likely use holographic glasses in much the same way as they use 3-D glasses. Video and computer games may also utilize holographic technology to enhance gaming, resulting in the glasses becoming necessary to fully enjoy the experience.

Source: http://www.wisegeek.com/what-are-holographic-glasses.htm

THE STEMAZING PROJECT™
WWW.STEMAZING.ORG

Gyro-Ring

STEM
DEMO
KIT

Inventory:

2 Gyro-rings

Directions:

1) Hit the small washers so they are wobbling.
2) Start turning the big ring to keep the small washers moving.

Short Science Story (S^3)

As you turn the big ring, once the small washers are wobbling, the big ring pushes on the washers as they wobble giving them the extra energy they need to keep wobbling.

Gyro-Ring - What the heck?

As the washers spin, precession causes them to touch the ring and lean to one side. At this point of contact, a force occurs between the ring and the washer. As the tilted washer “falls” on the ring, this force has an upward component (that keeps the washer from falling) and a component in the direction of the washer’s spin (that causes the washer to spin). As long as the ring is moving upward relative to the washer’s motion, the force occurs and the washer continues to spin.

It is somewhat similar to sliding down the banister of a spiral staircase. As long as you are moving downward relative to the staircase, the banister continues to push you around in a circle. The banister creates a force that has an upward component (to keep you from falling) and a “forward” component, to push you around the staircase. If you stop sliding downward, you also stop going around in a circle.

Source: http://www.arborsci.com/Data_Sheets/P3-3600_DS.pdf

Simple Generator

Inventory:

STEM
DEMO
KIT

2 PVC spool simple generator assembly

2 dowels with neodymium magnets on the end

Directions:

1) Push the magnets back and forth through to spooled magnet wire.
2) Make observations about what you observe going faster or slower.
3) Read the “What the heck?” on the back of this page to learn more about what you observe.

OBSERVATIONAL CHALLENGE: Run the magnets through the generator in just one direction. Do you see only one color of light or two?

Short Science Story (S^3)

As the magnets move through the coils of wire, they push on electrons inside the wire causing them to move first one way and then pull on them to move them back the other way. Moving magnets through coils of wire converts some of the kinetic energy of the magnets into electrical energy – lighting up the LED! This principal, called Faraday’s Law, is how we create 98% of our electricity – moving coils of wire through strong magnetic fields.

Simple Generator - What the heck?

An LED (light-emitting diode) is an electric device that converts electric energy into radiant energy. LEDs are directional which means electricity must move through it in a specific direction in order for it to work. The LED used in the simple generator is a bi-directional LED which is basically two LED's in one. When electricity moves through the LED in one direction, it will light up with a specific color of light. When the electricity moves through in the other direction, it will light up with a different color of light because it is using the other LED.

In this station, you were generating electricity using the electromagnetic effect. When you were moving the magnets through the coils of wire, the changing magnetic field induced a force on the loose electrons in the coils of wire pushing them in one direction. You should have noticed that the color of the LED switch when the magnets where halfway through the spool of coils. This occurred because the force on the electrons was reversed, changing their direction through the LED, which produced a different color of light. (If you did not observe this, go back and experiment a bit more while making careful observations.)

The electromagnetic effect used in this experiment is the same physics used to produce more than 98% of our electricity, just on a much larger scale. Whether the primary source of energy is coal or natural gas or wind or uranium or water, energy conversions take place which cause magnets to move through coils of wire or coils of wire to move through magnetic fields to produce electricity.

Technical Note: On a large scale, permanent magnets like the neodymium magnets used in this experiment, are replaced with electromagnets – magnetic fields produced when current moves through coils of wire. This seems counter intuitive to use electricity to produce magnetic fields that are then used to produce electricity. However, the net output based on the conversion of input kinetic energy from the primary energy source into electrical energy is significantly more than the electrical energy required to power the electromagnets. Also, no permanent magnets exist that would be large enough and strong enough to use in large-scale power plants.

Euler’s Disk

Inventory:

STEM
DEMO
KIT

Euler’s Disk (in a box)

- Euler’s Disk
- Mirror
- 3 Round Holographic Magnet Covers
- 6 Pie Piece Shaped Holographic Magnet Covers

Directions

1) Place the disk on the mirror base.
2) Hold it almost vertical and then give it a little spin as you let it go.
3) Observe the motion of the disk as well as the sound it makes.

CHALLEGE: Time who can get the disk to spin the longest!

Short Science Story (S^3)

The disk is slowly converting its initial potential energy into kinetic energy. Because of its large mass and the rounded edge along its corner, it loses very little energy to the conversion of thermal energy by friction. This combination of factors allows it to spoll (spin and roll combined) for a very long time.

Euler’s Disk - What the heck?

Conservation of Energy:
When Euler's Disk is spun, the disk contains both potential and kinetic energy. The potential energy is given to the disk when it is placed upright on its side. The kinetic energy is given to the disk when it is spun on the mirrored base. Euler's Disk would spoll (i.e., spin and roll) forever it it were not for friction and vibration.

Angular Momentum:
Another way of describing how Euler's Disk operates is by considering the disk's angular momentum. Like a top, Euler's Disk uses its angular momentum to hold itself upright. As the disk spolls around in a circle it is held in place by a balance of the gravitational force pulling the disk down and the force applied by the mirror base which holds the disk up. Again, if it were not for friction and vibration, the disk would rotate for a very long time.

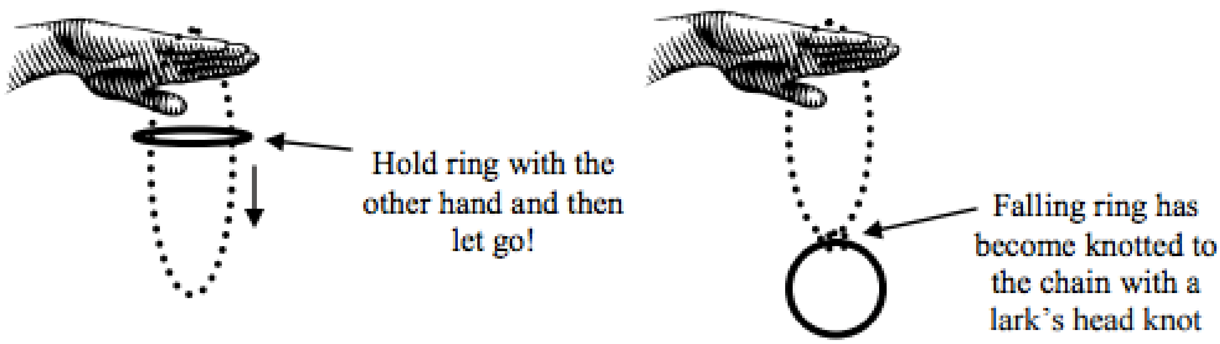
Source: http://www.eulersdisk.com/physics.html

Physics Ring and Chain Trick

Inventory:

5 Welded Rings

5 30” Ball Chains



Directions

1) Hold the chain out in the loop with one hand.
2) Pick up and hold the ring parallel to the ground with your other hand.
3) Move the ring under and up the chain so it is close to the hand holding the chain.
4) Let go of the ring just right and it will catch in a lark’s head knot at the bottom of the chain. Physics!

CHALLEGE: To master the ring and chain physics trick, you must get it to catch FIVE times in a row!

Short Science Story (S^3)

There is a lot of physics involved in this physics trick but none we will mention here. You must figure it out through observation and trial & error!

REMEMBER: Failure is a part of learning!

Left blank on purpose.

Buzz Off

Materials:

Two sticky foam tabs
One Index Card
Scissors
String
Rubberbands

Directions

1) Follow the assembly directions.
2) Once assembled, find yourself some open "air space" and whirl the Buzz Off around.
3) Enjoy the insect like sound it creates!

DESIGN CHALLEGE: Can you modify your Buzz Off so it makes a different sound? Who can make theirs the most annoying noisemaker?

Short Science Story (S^3)

As you whirl the Buzz Off around, the air causes the rubber band to vibrate which creates the sound you hear. The purpose of the index card is to keep the buzzer oriented the right direction so the rubber band vibrates the most.

Buzz Off - What the heck?

The air flowing above and below the rubber band causes the rubber band to vibrate. Vibration causes sound (outside of a vacuum). The rubber band will produce the most sound when the rubber band is at the leading edge of the card with the card moving parallel to the direction of the airflow. Aerodynamic drag on the card keeps the card and rubber band parallel to the airflow. The drag will increase if the card is at any other angle. The increased drag will automatically move the card back to being parallel with the airflow. The frequencies produced by the rubber band will depend on several variables such as the rotation speed, the rubber band tension, the rubber band’s dimensions, foam thickness and the size of the gap between foam pieces. A change in any of these variables can affect the sound that is produced.

Buzz Off Assembly Guide