Teacher's Guide

DOYLE AND FOSSEY, SCIENCE DETECTIVES

The Case of the Crooked Carnival

by Michele Torrey

illustrations by Barbara Johansen Newman

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Introduction

After many late nights brainstorming (and many cups of decaf) Drake Doyle and Nell Fossey are proud to introduce this teacher's guide. This guide provides additional activities that expand on the stories, concepts, and activities introduced in **The Case of the Crooked Carnival,** book five in the **Doyle and Fossey: Science Detectives** series. Drake and Nell invite you to use any or all of the suggestions.

The guide is quite organized. It begins with a section devoted to the language arts, complete with character analyses and highly important vocabulary terms. The rest of the guide is divided into activities and ideas related to the four science concepts introduced in **The Case of the Crooked Carnival:** sound and amplification, ecosystems, magnets, and resonance. It's all quite sensible, once you think about it. But, sensible or insensible, as the case may be, Drake and Nell simply want you and your students to have fun. So, enjoy!

Cheers,
Michele Torrey
www.micheletorrey.com

Language Arts:

Character Analyses

Of course, a terrific story just wouldn't be the same without terrific characters. Great characters make a story come alive, helping the reader to become involved. In order to create great characters, it is important for authors to know who their characters are, what they like and dislike, how they act, and how they perceive the world.

In this activity, you will help your students analyze the characters in **The Case of the Crooked Carnival**. Starting with either Drake or Nell, have a class discussion regarding the various characters and their traits. Here are some sample questions to get the juices flowing:

1. What does this character look like?
2. What kinds of things does this character like? Dislike?
3. Is this character happy? Unhappy? Somewhere in between? Why?
4. What do you know about this character's family and home life?
5. How well would this character fit in at your school?
6. If this character could do anything in the world, what do you think it would be?
7. If confronted with an angry monster, this character would likely________________.

Have students create their own fictional character
(see Reproducible #1 near the end of this guide).

What is a Mystery?

Whether in real life or between the covers of a book, mysteries pose a question. The question can be anything, from the dramatic to the mundane: Whatever happened to Amelia Earhart? Are crop circles really created by extra-terrestrials? What did Frisco have for breakfast? In literature, mysteries follow a pattern.

1. A mystery is posed: *How does Shady Jim always win at his carnival game, while everyone else loses?*
2. It is not enough merely to have a mystery. The mystery must be solved because the stakes are high: *June and her eleven siblings are down to their last two dollars. They're desperate to win the vacation for their struggling family. Could it be that Shady Jim is cheating (stealing their money)?*
3. Mysteries usually involve one or more antagonists: *Shady Jim and Frisco/Baloney.*
4. The antagonist usually has a motive: *money/greed, for example.*
5. One or more heroes or protagonists may also be involved: *Drake Doyle and Nell Fossey.*
6. The protagonist searches for clues to solve the mystery:
   a. *Shady Jim always wins*
   b. *Everyone else loses*
   c. *Baloney wins (Egads!)*
   d. *Frisco is nearby*
   e. *Frisco is wearing an overcoat, even though it's a hot day*
   f. *There is something in Frisco's pocket, etc. . . .*
7. Usually, the protagonist solves the mystery before the reader does.
8. The protagonist foils the antagonist and reveals to the characters and readers how he/she solved the case: *Shady Jim used an electromagnet to rig the game.*

The Mysterious Mystery

1. Have the class critically analyze the four mysteries in **The Case of the Crooked Carnival,** breaking the mysteries down into their various components. Identify the mystery, possible consequences if the mystery isn't solved, antagonists and motives (if any), protagonists, clues, and solution. Are there any mysteries which don't follow this pattern? Identify any deviations.

2. Have the students write their own mystery (see Reproducible #2). Encourage them to use the character they created in the Character Analyses Activity.

Alliteration

Alliteration is a repetitive sequence of the same sounds. Drake Doyle and Nell Fossey frequently use alliteration, for example, *Edgar Glum's got ghosts and ghouls.*

1. As a class, identify the different alliterations in **The Case of the Crooked Carnival.**
2. Have students write their own alliterations (see Reproducible #3).

Reader's Theater

The mysteries in the **Doyle and Fossey: Science Detectives** series make great read-alouds, especially for reader's theater. Your production can be as simple or as complex as desired. The following are some suggestions.

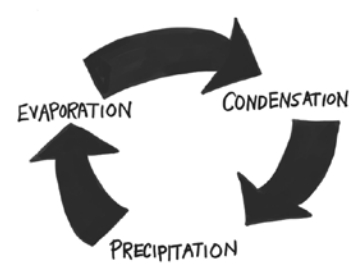
Choose one or more to help create an awesome reader's theater:

1. Have the class construct a bulletin board and/or theater stage that reflects the setting, the characters, and/or the science concept.
2. Hold auditions for the various character roles. You will need a narrator in addition to the other characters. The narrator will read everything that's not dialogue.
3. Create costumes for the characters. Don't forget the lab coats and sharpened pencils!
4. Perform the reader's theater. Actors can act or simply read dramatically.

Vocabulary and Key Terms

There are likely many words introduced in each **Doyle and Fossey: Science Detectives** book which will be unfamiliar to many students. The suggested activities included in this guide are meant to familiarize students with the vocabulary rather than to achieve total comprehension. While it is important to continue to build on comprehension, it is through context that most of these terms will be truly understood: context within the story itself, and context resulting from the activities, discussions, and experiments that follow.

alien
amplification
atoms
binoculars
biocontrol agent
biology
circuit
conclusions
condensation
current
diameter
ecosystem
electromagnet
evaporation
frequency
hypothesis
interconnected
molecules
noxious weeds
observation
periscope
precipitation
procedure
resonance
scientific method
simulation
solution
surveillance
terminal
vapor
vibration
wetland



Games:

1. Tape an index card with a vocabulary word to each student's back. Students can ask one another for clues as to the identity of their mystery vocabulary word. Of course, no one should say the actual word. After four clues, the students must guess which word is taped to them.

2. Assign each pair of students a word. On one piece of plain white paper they write the word, on another piece of plain white paper they write the definition. Have the class wad each word and definition into a ball and proceed with a "snow-ball" fight. (You might want to set a timer, specify the rules, i.e. throw only the paper, etc.) After the dust settles, each student selects a wadded paper and must locate its match.

3. Write the vocabulary words randomly on a chalkboard. Divide the class into two teams. One person from each team comes to the board. When a definition is read, whoever smacks the correct vocabulary word with a fly swatter first earns a point for his or her team.

   See Reproducibles #4 and #5 for additional vocabulary enrichment.

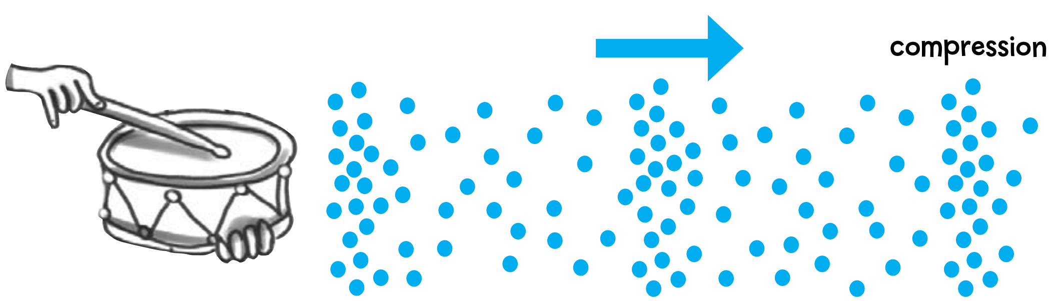
Science Units

Sound and Amplification

Sound
Sound can be difficult for some students to fathom, simply because it cannot be seen. There are three key concepts to help students understand sound:

KEY CONCEPTS
1. Sound is a vibration of molecules within matter.
2. Sound waves are caused by the back-and-forth nature of vibration.
3. Sound can move through different kinds of matter.

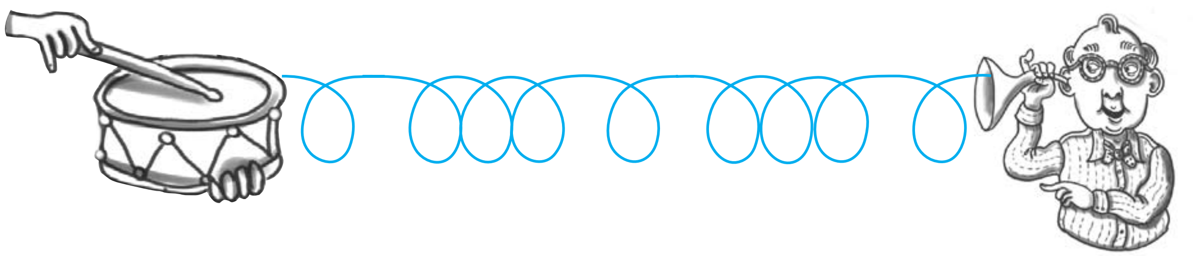
Sound is a vibration of molecules within matter
As Drake and Nell explained to Edgar Glum, sound is caused by the vibrations of molecules in the surrounding air, or, to be more universal, in the surrounding matter. For instance, when a drum is struck (energy input), the molecules in the surrounding air get pushed quickly and are compressed, then released. The resulting energy is transmitted from molecule to molecule in a series of compressions. (The less dense space in between compressions is called rarefaction.)



Soundwaves are caused by the back-and-forth nature of vibration

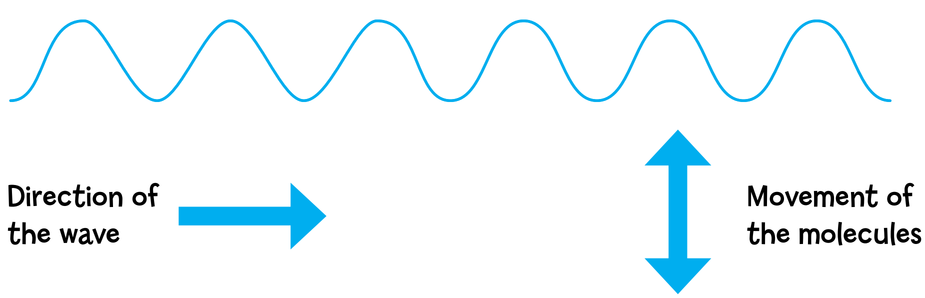
A metal slinky is perfect for demonstrating how sound waves travel. Have a student hold one end of the slinky, while you hold the other. Extend the slinky so that there is no slack and the slinky is fairly tight. With your free hand, create the "sound wave" and observe the wave traveling from one end of the slinky to the other. Be sure to illustrate the difference between a sound wave and a water wave.

Sound waves are horizontal, or *longitudinal*.

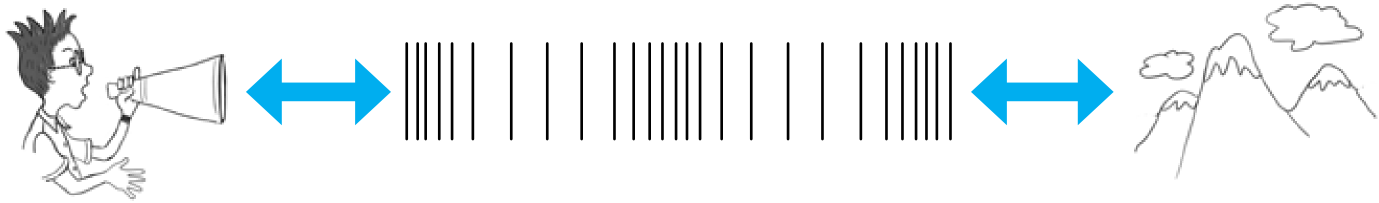


The different coils of the slinky illustrate how the individual molecules in a sound wave do not actually travel the distance between the source of the sound and the ear, but instead vibrate back and forth in the same direction of the wave.

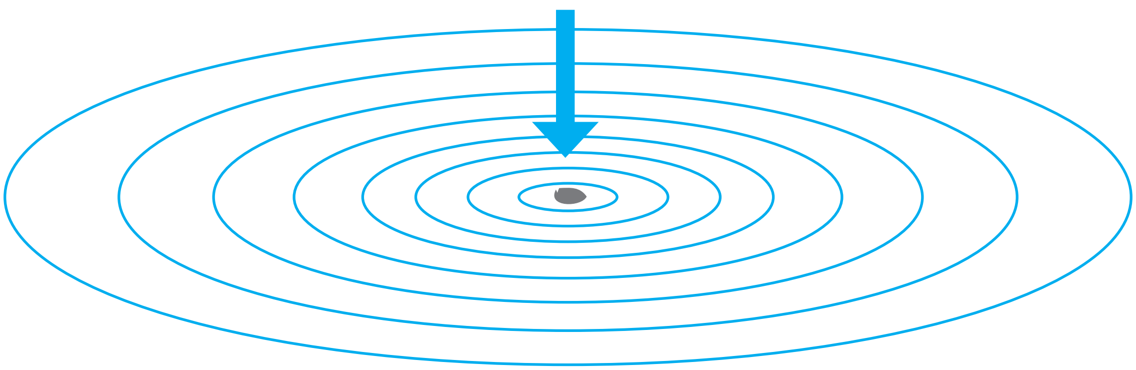
In contrast, water waves are vertical, or *transverse*. The molecules in a water wave do not move in the direction of the wave, but instead move perpendicular to the wave.



The slinky also clearly demonstrates the principle behind an echo, in which sound waves are reflected.



While these are great illustrations, they are limited in scope because of their two-dimensional nature. It is important for students to understand that sound waves travel in *concentric spheres in all directions from the source.* A stone dropped into the center of a pond or a kiddie pool is a good illustration, however, even that is only occurring at the surface of the water.



Sound can move through different kinds of matter:
Sound waves can travel through liquids and solids as well as gases. In fact, the denser the substance, the more quickly sound can travel. For instance, sound travels faster in liquids than in gases. Have you ever had your head underwater in a public swimming pool? It's a cacophony of sounds! This is because the molecules are packed closely together, making the transfer of energy easier. Sound also travels better in solids than it does in liquids.

WHAT'S THE MATTER?
In this activity, students will work in pairs to compare how sound travels through various forms of matter. Prior to doing each activity, have them predict the results. Then have them compare the results with their predictions and write their conclusions.

- One student puts his ear to one end of the table while his partner raps on the other end. Then, without putting his ear to the table, the student listens as his partner makes the same sound. Is there a difference? Which sound did he hear better?
- One partner whispers to the other from across the room. Then have the partner whisper again, but this time the listener holds a blown-up balloon against his ear. Can she hear her partner better now? Or not as well?
- Other ideas: putting an ear to a radiator (when it's not hot!), to the floor, to the wall, to an aquarium. . . (Remember in the movies, when people put an ear to the railroad rail? Or to the ground to hear the approaching posse?)
- Students can construct a string telephone. Have them explain the science behind the string telephone and why it works.
- Compare individual results with the class.

Amplification:

Sound waves can be amplified in multiple ways. For instance, sound waves can be amplified if you yell rather than whisper, or if you cup your hand around your ear.

As a class, discuss amplification.
Examples of discussion questions might be:

- What are some of the different ways sound can be amplified?
  - Input of energy (i.e. yell louder), concentration (i.e. funneling), and electricity (i.e. microphone).
- Where might you find examples of amplification in daily life?

Let the Music Play!
Acoustic guitars are great examples of amplification. The guitar box is the amplifier, creating an acoustic cavity where sound waves are reflected and can resonate. Consider bringing a guitar (or ukulele) to class to illustrate, or inviting a musician to play for the class.

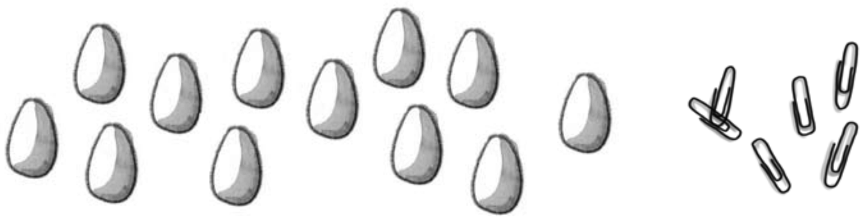
- Divide the class into groups of four. Have each group build their own guitar and amplifier. Give them some basic ideas and materials to work with, but let them be inventive on how best to make a guitar. (Materials should include plenty of different sizes of rubber bands, paper towel rolls, popsicle sticks, golf pencils (for a guitar bridge), funnels, and different sized "cavities" such as shoe boxes, tissue boxes, cereal boxes, or coffee cans.) Once finished, have each group demonstrate their guitar for the rest of the class. Which guitar sounded the best? Which guitar provided the most amplification?
- Want to take it to the next level? Students can create their own musical band by making other instruments. Instruments might include drums, bass fiddle, triangle or chimes, horns, tambourine, xylophone, and kazoos. The following website is a good resource with plenty of ideas on how the instruments might be made: http://www.artistshelpingchildren.org/musicalinstrumentsartscraftstideashandmadekids.html

Additional Enrichment:

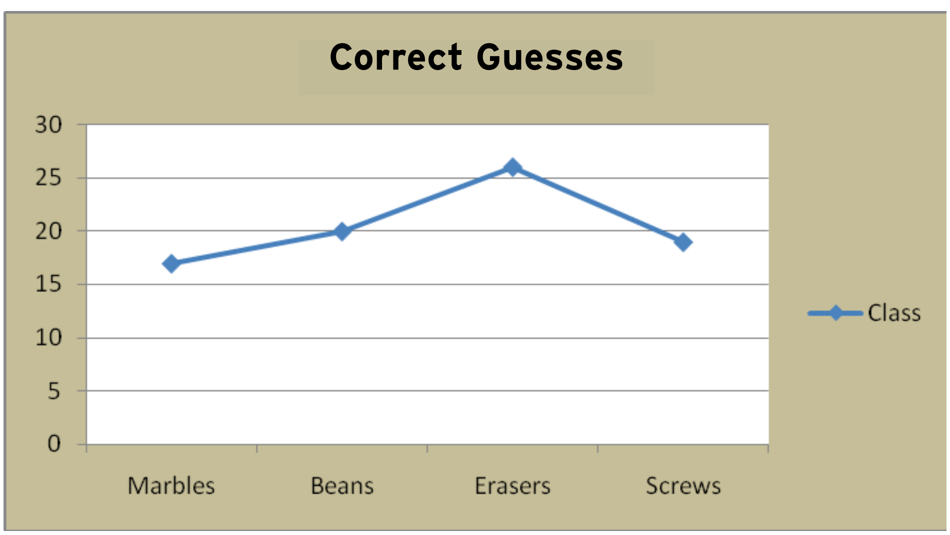
OUR AMAZING EARS

Our ears are amazing, complex organs. Not only can they distinguish with precision the origin of a sound, but they can usually distinguish what produced the sound.

For this activity you will need about one dozen plastic eggs. Place about six marbles into the first egg. Place similar items into the other eggs, such as beans, bb's, small sea shells, peanuts, raisins, coins, screws, erasers, paper clips, macaroni, m&m's, buttons, straight pins, and toothpicks.



Students will try to guess the contents of each egg when it is shaken, recording their guesses in their lab notebooks. Tally the correct guesses, and then graph the results. For extra pizzazz, students can use the eggs as percussion instruments to accompany an African, Latin, or Carribbean song, such as "Under the Sea" from Disney's "The Little Mermaid."



Ecosystems

Ecosystems are one of the most exciting topics for students to study. Once students understand what an ecosystem is and what characterizes a healthy ecosystem, they see the world with new eyes. Additionally, they will better understand the impact that they have, both individually and collectively, on their world.

Facilitate a class discussion on ecosystems by constructing a large-scale terrarium, using the activity in the back of **The Case of the Crooked Carnival** as a guide. Discussion suggestions:

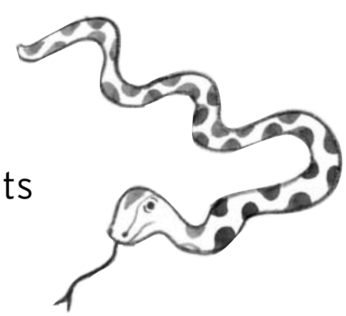
- Introduce the word **biodiversity.** Why is biodiversity a good thing?
- What are the characteristics of a healthy ecosystem? An unhealthy ecosystem?
- What does it mean when an ecosystem is in balance? Why is balance important? What are some of the factors that can cause an ecosystem to become out of balance?
- Pose questions such as, "What do you think would happen if [mice, insects, rabbits, wolves, sharks . . .] were removed from the ecosystem?"
- Is the earth itself one giant ecosystem?
- How does your classroom compare to a natural ecosystem?

Need to buff up on your ecosystems/invasive species knowledge? See http://www.puc.edu/Faculty/Gilbert_Muth/botlec38.htm for a terrific resource.

Nature Headquarters

Create your own Nature Headquarters by decorating a corner of your classroom like a jungle. Make it as simple or as involved as you wish. Some suggestions:

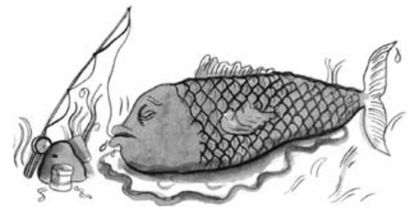
- Create a Nature Headquarters bulletin board. Have students find interesting facts about nature to display.
- Paint a jungle mural on the wall.
    - Cut out stencil sponges in the shapes you will need, such as leaves, flowers, and birds.
- Make tree trunks starting with a wood post wrapped with chicken wire. Stick actual branches in the chicken wire, cover it all with papier mâché and paint it brown. Make giant leaves from green construction paper; glue and glitter the veins. Vines can be made from torn up paper bags painted green and brown, and tropical flowers made from tissue paper.
- For extra pizzazz, add some snakes. Construct snakes from a thin paper plate. Start at the edge and cut in a spiral, ending with a head shape at the center. Have students research various types of jungle tree snakes, and paint or color with magic markers to match. Glue on wiggle eyes and add a tongue made of red ribbon.
    - Have the students research jungle "factoids" and write them on index cards. Glue or paper clip onto the leaves.
    - Add a stuffed toy monkey or toy parrot to the tree.
- Bring in real potted plants, such as bamboo. Teach the students how to care for plants that are not in a terrarium.



Making it Real

According to the National Wildlife Federation, today's child spends only 4-7 minutes each day playing outside, compared to over 7 hours spent playing indoors. You can help reconnect children with their natural world by planning a field trip to a wetland or other ecosystem, such as a desert or beach.

How will students prepare for the trip? What tools will they need to conduct their observations? What samples will they bring back to the lab for analysis? Soil samples? Water samples?



- See Reproducible #6 for an activity on soil analysis. (Visit www.school.discoveryeducation.com/schooladventures/soil/index.html to brush up on your soil biology.)
- Conduct a pH analysis on the water samples (see "Those Poor Little Fish" in **The Case of the Terrible T. rex,** Book 6).
- To encourage awareness of belonging to a larger, world community, arrange the field trip to occur during:
  - *World Environment Day,* June 5
  - *World Environment Week,* June 5 – 11
  - *Earth Day,* April 22
  - *World Rainforest Week,* second full week in October
  - *National Wildlife Week* (USA, sponsored by National Wildlife Federation, www.nwf.org), usually March or April

Ecosystems, Anyone?

If you can't take the class on a field trip, a virtual field trip is the next best thing. Divide the class into teams of two to four. Assign each group an ecosystem to research. They can develop an informational poster board, write a newspaper article, and/or create an art project, such as a 3-D collage, to illustrate their ecosystem. Have them present their ecosystem to the class and share how the various elements of the ecosystem interact. Encourage them to provide samples of their ecosystem, such as sea shells, pine cones, or a recording of whale sounds.

Ecosystems

Forest, desert, coral reef, mountain, Arctic and Antarctic polar, wetlands, grasslands, tundra.

Many ecosystems can be further subdivided according to location and climate. For instance, a tropical rainforest in Brazil will have a vastly different ecosystem than a conifer forest in British Columbia. Also, there are certain parts of the world that have developed their own unique ecosystems, such as those found on the Galapagos Islands.

Backyard Analysis

Students don't have to travel far to find an ecosystem. Ecosystems are everywhere, even in our own backyards. Assign students the task of analyzing their own backyards, or even the school grounds. Tools such as binoculars and magnifying glasses are helpful.

Questions to consider: What kinds of plants are there? What kinds of animals? Insects? Birds? How do they interact? What is the climate like? The terrain? What and where is the water source? What effect have humans had on the ecosystem? Is the ecosystem in balance? What can they do to improve the health of their ecosystem? Have them take samples (so long as it doesn't hurt anything), take photographs, draw pictures, and record their observations.

Want to take it a step further? See Reproducible #6 for an activity on soil analysis.

Those Pesky Aliens!

In this activity, students will work in teams of 2-3 and research a real-life invasive species from the following list:

water hyacinth *(Eichornia crassipes)*
brown tree snake *(Boiga irregularis)*
cane toad *(Bufo marinus)*
European starling *(Sturnus vulgaris)*
zebra mussel *(Dreissena polymorpha)*
Asian carp (multiple scientific names)
common reed *(Phragmites australis)*
purple loosestrife *(Lythrum salicaria)*
tansy ragwort *(Senecio jacobaea)*
old world climbing fern (*Lygodium microphyllum*)
nutria *(Myocaster coypus)*
northern snakehead *(Channa argus)*
chilli thrips *(Scirtothrips dorsalis)*
Chinese tallow tree *(Sapium sebiferum)*

QUESTIONS STUDENTS SHOULD CONSIDER:

- Where did the invasive species originate?
- How and when was the invasive species originally introduced into the non-native environment?
- What damage has been done? Include environmental and economic damages.
- What measures have been taken to eradicate it? Have those measures been successful?

Students can expand on this project by creating an informational poster board, writing a newspaper article, or creating an art project, such as a diorama.

Want more? Here are some great resources:

- http://livinggreen.ifas.ufl.edu/tv_episodes/invasive_exotics.html
  Treat your students to a great 29-minute video presentation about invasive species.
- http://www.eco-pros.com/invasive_non-native_species.htm
- http://www.invasivespeciesinfo.gov/

Oops in the Outback

Australia has a unique ecosystem. Some plant and animal species native to Australia are found nowhere else on Earth, such as the kangaroo. Likewise, many species commonly found elsewhere are not found naturally in Australia. Take rabbits, for instance.

Twelve pairs of rabbits were first released into Australia in 1859 by a British landowner who wanted to bring a touch of home to the outback and provide some hunting sport. Within ten years, there were so many rabbits that two million could be killed annually with no detectible effect on their population.

Bunny Facts

- 12 rabbit pairs introduced to Australia in 1859
- 1 billion rabbits by the mid-1900s
- One pair of breeding rabbits can produce 30-40 offspring per year
- 9-10 rabbits consume as much as one sheep

By the mid-1900s there were an estimated one billion rabbits in Australia, with estimates ranging as high as ten billion. The introduction of rabbits into Australia remains one of the most devastating invasive species events in modern history, responsible for much of the species loss and erosion on that continent. It also caused enormous economic hardship to farmers as the rabbits stripped farmlands of existing vegetation.

In 1950, scientists released a virus into the environment, eradicating 99% of the rabbit population. It was the first successful biocontrol agent in history, and the sheep and other livestock industries rebounded dramatically. Ironically, the poor farmers, who had come to rely on rabbits as a primary source of protein, were devastated. More recently, the rabbit population has made a comeback due to increased resistance to the virus.

Unlike the landowner who believed no harm could come of his rabbit habit, students will do the math so they can fully comprehend the explosive dynamics involved (see Reproducible #7). Depending upon your students' math level, you can adjust accordingly. Here are some ideas for further enrichment:

- Convert grams to kilograms and/or pounds and ounces
- Introduce exponents and exponential growth
    - See http://www.otherwise.com/population/exponent.html for a program showing population growth over generations. Input the number of offspring from a breeding pair (of fish). Includes a chart of your numbers.
- Chart population growth
- Calculate growth rate in terms of percentage

The following is a wonderful resource for teachers, including a .pdf slide show on the Australia rabbit problem, "Feral Animals in Australia."
(Beware: some of the images have to do with bunny eradication.)
http://bit.ly/aJnKEd

Magnets

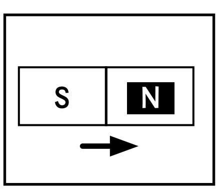
In this section, students will not only have fun with magnets, but will learn about their basic properties. Before beginning any activities, be sure to instruct your students regarding safety precautions when dealing with magnets.

Key concepts:

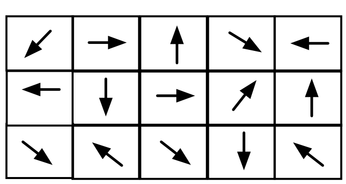
1. All magnets have magnetic north and south poles. Magnetic poles are attracted, repelled, or unaffected by surrounding matter.
2. All magnets have magnetic fields which extend beyond the magnet's physical boundaries. These magnetic fields can act upon other matter.
3. Earth is a giant magnet with its own magnetic field.

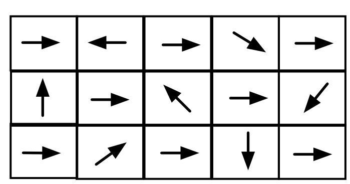
Attraction and Repulsion

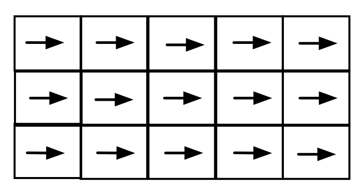
What makes a magnet a magnet? Magnets have unique magnetic properties because of the way the atoms arrange themselves. In all matter, atoms arrange themselves into clusters called domains. Each domain has one side that is attracted to the magnetic south pole of the Earth, while the other side is attracted to the magnetic north pole. In non-magnetic materials, the domains are oriented randomly and cancel one another out. In magnetic matter, however, most of the domains are aligned, giving the object a north and south pole. The more the domains are aligned, the more magnetic the object is.



Domain magnet


Non-magnetic object


Semi-magnetic object


Strong magnet

CAUTION: Keep all magnets away from computers, DVDs, CDs, video/audio tapes, ipods, iphones, blackberries, electronic equipment such as TVs, stereos, and any cards with magnetic strips, such as credit cards or library cards.

Magnets

Letting students explore magnets "hands-on" is the best way to help them comprehend magnets and their properties. For each of the following activities, you can either demonstrate, or students can work in pairs. Make certain they work on a wooden desk or table, not metal. Each student pair will require two bar magnets with the poles clearly marked. Again, you can have students perform as many or as few of the activities as you wish. (If you would prefer to teach this section in combination with a handout, see Reproducible #8.)

1. Using string and tape, students can suspend one of the bar magnets from the edge of a table. By bringing the second magnet close to the first, they can see what happens when N/N, S/S, and N/S poles are brought together.

2. Students can test various materials for magnetic qualities. Materials suggestions include: safety pins, beans, iron nails, various coins, paper clips, glass marbles, steel bb's, aluminum foil, thread, chalk, screws, jelly beans, and rubber bands.
3. As a variation on #2, conduct a scavenger hunt where students collect objects for testing. Have them divide the objects into three piles, based upon their predictions:

   a. Will attract
   b. Won't attract
   c. Unsure

Then have them test their predictions. Were they right?

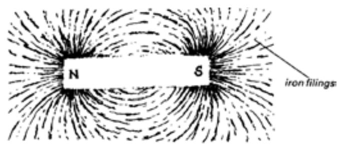
4. Combine equal amounts of iron filings and salt. Ask the students how they would separate the two with the least amount of effort. Pour the mixture onto a piece of paper and place your magnet under the paper. Once the iron filings all cling to the magnet, pour off the salt.
5. Have students try to pick up paper clips with an iron nail. Then have them magnetize their nail by stroking it gently in one direction only using the north pole of a magnet. After three to four minutes of stroking, most of the domains in the nail should be aligned. It is now a magnet and can pick up paper clips.

   a. Carry it a step further by charting how many paper clips the nail will pick up after stroking the nail with a magnet for 30 second time intervals, from 0.0 through 4.0 minutes.

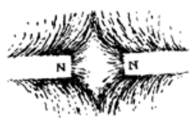
Magnetic Fields

Like sound, magnetic fields can't be seen. However, their effects can be seen. Again, the following activity can be done either as a demonstration, or as a student activity. For this you will need a pair of powerful bar magnets and about 1⁄4 to 1⁄2 cup of iron filings. (You can order iron filings from online or, better yet, get them for free at your friendly neighborhood auto mechanic shop. Take a Ziploc bag and be prepared for raised eyebrows!)

1. Place a piece of construction paper over a magnet. Pour enough iron filings onto the paper so that the magnetic field becomes visible. Explain how the magnetic field is there all along, even though we can't see it.



2. Now demonstrate attraction and repulsion by using two bar magnets under the paper:



3. It is important for students to understand that the above demonstrations are only two dimensional, while magnetic fields are actually three dimensional. To help students visualize a 3-D magnetic field, tie a string around a plastic-wrapped magnet; mix iron filings in a beaker of liquid (water, corn syrup, or vegetable oil) and quickly lower the magnet into the liquid.

Magnets

The Biggest Magnet of All: Earth

Just like a small magnet, our planet has a magnetic field with a magnetic north pole and a magnetic south pole. Magnetic fields extend infinitely, although they weaken the farther they get from their source. The active magnetic field surrounding earth, which extends for hundreds of miles into space, is called the *magnetosphere*.

Compass Curiosities

Compasses work using a lightweight magnet balanced on a pivot point. The end of the needle marked "N," or the red end, always points toward Earth's magnetic north pole. In this section, students will explore compasses through the following activities. Each student pair should have a compass.

1. First teach students how to read a compass. Once they have a few "pointers," you can play the following games to increase aptitude.

   a. Have the students stand in pairs around the room. Call out a direction such as east or north. Students have ten seconds to consult their compasses and then face the correct direction. For each correct answer, the pair gets a point. Gradually make it more complicated by using directional combinations such as NW, or SE, or call out two directions at once, and each student pair must then divide and conquer. At the end, declare the winners.

   b. Give each student pair a map of their nation, geographic region, or city/town which they can lay flat on a desk. Have them orient their map so that north points north. (If there is a pre-printed compass on the map, have them cover it up.) Ask them to identify the various geographical directions by using their compass. For instance, if you are working with a map of the United States, have students identify the Northeast, the West, and so on. Have them find their own town on the map and answer questions such as,

      i. What is the closest city or town to the north?

      ii. What is the closest state to the southwest?

      iii. What is the southernmost state?

CAUTION: Never touch a magnet to a compass!

c. Take the class on a treasure hunt. They will need compasses and pieces of string cut in ten-foot increments. Pre-plan by hiding a treasure somewhere on the school grounds or in your classroom. Decide the route students will travel to get there and record it in terms of directions and distance. For instance, you might start under the big oak and say, "Go northwest thirty feet" . . . "Turn to the east and go twelve feet . . ." (NOTE: You may want to plant messages at each point so that students remain oriented.)

   i. For a variation or enrichment, divide the class into groups of four. Each group will create a treasure hunt. After all treasure hunts have been created, the hunts are shuffled and each group must solve another group's treasure hunt.

   ii. For another variation, conduct a similar quest indoors using only maps, compasses, and rulers. All student pairs must have the same map. Given a starting point on the map, they must work their way through the various clues, for example "Go SSW 2.7 inches," until they arrive at the secret destination.

2. See Reproducible #9 for an activity on constructing handmade compasses.

Going on a Magnet Hunt

As Drake and Nell explained in the story on electromagnets, some magnets occur naturally. An example would be lodestones, composed of magnetite. Ancient peoples discovered the existence of magnetism when they stumbled across lodestones. Lodestones became a means of early navigation, especially for ancient Arab and Greek explorers.

For this activity, students can hunt for their own naturally occurring magnets. Any magnets found will likely be mini-stones containing magnetite, or even manganese, hematite, and franklinite, other magnetic minerals.

Each student must have a strong U-shaped magnet protected in a plastic baggie. Conduct the search for mini-magnets by running the magnet through soil or sand (sand is especially good for this). Any mini-magnets will cling to the outside of the bag. Collect the mini-magnets in another plastic bag. If possible, study the particles under a low-powered microscope.

Resonance

The collapse of the Tacoma Narrows Bridge in 1940 is a spectacular example of resonance. If your class hasn't done so already, watch the four-minute video of the Tacoma Narrows Bridge: http://www.youtube.com/watch?v=3mclp9QmCGs. Afterward, discuss the concept of resonance.

Key Concepts:

1. All matter, from atoms to redwood trees, from bridges to skyscrapers, has a natural frequency. The natural frequency is that point at which an object vibrates freely. (Frequency equals the number of vibrations per second.)
2. When external forces exert vibrations at a frequency that matches an object's natural frequency, resonance occurs. When there is resonance, the vibrations become more pronounced, even violent.
3. Likewise, when external forces oppose an object's natural frequency, the vibrations become less pronounced.

All of the above key concepts can be easily discussed using a swing as an illustration, something with which most children are quite familiar.

1. Each swing has its own natural frequency, the rate at which it swings or vibrates back and forth. This natural frequency does not change, regardless of the length of the vibration. (The number of vibrations per second is constant.)
2. When someone pushes someone else on a swing, they match the swing's natural frequency by pushing away just as the swing pushes away. This creates resonance, and the vibrations become larger and more pronounced.
3. Likewise, if someone were to push away just as the swing comes toward them, they would oppose the swing's natural frequency, causing the strength of the vibrations to decrease.

Good Vibrations

The following activity can either be done as a demonstration or in pairs. For this you will need modeling clay, pipe cleaners, and a Styrofoam™ block. Before each demo, have the students predict what will happen.

1. Make three equal-sized balls of clay, about 1.5 to 2 cm in diameter.
2. Stick a 10 cm piece of pipe cleaner into the center of each ball so that it looks like a lollipop. (NOTE: You can make longer stems by using stiffer wire or smaller balls.)
3. Poke each stick and ball into the Styrofoam™ block so that they stand at different heights – 3.5, 5.0, and 6.5 cm, for example.
4. One at a time, gently pull back each ball and release. Note the vibrational frequency. This is its natural frequency. Ask the class which stick and ball has the highest frequency. (The one with the fastest vibration.) Notice that the natural frequency of each stick and ball stays the same, regardless of the size of the vibrations.
5. Now move the Styrofoam™ block back and forth with your hand. Start slowly and gradually build up speed. One by one, beginning with the stick and ball with the lowest frequency, the rhythm of the Styrofoam™ will match the frequency of the stick and ball, creating resonance. The vibrations of that stick and ball will increase dramatically. As you continue to increase the frequency, you will pass out of its natural frequency range and the resonance will decrease. The stick and ball with the next highest frequency will then begin to resonate with the increased frequency, and so on.
6. This demonstration can be varied as follows:
   a. Vary the size of the ball but keep the stick the same height.
   b. Vary the size of the ball as well as the height of the stick.
   c. Use two pipe cleaners in a ball instead of one.
7. Ask the class whether this demonstration illustrates some of the dynamics happening in an earthquake. In what ways are the different sizes and heights of the balls and sticks similar to the variety of buildings?

NAME ______________________________ **Reproducible #1**

Create your own character

In this activity you will create your own character. Just use your imagination and have fun!

Name of your character: ______________________________

What does your character look like? (Eye color, hair color, big elbows, etc.)

____

____

What kinds of things does your character like? Dislike? ______________________________

____

____

What will your character be when he/she grows up? ______________________________

____

____

What is the most unusual thing about your character? ______________________________

____

____

What secret does your character have? ______________________________

____

____

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How would your character interact with Drake Doyle and Nell Fossey?____________________

____

____

How would your character interact with James Frisco and Baloney?______________________

____

____

If you met your character in real life, do you think you would like him or her?
Why or why not?____

____

____

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NAME ______________________________ **Reproducible #2**

The Mysterious Mystery

Roll up your sleeves and get ready to write your very own mystery. Like all good writers (and scientists), you must first think about your mystery and make preparations.

Think about it:

Choose one of the following titles for your mystery or make up one of your own:
a. The Case of the Dangerous Doormat
b. The Case of the Pie-Eating Plant
c. The Case of the Missing Mayor

What mysterious thing has happened? ______________________________

____

Who will be the hero (protagonist) of your mystery? ______________________________

____

Who (or what) is the antagonist? ______________________________

____

What is the possible motive? ______________________________

____

What will happen if the mystery isn't solved? ______________________________

____

What clues are there to help your protagonist solve the mystery? ____________________

____

How will your mystery resolve? ____

____

Now write your mysterious mystery!

____

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NAME ____________________________________

Alliteration

A sequence of the same sounds is called alliteration. Drake Doyle and Nell Fossey frequently use alliteration, such as when Drake says, "Edgar Glum's got ghosts and ghouls." In this activity, you will construct your own alliterations. **Complete the following sentences, using alliteration.** Use your imagination!

Example: *Penelope plopped purple potatoes upon her plate.*

1. Betty bought ____

2. Carrie carried ____

3. Dan didn't ____

4. Fred found ____

5. Sam saw ____

6. Noah never ____

Make up an alliterative sentence of your own:

____

____

NAME ____________________

Operation Word Find

Put on your detective gear and find the following words in the grid below.
The words are hidden forwards and backwards, up and down, and even diagonally.

alien
amplification
atoms
binoculars
biocontrol agent
biology
circuit
conclusions
condensation
current
diameter
ecosystem
electromagnet
evaporation
frequency
hypothesis
interconnected
molecules
noxious weeds
observation
periscope
precipitation
procedure
resonance
scientific method
simulation
solution
surveillance
terminal
vapor
vibration
wetland

D	F	I	W	E	B	I	N	O	C	U	L	A	R	S	O	F	I	S
I	Z	O	S	I	M	U	L	A	T	I	O	N	E	P	C	R	S	Y
F	S	G	E	O	O	H	N	O	X	I	O	U	S	W	E	E	D	S
N	C	H	Z	U	L	Y	I	L	B	I	M	F	O	A	R	Q	N	P
E	I	Y	U	H	E	C	C	A	T	D	W	S	N	L	U	U	A	N
E	E	D	T	S	C	U	R	A	B	R	O	U	A	E	D	E	L	O
V	N	O	I	S	U	R	V	E	I	L	L	A	N	C	E	N	T	I
A	T	I	Y	N	L	R	A	C	O	J	P	S	C	T	C	C	E	T
P	I	H	S	L	E	E	P	O	C	S	I	R	E	P	O	Y	W	A
O	F	Y	G	S	S	N	O	S	O	Y	T	T	O	E	R	N	I	R
R	I	P	B	C	O	T	R	Y	N	U	E	K	S	W	P	O	E	B
A	C	O	J	Q	U	E	L	S	T	V	R	B	U	I	D	I	S	I
T	M	T	U	E	L	E	C	T	R	O	M	A	G	N	E	T	C	V
I	E	H	Y	T	S	A	I	E	O	F	I	H	N	X	U	A	O	E
O	T	E	R	S	T	P	R	M	L	A	N	E	T	I	O	T	N	D
N	H	S	R	O	I	T	Y	E	A	B	A	D	H	P	L	I	S	I
E	O	I	M	L	R	R	U	Y	G	O	L	O	I	B	C	P	O	A
I	D	S	D	U	T	I	A	E	E	X	C	I	R	C	U	I	T	M
L	T	I	N	T	E	R	C	O	N	N	E	C	T	E	D	C	E	E
A	M	P	L	I	F	I	C	A	T	I	O	N	S	F	U	E	B	T
Q	U	E	C	O	N	C	L	U	S	I	O	N	S	D	M	R	O	E
C	V	L	I	N	O	I	T	A	S	N	E	D	N	O	C	P	V	R

NAME ____________________ **Reproducible #5**

Operation Circle-the-Word

Complete the following sentences by circling the correct word.

1. Nell studied the leaf with her magnifying glass and recorded her *observations / scientific method* in her lab notebook.

2. Birds, frogs, and marsh grasses are found in *molecules / wetlands*.

3. Drake observed the mossy lake bridge, noting the frequency of its *current / vibration*.

4. After the experiment was complete, Drake said, "Ah-ha! I know the answer!" and wrote his *hypothesis / conclusions* in his lab notebook.

5. It was a powerful *simulation / electromagnet*, capable of picking up cars and even trucks.

6. The purple loosegoose was a *noxious weed / biocontrol agent* that didn't belong in the wetland.

7. When the crowd couldn't hear Nell speaking, she used a megaphone for *amplification / frequency*.

8. When Drake snipped the wire, he broke the electrical *circuit / terminal* which led from Frisco's pocket to the electromagnet.

9. Nell observed that when she sang in the shower, one note in particular had *resonance / condensation* with the bathroom.

10. Wetlands, deserts, ocean beaches, and prairies, are all examples of *aliens / ecosystems*.

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NAME ________________________ **Reproducible #6**

It's Just Dirt, Right?

Ever wondered what's lurking in dirt? Maybe not, but you're going to find out anyway. **Conduct the following activity and brace yourself for the results.**

MATERIALS:

- rubbing alcohol
- clear glass jar or bottle
- fine-meshed screen (should be pliable with no stiff borders)
- funnel
- handful of soil (must NOT contain pesticides!)
- lamp with bright light
- stir stick
- eye dropper
- microscope slide
- low-powered microscope



Procedure

1. Pour alcohol into the jar/bottle until it is 1/2 inch deep.
2. Fit the screen into the funnel so that when soil is placed in the funnel, it cannot fall through.
3. Place the funnel into the mouth of the jar/bottle.
4. Pour the soil into funnel (nestled inside the screen).
5. Shine a lamp into the top of the funnel.
6. After 2-3 days, remove the funnel and gently stir the alcohol.
7. Using the eye dropper, place a drop of alcohol on a slide and observe under a low-powered microscope.
8. Record your observations in your lab notebook. Include drawings of what you see.
9. As you write your conclusions, here are some questions to consider:
   a. Is soil its own miniature ecosystem?
   b. If soil is a mini-ecosystem, what characteristics make soil healthy?
   c. What effect would pesticides have on soil? Is that good or bad? Why?
   d. What kind of soil do you think plants would grow well in? Why?

NAME ____________________ **Reproducible #7**

Do the Math

The Background:

- It's 1858. You are Lord Wrightway of London, and you've just moved to Australia. You miss home. You write your nephew and ask him to send you twelve pairs of rabbits because there aren't any rabbits in Australia.
- Ten months later the rabbits arrive and you release them onto your vast estate.

The Problem:

- There are few natural predators in Australia.
- Rabbits like to have babies. Lots of babies.

Female rabbit: **doe**
Male rabbit: **buck**
Baby rabbit: **kit** or **kitten**

The Math:

1. A doe can have up to seven litters per year. If there are six kits per litter, how many kits will one doe produce in one year?

2. How many kits will twelve does produce in one year?

3. Assume that half of the kits produced in #2 are female. Once they can have babies themselves, how many kits would they produce in one year?

4. If one breeding pair of rabbits produces a total of 184 kits in 18 months (including grandkits, and great-grandkits, etc., etc.) then how many kits would 12 breeding pairs produce in the same amount of time?

5. If one rabbit eats 200 grams of vegetation per day, how many grams would one rabbit eat in one year?

6. A sheep eats 730,000 grams of vegetation per year. How many rabbits would it take to eat that much vegetation in one year?

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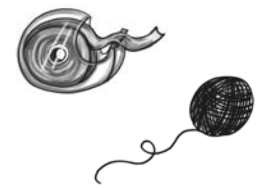
NAME ____________________________________ **Reproducible #8**

Magnet Magic



1. Using tape and string, suspend a bar magnet from the edge of a table so that it hangs freely. Bring a second bar magnet to the first and record what happens when you do the following:

   a. North pole to north pole: ____________________________________

   b. South pole to south pole: ____________________________________

   c. South pole to north pole: ____________________________________

   d. North pole to south pole: ____________________________________

2. Now test what kinds of objects your magnet is attracted to. Before you test each one, make your prediction. Then test the object and write your results. Were you right?

	Prediction	Result
a. Safety pins	Yes / No	________
b. Beans	Yes / No	________
c. Iron nails	Yes / No	________
d. Pennies	Yes / No	________
e. Paper clips	Yes / No	________
f. Glass marbles	Yes / No	________
g. Steel bb's	Yes / No	________
h. Aluminum foil	Yes / No	________
i. Thread	Yes / No	________
j. Piece of chalk	Yes / No	________
k. Jelly beans	Yes / No	________
l. Rubber bands	Yes / No	________

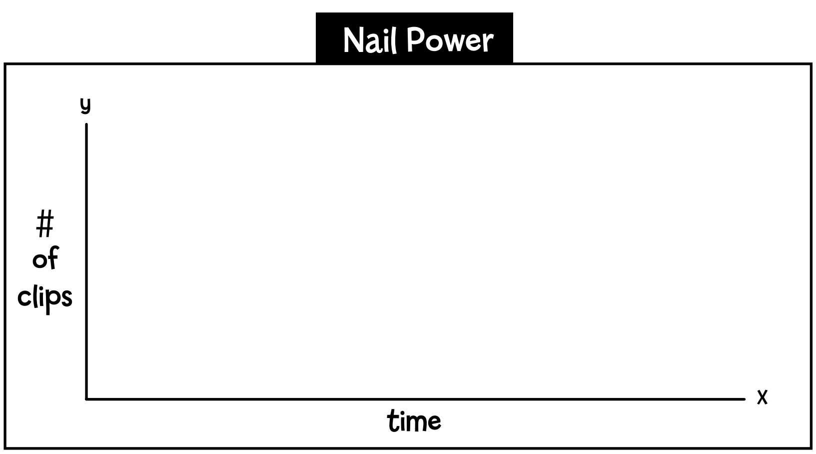
3. First, see how many paper clips you can pick up using just an iron nail. Then take your magnet and stroke the nail for 30 seconds in one direction over and over again with the north pole of your magnet. How many paper clips can the nail pick up now? Record your answer. Continue another 30 seconds as you fill in the data below:

Time	# of paper clips	Time	# of paper clips
a. 0 sec	________	f. 2 min, 30 sec	________
b. 30 sec	________	g. 3 min	________
c. 1 min	________	h. 3 min, 30 sec	________
d. 1 min, 30 sec	________	i. 4 min	________
e. 2 min	________		

What happened and why? ____

____

4. Graph your results from #3:



GRAPHING HINTS:

- Plot your time intervals along the “x” axis.
- Plot the # of paper clips along the “y” axis.
- Use your results to place a dot where “x” and “y” intersect.
- Connect the dots.

NAME ______________________________

Lost in the woods . . .

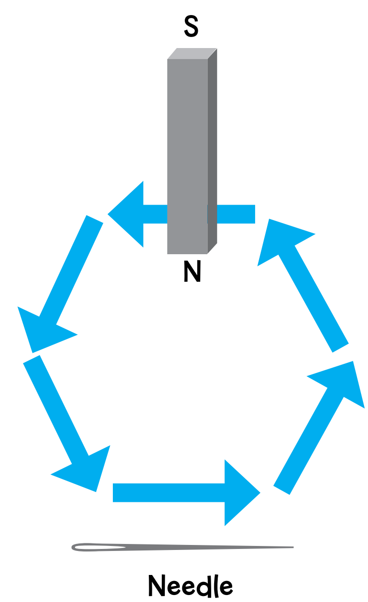
Imagine it. You're lost in the woods with no compass. You check your pockets and all you have is a magnet, a glass pie plate, a sewing needle, and a piece of cork. Great Scott, you're in luck! With those materials you can make your own compass and then head in the right direction!

Materials:
• bar magnet
• glass pie plate
• sewing needle
• piece of cork or piece of Styrofoam™

CAUTION: Be careful with your sewing needle as it is very sharp. Do not poke yourself or anyone else with it!

Procedure

1. Fill the glass pie plate 1/2 full of water.
2. Place the piece of cork or Styrofoam™ on the water. It should float freely. If it doesn't, add more water.
3. Using only the north pole end of your magnet, stroke the sewing needle *in one direction only*, over and over again for two minutes. (Note: keep the magnet far away from the needle whenever you bring the magnet back into the start position. A circular-type motion works well.)
4. Now place the needle on the cork or Styrofoam™. The end of the needle that was at the start of the stroke will point North.
5. Pick up the cork and needle and place it back down, this time pointing in a different direction. What happens?
6. Check the accuracy of your home-made compass against a real compass. How accurate is it?



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