This edition of the WonderWorks Lab Manual represents our commitment to assist educators and parents in teaching scientific concepts to their students.

These lessons include the New York State Standards for your convenience. Understanding the trends in education, we have also included some reading literature for your reference. Each activity is interesting and will be easy for the students to perform. Please feel free to use the material contained in this manual at your discretion.

We look forward to greeting your student groups in the near future.
If you have any questions or suggestions, please do not hesitate to contact us.

Scientifically,

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Special thanks to all the teachers that contributed with their innovative ideas and submitted their classroom activities. These plans have been adapted from our Florida location to meet the New York State Standards.

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Angles with the Strongest Bubbles

Submitted by LeeAnne C. Herold

WonderWorks Connection: *Bubble Lab*

NY State Standards

Strand PS: Physical Setting – Properties of Matter

PS3.1f: Compare materials and objects according to properties such as size, shape, color, texture, and hardness.
PS3.1e: Measure and compare objects and materials based on their physical properties including mass, shape, volume, color, hardness, texture, odor, taste, attraction to magnets.
PS3.1b: Compare and contrast the basics properties of solids, liquids and gases, such as mass, volume, color, texture, and temperature.
PS3.1a: Classify and compare substances on the basis of characteristic physical properties that can be demonstrated or measured; for example, density, thermal or electrical conductivity, solubility, magnetic properties, melting and boiling points, and know that these properties are independent of the amount of the sample.
PS3.1: Distinguish among mixtures (including solutions) and pure substances.

Strand S: Scientific Inquiry

S1.1.4: Compare the observations made by different groups using the same tools and seek reasons to explain the differences across groups.
S1.3.1: Keep records as appropriate, such as pictorial, written, or simple charts and graphs or investigations conducted.
S1.3.2: Attempt reasonable answers to scientific questions and cite evidence in support.
S1.3.2: Recognize and explain the need for repeated experimental trials.
S1.1.: Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.

Related Literature:
How to Make Monstrous, Huge, Unbelievably Big Bubbles by David Stein
Bubble Bubble by Mercer Mayer
Bubble Trouble (Ready-to-Reads) by Stephen Krensky and Jimmy Pickering
The Science of Soap Films and Soap Bubbles by Cyril Isenberg

Activity

Materials:

- Dropper
- Three beakers
- Water
- Dawn dish detergent
- White Karo syrup
- Bubble wand (purchased or created from wire)
- White paper
- Black marker
- Protractor
- Stop watch

Procedure:

1. In the first beaker, mix ten drops of water, five drops of dish detergent, and five drops of Karo syrup. Label the beaker "High Water".
2. In the second beaker, mix five drops of water, ten drops of dish detergent, and five drops of Karo syrup. Label the beaker "High Detergent".
3. In the third beaker, mix five drops of water, five drops of dish detergent, and ten drops of Karo syrup. Label the beaker "High Syrup".
4. Most bubble solutions that you purchase contain glycerin. A substance that acts in the same was as glycerin in terms of bubbles is Karo syrup. Make a hypothesis about which one of your bubble solutions will produce the longest lasting bubbles. In your hypothesis, also state which solution you think will produce the shortest lasting bubbles. Make sure you give reasons to back up what you think will happen.

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5. Using the "High Water" beaker and the bubble wand, blow a bubble. As accurately as possible, determine and record the amount of time the bubble lasted. Repeat this five times.
6. Using the "High Detergent" beaker and the bubble wand, blow a bubble. As accurately as possible, determine record the amount of time the bubble lasted. Repeat this five times.
7. Using the "High Syrup" beaker and the bubble wand, blow a bubble. As accurately as possible, determine and record the amount of time the bubble lasted. Repeat this five times.

8. Answer the following questions based on what you observed.
   Was your hypothesis correct? What data did you collect that let you know how accurate your hypothesis is?

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   Try blowing a bubble with just the Karo syrup alone. What is the result?

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   What do you think would happen if you tried blowing a bubble with just the water? What about using just the dish detergent?

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   Using your own knowledge, or with the direction of your teacher, construct a 120 degree angle on the white paper. Trace the angle with the black marker. With two of your friends, use the High Syrup beaker and the bubble wands to blow one bubble each. You will each need to keep the bubble on the wand for this activity. Now, move your wands so that all three of the bubbles are touching. Hold the paper with the 120 degree angle under your bubbles. Does the angle you drew line up with the angles formed where the bubbles meet?

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   Amazingly, when three or more bubbles join, the angles formed will always measure 120 degrees. Try this with four friends and bubbles, then five, then six. Do you always get 120 degrees?

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Angles with the Strongest Bubbles

Writing Prompt:

An astronaut living on the Space Station discovered that (in space) extremely strong bubbles can be created using only water. This amazing discovery happened accidentally. Think of a time that you were part of an accident. What happened? Was the outcome favorable or unfavorable? How was the accident useful?

Average Speed Machine

Submitted by LeeAnne C. Herold

WonderWorks Connection: *Velocity Ball, WonderCoaster*

NY State Standards

Strand PS: Physical Setting – Forces and Changes in Motion

PS4.1a: Observe and describe some basic forms of energy, including light, heat, sound, electrical, and the energy of motion.

PS4.1e: Investigate and describe that energy has the ability to cause motion or create change.

PS4.3: Recognize that an object in motion always changes its position and may change its direction.

PS5.1a: Investigate and describe that the speed of an object is determined by the distance it travels in a unit of time and that objects can move at different speeds.

PS4.5b: Investigate and explain that energy has the ability to cause motion or create change.

PS5.1b: Identify familiar forces that cause objects to move, such as pushes or pulls, including gravity acting on falling objects.

PS5.1d: Investigate and describe that the greater the force applied to it, the greater the change in motion of a given object.

PS5.1d: Measure and graph distance versus time for an object moving at a constant speed. Interpret this relationship.

PS5.2a: Investigate and describe types of forces including contact forces and forces acting at a distance, such as electrical, magnetic, and gravitational.

Activity

During this activity, you will be building a "machine" that rolls a marble at an average speed of 10cm/second. To do this you first need to know that average speed is a calculation of the averages of all the actual speeds at which an object was moving during a trip.

To find average speed, you take the total distance traveled, and divide it by the time it took for the object to travel that distance. This gives you the formula:

average speed = distance / time.

Materials:

- Copy paper
- Scotch tape
- Metric ruler
- Stop watch
- Yarn
- Marble

Procedure:

1. Construct a "machine" from the copy paper and tape. The design of the machine is completely up to you, but must create an average speed of 10cm/second for the marble that will be traveling in the machine.

Machine Requirements:

1. The machine must launch the marble at the starting point.
2. The marble must travel at an average speed of 10cm/second.
3. The marble must come to a complete stop at the end point.

Helpful Hints:

1. Lay the yarn inside your track, and then measure the yarn to find the distance the marble traveled.
2. Think about things that speed up, or slow down, people when they are driving, riding a bike, running, etc. How can these things apply to the construction of your machine?
3. Use the stop watch to time the marble. Have one group member control the stop watch; have another member start the marble.

Questions:

1. Did you find you had to work to speed up, or slow down your marble?

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2. What frustrations did you encounter as you constructed this machine?

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3. How did you overcome the items that were frustrating?
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4. Research Newton’s Three Laws of Motion. How is each of the three laws represented by your average speed machine?

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Average Speed Machine

Writing Prompt:

Machines are inventions that were created to solve problems and make work easier. Choose three machines that you think are the most useful to people. Tell what the machines are, and why they have received your vote for being the most useful. What jobs do they help people do? What would happen if the machines were no longer available?

Categorizing Illusions

Submitted by LeeAnne C. Herold

WonderWorks Connection: *Inversion Tunnel*, *Spiral Vortex*, *Anti-Gravity Chamber*

NY State Standards

Strand LE: Living Environment

LE3.1a: Identify the organs in the human body and describe their functions, including the skin, brain, heart, lungs, stomach, liver, intestines, pancreas, muscles and skeleton, reproductive organs, kidneys, bladder, and sensory organs.
LE3.1a: Describe the structure of sensory organs. Relate structure to function in vertebrate sensory systems.

Strand S: Scientific Inquiry

S1.1a: Define a problem, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types such as: systematic observations, experiments requiring the identification of variables, collecting and organizing data, interpreting data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
S1.1b: Define a problem from the sixth grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types such as: systematic observations, experiments requiring the identification of variables, collecting and organizing data, interpreting data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
S1.1: Recognize that science involves creativity, not just in designing experiments, but also in creating explanations that fit evidence.

Related Literature:
"What is an Illusion" by JR Block, Ph. D.
The Great Book of Optical Illusions by Al Seckel
Amazing Optical Illusions by Illusionworks
Simple Optical Illusion Experiments with Everyday Materials by Michael A. DiSpezio
The Optical Illusion Book by Seymour Simon

Activity One:

Materials:

- Snack size Ziploc bag
- Quart size Ziploc bag
- Gallon size Ziploc bag
- Jellybeans
- Triple beam balance scale

Procedure:

1. Fill the snack size Ziploc bag with jellybeans.
2. Count the number of jelly beans it took to fill the bag.
3. Place the jellybeans back in the snack size Ziploc bag and seal the bag.
4. Place the same number of jellybeans in the quart size Ziploc bag.
5. Seal the quart size bag.
6. Place the same number of jellybeans in the gallon size Ziploc bag.
7. Seal the gallon size bag.
8. Hypothesize the weights of the bags containing the jellybeans.
9. Lift each one of the Ziploc bags containing the jellybeans.
10. Place them in order from heaviest to lightest.
11. Weight the snack size bag with the jellybeans and record the weight.
12. Estimate the weights of the other two bags containing jellybeans and record your predictions.
13. Weigh the other bags and record their actual weights.
14. Answer the following questions.

Post-Lab Questions:

1. Did the smallest bag feel considerably heavier than the largest bag when you lifted it?

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2. Were your predictions of the weights of the quart and gallon size bags very accurate?

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3. Were you surprised to find that there was such a small difference in the weights of the three bags containing jellybeans?

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What you just experienced is an example of an illusion. This illusion is brought about by expectation. When you see something large, you prepare yourself to lift a heavier object. In comparison, when you see a small object, you don't expect it to be very heavy.

Because your expectation of the larger bag caused you to exert more effort, the bag seemed much lighter than the smaller bags with the same number of jellybeans. Again, because of your expectation of the smaller bag, you automatically exerted less force when lifting it. This gave the illusion that the smaller bag was heavier, even though you knew it contained the same number of jellybeans.

Activity Two

Access the site www.sandlotscience.com. On this site, read "What is an Illusion?" by JR Block, Ph. D.

Answer the following questions using the article and the site listed above:

1. What are the main categories of optical illusions? Give the name and a description of each category.

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2. Now you will have the opportunity to view optical illusions. Enjoy doing so as you find *three examples for each of the main optical illusion categories*. List the category and the title of the each illusion in the space below.

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Categorizing Illusions

Writing Prompt:

Sometimes things aren't exactly as they seem. Think of a time that you misperceived a situation. What did you think was happening? What was really happening? How did your misperception of the situation affect your thoughts, feelings and/or actions? What was the outcome of the situation?

Constantly Changing World

Submitted by Nanita Lent

WonderWorks Connection**:** *Hurricane Shack, Earth Tic-Tac-Toe & Natural Disasters*

NY State Standards

Strand PS: Physical Setting

PS1.1a: Compare and describe changing patterns in nature that repeat themselves, such as weather conditions including temperature and precipitation, day to day and season to season.
PS2.1: Recognize that some of the weather-related differences, such as temperature and humidity, are found among different environments, such as swamps, deserts, and mountains.
PS2.1b: Describe characteristics (temperature and precipitation) of different climate zones as they relate to latitude, elevation, and proximity to bodies of water.
PS2.1d: Describe and give examples of ways in which Earth's surface is built up and torn down by physical and chemical weathering, erosion, and deposition.
PS2.1b: Describe how global patterns such as the jet stream and ocean currents influence local weather in measurable terms such as temperature, air pressure, wind direction and speed, and humidity and precipitation.
PS2.1e: Investigate how natural disasters have affected human life in New York.

Strand LE: Living Environment

LE3.1a: Describe how animals and plants respond to changing seasons.
LE2.1a: Explain that although characteristics of plants and animals are inherited, some characteristics can be affected by the environment.
PS7.1c: Recognize ways plants and animals, including humans, can impact the environment.

Strand S: Science Inquiry

S1.1-3 Raise questions about the natural world, use appropriate reference materials that support understanding to obtain information (identifying the source), conduct both individual and team investigations through free exploration and systematic investigations, and generate appropriate explanations based on those explorations

For grades 6^{th} – 8^{th}: S1.1a & b

Activity One

Pre-Lab Questions:

1. What is a hurricane?
2. How many hurricanes are predicted for this year?
3. How many of you have experienced a hurricane?
4. What were some things that happened during a hurricane?
5. Can you think of things we do to prevent damage from hurricanes?
6. How do you prepare for a hurricane?
7. How do man's actions hurt the chances of our environment and the organisms that live there to survive a hurricane?
8. How do you think the animals prepare and adapt to hurricanes?

Materials:

- Piece of Styrofoam 3' X 18" painted to look like the water with a beach on one end and a farmer's field on the other. Cut rows horizontal so that the rows run up to the beach area.
- Powdered Kool-Aid or Tempura Paint
- Spray bottle of water
- Plastic tub big enough to prop the Styrofoam in.

Procedure:

1. Make a KWL chart on hurricanes.
2. Have students break up into groups of 4-5.
3. Discuss with the students the problems the farmers face daily and yearly with their crops (drought, insects, wind damage, heavy rain, disease, etc.) and what they need to do to combat these problems.
4. Next have one student in each group sprinkle lightly the powdered Kool-Aid on the rows of crops on the Styrofoam to represent the fertilizers and pesticides used.
5. Have a student spray the crops with the spray bottle of water to represent water as the Styrofoam is tilted in the plastic tub (crops at the top)
6. Observe and record observations.
7. Discuss why this is bad for the environment and how it would cause the environment and organisms to be more susceptible to hurricane damage.
8. Discuss how to prevent the run-off into the water.

Post Lab Questions:

1. How were man's actions bad for the environment?
2. How could this type of damage be prevented?
3. Where have we seen this type of damage before? (New Orleans)
4. What are wetlands?
5. Why are they important to our environment as well as other organisms that depend on the wetlands?

Activity Two

Materials:

- Tubs of waters
- Sand
- Board big enough to hold the pans
- Dowels to use as rollers
- Hairdryer (optional)

Procedure:

1. Have the students create a beach in the tub and add water to simulate a beach. (optional to add buildings)
2. Have students place board on dowels.
3. Place tub on board.
4. Gently roll the tub back and forth to simulate wave action.
5. Observe what happens to the sand.
6. Roll faster and observe the difference.
7. Design a Venn Diagram to compare the gentle waves to the harder waves on the beach.
8. If you wish, use a hairdryer to simulate wind pushed waves on the beach and observe the results.
9. Compare results with the shaking waves.

Post Lab Questions:

1. What is the worst part of a hurricane for our beaches?
2. How can we possibly prevent this?
3. Are there other ways to cause large waves on the beach?
4. How does this compare to a Tsunami?

Extensions:

1. Have students design ways to prevent beach erosion and test.
2. Have students design buildings that could withstand a hurricane's wind and/or surge.
3. Tie it into Earthquakes by having students see how Earthquakes shape the Earth changing environments and ecosystems.
4. Look at a hurricane from an animal's point of view.
5. Research how wild animals survive hurricanes and other natural disasters.
6. Calculate the probability of hurricanes that could hit Florida based on currents (Use NOAA data) or base it on the number of hurricanes that hit in the last 10 years.

Design a Simple Machine Olympics

Submitted by LeeAnne C. Herold

WonderWorks Connection: *Pull Yourself Up!*

NY State Standards

Strand PS: Physical Setting – Forces and Changes in Motion

PS5.1: Identify familiar forces that cause objects to move, such as pushes or pulls, including gravity acting on falling objects.

PS5.1d: Investigate and describe that the greater the force applied to it, the greater the change in motion of a given object.

PS5.1d: Investigate and describe that the more mass an object has, the less effect a given force will have on the object's motion.

Strand S: Scientific Inquiry

S1.1: Raise questions about the natural world, investigate them individually and in teams through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.

S1.1: Recognize that science involves creativity in designing experiments.

S.1a & b: Define a problem, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types such as: systematic observations, experiments requiring the identification of variables, collecting and organizing data, interpreting data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

Related literature:
Simple Machines (Starting with Science) by Adrienne Mason
Simple Machines by Allan Fowler
How Do You Lift a Lion? by Robert Wells
Experiments with Simple Machines by Salvatore Tocci
Simple Machines Made Simple by Ralph St. Andre

Activity

During this activity, you will be working to design "events" for an "Olympics" that is based on simple machines. Because there are six basic types of simple machines, you will design six events. In each event, teams of four must work together to complete the task that you have created. You will also have to have a system for determining the winner of each event.

Please respond to the following as you research the simple machines, and plan your events:

Lever:

1. What is a lever? How does a lever work?
2. What will the teams be doing in your lever event?
3. How will you determine the winner of this event?

Inclined Plane:

1. What is an inclined plane? How does an inclined plane work?
2. What will the teams be doing in your inclined plane event?
3. How will you determine the winner of this event?

Wedge:

1. What is a wedge? How does a wedge work?
2. What will the teams be doing in your wedge event?
3. How will you determine the winner of this event?

Screw:

1. What is a screw? How does a screw work?
2. What will the teams be doing in your screw event?
3. How will you determine the winner of this event?

Wheel and Axle:

1. What is a wheel and axle? How does a wheel and axle work?
2. What will the teams be doing in your wheel and axle event?
3. How will you determine the winner of this event?

Pulley:

1. What is a pulley? How does a pulley work?
2. What will the teams be doing in your pulley event?
3. How will you determine the winner of this event?

List the materials you will need for each event:

1. Lever
2. Inclined Plane
3. Wedge
4. Screw
5. Wheel and Axle
6. Pulley

The purpose of simple machines is to make-work easier. Tell how the simple machine used in each event makes work easier for the teams.

1. Lever
2. Inclined Plane
3. Wedge
4. Screw
5. Wheel and Axle
6. Pulley

Where will you hold your Simple Machine Olympics?

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What people will you need to get permission and help from in order to make this event successful?

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List the steps you will follow to make your Simple Machine Olympics run smoothly:

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Design a Simple Machine Olympics

Writing Prompt:

Planning a large event takes a great deal of planning. Tell about a large event that you were a part of that required lots of planning for it to be successful. What was the event? What steps did you take to prepare for the event? What steps were necessary for the event to be carried out?

Electrifying Balls

Submitted by Heather Himes

WonderWorks Connection: *Wacky Wires*

NY Standards

Strand PS: Physical Setting (suitable for grades 6-12)
Focus of Lesson: Electricity (Series vs. Parallel Circuits and Conductors vs. Insulators)

PS3.2e: Explore the Law of Conservation of Energy by differentiating between potential and kinetic energy. Identify situations where kinetic energy is transformed into potential energy and vice versa.

PS5.2a: Investigate and describe types of forces including contact forces and forces acting at a distance, such as electrical, magnetic, and gravitational.

PS45b: Investigate and describe the transformation of energy from one form to another.

PS4.5a: Cite evidence to explain that energy cannot be created nor destroyed, only changed from one form to another.

PS3.1a: Classify and compare substances on the basis of characteristic physical properties that can be demonstrated or measured; for example, density, thermal or electrical conductivity, solubility, magnetic properties, melting and boiling points, and know that these properties are independent of the amount of the sample.

Strand S: Scientific Inquiry

S1.1a & b: Define a problem, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types such as: systematic observations, experiments requiring the identification of variables, collecting and organizing data, interpreting data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

Activity

Materials: (per group of 4-5)

- Circuits, Conductors, & Insulators Handout;
- tennis ball
- 1 beaker of dish liquid, 1 beaker of water, 1 beaker of soda
- paper clip
- piece of wood
- felt
- penny
- rubber band
- colored pencil
- Ziploc bag
- glass marble
- aluminum foil
- energy ball
- construction paper
- markers/colored pencils/crayons
- rulers

Objectives: The student will

- ✓ Use energy balls to model series and parallel circuits and demonstrate various properties of the two types of circuits.
- ✓ Identify energy transformations.
- ✓ Compare/contrast series and parallel circuits.
- ✓ Identify examples of series and parallel circuits found in his/her house.
- ✓ Contrast conductors and insulators.
- ✓ Predict whether various materials are conductors or insulators.
- ✓ Design an experiment using an energy ball to determine if various materials are conductors or insulators.
- ✓ Make a generalization about which materials make good conductors and which make good insulators.
- ✓ Create a poster summarizing what he/she has learned about electricity.

Assessment: Student responses to discussion, lab reports, posters, and teacher observations

Instruction:

- Discuss top portion of handout on circuits (see attached).
- Energy Ball Demonstrations
  - Energy balls are ping pong balls with built-in circuits. When the circuit is closed, the energy ball will light up and make a sound. They can be found at http://www.physlink.com/estore/cart/EnergyBall.cfm
  - Have students form a large circle and join hands. The teacher will touch one connector on the energy ball, while the student next to her touches the other

connector. As long as the students' hands are joined, the energy ball will flash and make an "eerie" sound.
    - Have two students drop hands, breaking the series circuit and observe what happens.
    - Repeat demonstration, but with a parallel circuit instead. Have 4-5 students form a second pathway down the center of your original circuit.
    - Discuss applications of observations and energy transformations. Have students complete activity sheet.
    - Lead into discussion about conductors and insulators by pointing out that we allowed the current to pass through us as we were holding hands. Are there materials that will not allow current to pass through?
- Conductor/Insulator Lab (see attached)
    - Place students in groups of 4-5. Have the students work on their predictions while you distribute supplies.
    - Allow students time to conduct lab and answer questions.
    - Discuss findings and address any misconceptions.
- Poster Wrap-up
    - Have the groups create posters summarizing what they have learned about electricity today.
    - Poster must include at least two illustrations.

Scientific Explanation of the Activity

Through this lesson the students will be able to be a part of a series and a parallel circuit and witness some pros and cons to the different circuits. Additionally, they will be able to distinguish between conductors and insulators and identify our own bodies as conductors. Furthermore, they will be working on scientific skills, such as predicting, classifying, and designing experiments. Finally, the poster allows them to be creative, while at the same time demonstrating what they have learned. This not only provides reinforcement of the ideas and concepts; it allows the teacher to quickly assess student learning.

Reading/Literacy Strategies

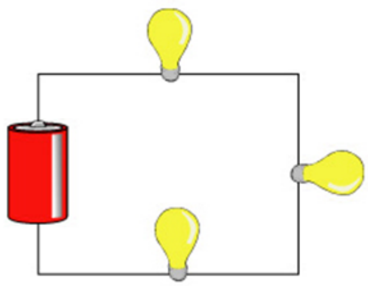
- ✓ Building Background Knowledge
- ✓ Categorize/classify
- ✓ Compare/contrast
- ✓ Drawing conclusions
- ✓ Interpreting diagrams and illustrations

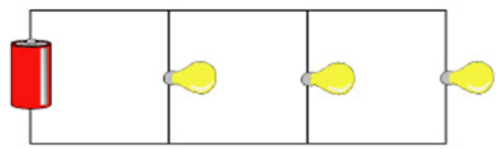
Circuits

Circuit – a closed path through which a continuous charge (electricity) can flow

Series circuit – one path for the current to follow

Parallel circuit – more than one path for circuit to flow





Which diagram represents a series circuit? A parallel circuit?

1. Identify at least three circuits that are in your actual house or items in your house that are series circuits.

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2. Identify at least three circuits that are in your actual house or items in your house that are parallel circuits.

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3. What energy transformations took place in our activity?

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Conductors and Insulators

Conductor – material that transfers electric charge easily

Insulator – material that does **not** transfer electric charge easily

Directions: Using your energy ball, develop a way to determine if the following materials are insulators or conductors.

*Before you begin, use your prior knowledge to predict whether or not the materials are insulators or conductors.

Material	**Prediction** Insulator or Conductor?	**Conductor**	**Insulator**
Tennis Ball			
Dish Liquid			
Paper Clip			
Water			
Wood			
Felt			
Penny			
Rubber band			
Colored Pencil			
Plastic (Ziploc bag)			
Glass (marble)			
Aluminum foil			
Soda			

Conclusions:

1. How did your predictions compare to your actual results?

2. Write a generalization about the types of materials that are good conductors and the types of materials that are good insulators.

Just Take It Easy

Submitted by Tim Brewer

WonderWorks Connection*:* *MindBall*

NY State Standards

Strand LE: Living Environment

LE3.1 Identify the organs of the human body and describe their functions, including the skin, brain, heart, lungs, stomach, liver intestines, pancreas, muscles and skeleton, reproductive organs, kidneys, bladder, and sensory organs.

Strand S: Scientific Inquiry

S1.2: Recognize and explain that science is grounded in empirical observations that are testable; explanation must always be linked with evidence.

Introduction:

Houghton Mifflin Harcourt Publishing Company Fifth grade textbook has a story that talks about ***Biofeedback Technology*** (Section 4 Mae Jemison Space Scientist: Pages 210-222)

Mae Jamison was an astronaut on the space shuttle Endeavour that was launched on September 12, 1992. She was the first African women in space. Her mission was to use biofeedback techniques to help with space sickness.

Helpful Internet sites (articles) that student can read to supplement the textbook story:

- http://www.umm.edu/altmed/articles/biofeedback-000349.htm
- http://www.7hz.com/what.html

The Heart

Today we will do nothing in science! Yes, that’s right; we will investigate how doing as little as possible affects our heart.

Pre-Lab Question:

1. How does relaxing affect our heart rate and respiration rate?

Hypothesis:

I think the less I do ……

Materials:

- Stop watch

Procedure:

1. Before starting the lesson all students should be shown how to take their pulse
2. After walking in place for 3 minutes take heart rate for 1 minute.
3. After pulse, count how many breaths the student take in 1 minute.
4. Record results.
5. Turn out lights and have students sit on a chair.
6. Wait 3 minutes and take pulse for 1 minute and then respiration rate for 1 minute, record results.
7. Finally have students place head down on desk or lie on floor and do as little as possible for 3 minutes.
8. Take pulse rate for 1 minute and then respiration for 1 minute
9. Compare results and graph.

Observation:

Activity	Pulse	Respiration
1. Walking		
2. Chair		
3. Head down		

Conclusion:

How did the heart rate and respiration rate change?

Extension 1: At *WonderWorks* ***MindBall*** exhibit, students can experience biofeedback technology first hand. Participants wear headbands containing electrodes which are constantly measuring the participants' brains EEG activities. Alpha & Theta brainwaves are strongest when a person is calm and relaxed or concentrating intently. The players and the audience can follow the mental process during the game as the player's brain activity is presented graphically on a 52" monitor. The most relaxed player wins!

Puzzling Plates

Submitted by LeeAnne C. Herold

WonderWorks Connection: *Natural Disasters Computers*

NY State Standards

Strand PS: Physical Setting

PS2.1g-i: Describe the basic differences between physical weathering (breaking down of rock by wind, water, ice, temperature change, and plants) and erosion (movement of rock by gravity, wind, water, and ice).

PS2.1h: Describe and give examples of ways in which Earth's surface is built up and torn down by physical and chemical weathering, erosion, and deposition.

Strand S: Scientific Inquiry

S1.1: Raise questions about the natural world, use appropriate reference materials that support understanding to obtain information (identifying the source), conduct both individual and team investigations through free exploration and systematic investigations, and generate appropriate explanations based on those explorations.

S1.3: Attempt reasonable answers to scientific questions and cite evidence in support.

S1.1a & b: Define a problem, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigations of various types such as: systematic observations, experiments requiring the identification of variables, collecting and organizing data, interpreting data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.

Related Literature:

Earthquakes (Let's Read and Find Out Science) by Franklyn M. Branley
Earthquakes by Seymor Simon
Plate Tectonics (Great Ideas of Science) by Rebecca L. Johnson
Earth's Changing Crust: Plate Tectonics and Extreme Events by Rebecca Harman

Activity

Materials:

- Oval shaped paper plate
- Colored pencils, crayons, and/or markers
- Robinson Projection World Map with the major tectonic plates outlined

Procedure:

1. Recreate the Robinson Project World Map on your paper plate. It is easiest to do this with the plate flipped upside down.
2. Add the outline of the major tectonic plates to your map.
3. Using the colored pencils, crayons, and markers add color and detail to your map.
4. Once you have finished, cut the map apart following the outline of the major tectonic plates.
5. Practice putting together the Tectonic Plate puzzle that you just created.
6. Trade puzzles with a friend, and practice putting their puzzle together.

Answer these questions as you observe the features of the puzzle:

1. What statements can you make about the sizes of the plates? Are they all about the same size and shape, or do you notice differences?

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2. Are the plates covered equally by both land and water? What statements can you make about the differences in amounts of land and water?

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3. These tectonic plates float on top of the lower part of the Earth's mantle, which is made of partly melted rock. Move the North American Plate away from the Eurasian Plate in your

puzzle. If this were to happen with the real tectonic plates, what do you think the melted rock underneath the plates would do? What landform could develop as a result of this?

4. Tectonic plates can move apart, collide, or slide past each other. This type of movement happens very slowly. Using your puzzle, move the North American Plate and the Pacific Plate past each other. If this were to happen with the real tectonic plates, what do you think the result would be?

5. Sometimes two plates push against each other. When this happens, the plates can both rise up or one plate can slide under the other. Using your puzzle, push the Eurasian Plate and the Indian Plate against each other. If this were to happen with the real tectonic plates, what do you think the result would be?

Conclusion:

The Theory of Plate Tectonics is used by scientists to explain many of the Earth's features. As the plates of the Earth's lithosphere move slowly, mountains and valleys can form. Additionally, earthquakes and volcanoes can result when the plates move against each other along the plate boundaries.

Puzzling Plates

Writing Prompt:

Being prepared for a natural disaster, such as a wild fire, hurricane, or earthquake is very important if you live in an area where it may occur. Think of a major event that your family has had to prepare for. What did you do to get ready? Why did you do these things? What was the outcome?

Searching For Shadows

Submitted by LeeAnne C. Herold

WonderWorks Connection: *Strike a Pose*

NY State Standards

Strand PS: Physical Science – Energy & Properties of Matter

PS3.1f: Sort Objects by observable properties, such as size, shape, color, temperature (hot or cold), weight (heavy or light), texture, and whether objects sink or float.
PS3.2c: Investigate that materials can be altered to change some of their properties, but not all materials respond the same way to any one alteration.
PS5.1: Recognize that energy has the ability to cause motion or create change.
PS4.4b: Demonstrate that light can be reflected, refracted, and absorbed.

Related Literature:
Hand Shadows and More Hand Shadows by Henry Bursil
Moonlight and Shadow by E. Jones
What Makes a Shadow by Clyde Robert Bulla
Bear Shadow by Frank Asch
Nothing Sticks Like a Shadow by Ann Tompert

Activity

This activity could be used as a fantastic home to school connection piece. You may want to write a letter letting your families know that your students are studying shadows and classifying objects by common characteristics. Your families can help by assisting their children in locating objects that will cast a shadow, and objects that will not cast a shadow. Your students can in turn enjoy a sense of empowerment by teaching their families to make a hand shadow using the book Hand Shadows and More Hand Shadows by Henry Bursil. What a fun way to work on fine and gross motor skills!

Materials:

- Objects from home or school that will cast a shadow
- Objects from home or school that will not cast a shadow
- Flashlight
- Large piece of white construction paper, taped to the wall
- Copy of "Predicting Shadows" paper

Procedure:

1. Look around your house or classroom to find three items that you think will make shadows.

1. Look around your house or classroom to find one item that you think will not make a shadow.

1. In the box labeled “Shadow Makers”, draw the three objects you think will make shadows.

1. In the box labeled “Not a Shadow Maker”, draw the object you think will not make a shadow.

1. Work with a friend. Sit in front of the construction paper that is taped to the wall. Have your friend shine the flashlight on the paper. Hold an object between the flashlight and the paper.

1. If the object makes a shadow, put it in one pile. If it does not, put it in another pile.

1. Try another object. Put the object in the right pile, depending on whether or not it made a shadow.

1. Continue with your other objects, until you have classified all of them as making a shadow or not making a shadow.

1. Now let your friend take a turn with the objects he or she found, while you hold the flashlight.

1. Show your teacher what you discovered.

1. Finally, look back at your prediction sheet. Circle the objects that you predicted correctly.

Predicting Shadows *By* ______________________

I think these objects will make shadows.

Shadow Makers

I think these objects will not make a shadow.

Not a Shadow Maker

Searching for Shadows

Writing Prompt:

There is a song that talks about a person's shadow being his best friend. The shadow was "always with" the person, and "liked to do" whatever the person was doing. Think about yourself in terms of being a good friend. What characteristics do you have that make you a high quality friend? What characteristics do you have that sometimes might make you hard to get along with? Who would say you are a good friend, and what examples would they give to back up their statement?

The World of Color and Light

WonderWorks Connection: *Recollections, Strike a Pose, Carnival Mirrors*

NY State Standards

Strand PS: Physical Setting – Forms of Energy, Energy Transfer

PS4.1d: Identify some basic forms of energy such as light, heat, sound, electrical, and mechanical.
PS4.1e: Recognize that energy has the ability to cause motion or create change.
PS4.4b: Demonstrate that light can be reflected, refracted, and absorbed.
PS4.4b: Observe and explain that light can be reflected, refracted, and/or absorbed.

Strand S: Scientific Inquiry

S1.3.1: Keep records as appropriate, such as pictorial, written, or simple charts and graphs, of investigations conducted.
S1.2c: Infer based on observation.
S1.2c: Explain the difference between an experiment and other types of scientific investigation, and explain the relative benefits and limitations of each.
S1.1: Recognize that science involves creativity, not just in designing experiments, but also in creating explanations that fit evidence.

Pre-Lab Questions:

1. Can anyone explain what is light?
2. Can anyone tell how we see light?
3. What types of waves are represented by light?
4. Does anyone know how fast light travels?
5. Can anyone give examples of light you see every day?

Activity One: Freeze Frame

Materials:

- Photosensitive Paper
- Various shapes (natural or man-made)

Procedure:

1. Have students select a shape they wish to use. Can have them do a scavenger hunt around the school to find interesting natural objects.
2. Be careful not to expose paper to light before use.
3. Place object on paper and place in direct sunlight.
4. Wait about 20-30 minutes.
5. Observe results.
6. Fill in a Cause and Effect Flow Chart.

Data:

<u>Student</u> <u>Observation</u>

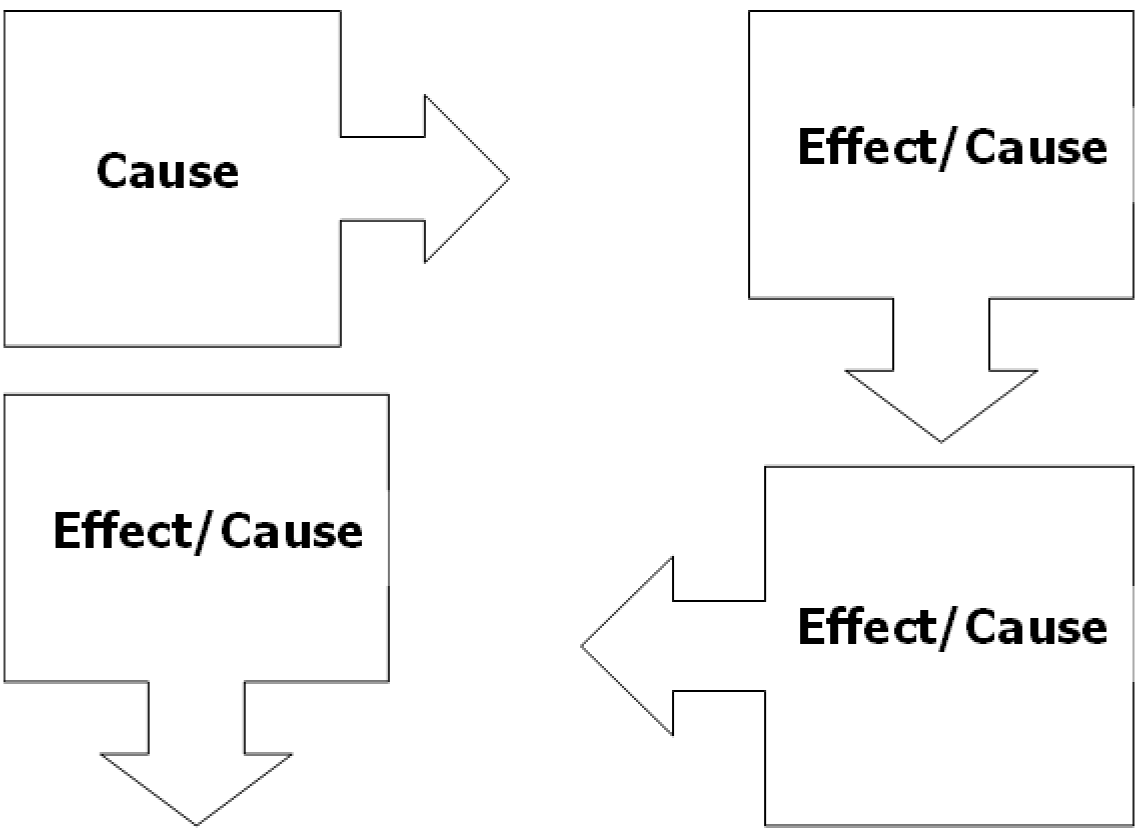
1.____

2.____

3.____

4.____

<u>Cause and Effect Flow Chart:</u>



Post Lab Questions:

1. Which objects worked the best?
2. What conditions would be best for this experiment?
3. Do you think that this experiment would work on a cloudy day?
4. Would mass of the objects affect the result of experiment?
5. What caused the paper to change? Was it the visible light or the UV rays?
6. Do you think that age of the paper makes a difference in your results?
7. Do different sources of light give different results (incandescent, black lights, fluorescent, etc.)?

Extensions:

1. Redo this experiment on a cloudy day and record the results. Do a Venn Diagram with the results.
2. Try different brands and/or ages of photosensitive paper.

Activity two: Color My Feelings

Materials:

- Book *Hailstones and Halibut Bones* by Mary O'Neill
- Drawing Paper
- Crayons, Colored Pencils, Markers or Paint/Finger Paint

Procedure:

1. Read several poems from *Hailstones and Halibut Bones*.
2. Discuss how color makes you feel.
3. Have younger students draw pictures that match their favorite color. Older students can write about their favorite color.
4. Share your results with the class and explain how you feel.

Extensions:

1. Write poetry about how colors make you feel.
2. Put a picture book to music.
3. Play various types of music and have students write or draw about how it makes them feel.
4. Can extend into Art with working with Primary, Secondary and Tertiary colors.
5. Tie into Prisms and rainbows (Roy G. Biv)
6. Tie into reflection and refraction of light waves. Use a Venn Diagram to compare and contrast reflection and refraction of light.

Wax Paper Roller Coaster

Submitted by James Perlmutter

WonderWorks Connection: *WonderCoaster*

NY State Standards

Strand PS: Physical Setting – Forms of Energy & Energy Transfer

PS3.2e: Explore the Law of Conservation of energy by differentiating between potential and kinetic energy. Identify situations where kinetic energy is transformed into potential energy and vice versa.
PS4.1: Measure and graph distance versus time for an object moving at a constant speed. Interpret this relationship.
PS5.2a: Investigate and describe types of forces including contact forces and forces acting at a distance, such as electrical, magnetic and gravitational.
PS5.1: Analyze the motion of an object in terms of its position, velocity, and acceleration (with respect to a frame of reference) as functions of time.

Strand S: Scientific Inquiry

S1.1a & b: Define a problem from the sixth grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
S1.1: Design and conduct a study using repeated trials and replication.
S1.2: Understand that scientific investigations involve the collection of relevant empirical evidence, the use of logical reasoning, and the application of imagination in devising hypotheses, predictions, explanations and models to make sense of the collected evidence.

Objective: To explore and discover how potential, kinetic and activation energy are used in the designing of slides and roller coasters.

Activity

Materials:

- Wax paper
- Droppers
- Water

- Tape measure (optional)
- Stop watch (optional)
- Computer/internet access.

Day 1:

Vocabulary:

Energy
Potential Energy
Kinetic Energy
Activation Energy
Law of Conservation of Energy

Reading: http://www.eia.doe.gov/kids/energyfacts/science/formsofenergy.html
Follow-up Reading with energy questions/puzzle

Day 2:

Review reading/questions/puzzle from day before.

<u>Lecture</u>

Lecture Notes (provided as example of starting point—they can remain this simple or additions can be made to increase level)→

All energy can be placed into two categories

1. **Potential energy**—ask what potential means…if someone says you have potential or the potential to do work or get a good grade…what does that mean?
    - stored energy or energy at rest…the energy is ready to and can do work but is not.
        - examples: an unlit match, a boulder at the top of a hill or water behind a dam or at the top of a waterfall, at pitcher with their arm pulled back, diver at the edge of a diving board
    - things can have a lot or a little potential energy, it depends on how much work they can do.
        - examples: a diver on a high board vs. a diver on a low board— who will move more water when they land? Firecracker vs. TNT
        -
2. **Kinetic**—ask, now that you know what potential means what do you think kinetic means…if potential is ready to do but now doing work then what is kinetic?
    - energy in motion, energy that is doing work
        - examples: a lit match, exploding dynamite, pitcher throwing ball, boulder rolling down a hill, diver in midair or entering the water.
    - faster and more motion means more work and more kinetic energy.

Day 3:

Lab: Wax Paper Roller Coaster

Create wax paper slides as elaborate as they can from the top of the desk to the floor using books and chairs to create hills and dips and race water droplets along them.

Step 1: Explain to them what they are going to do and even diagram a slide on the board (this can easily be related to roller coasters and you might even want to look up info on roller coasters to explain the physics of them…there are even sites where they can make their own virtual coasters and try them which may be fun follow up)

Step 2: DISCUSSION Questions (to be asked of and discussed with class prior to the start of the lab but not actually answered with definite answers…yet). Ask them what will determine if the water will make it all the way across the slide or not. Coax them but do not give them the answers….even if they do not entirely get it (the potential and kinetic energies must be equal…if the hills take more energy then the dips the droplet will not make it over the hill). DO NOT REVEAL THE ANSWERS OR EXPLANATION UNTIL AFTER THE ACTIVITY.

Step 3: Let the students experiment. They must diagram the slide each time and they must time the drop so see how long it takes (they will all have the same length of wax paper…good way to discuss constants after it is done) and show on the diagram if their droplet gets stuck.

- For each diagram they should show where the drop had potential or kinetic energy (they can label the slide with a P or K and put a star where it had the most of each).
- Challenge them to come up with the slide where the droplet takes the longest to make it all the way down the slide.
- Bring the class back together and have each group put their favorite slide on the board and label it.
- Now ask them why the drop made it all the way on some slides and not on others. They will probably mention it needed speed or power but bring them around to momentum and ENERGY…kinetic vs. potential.
- Finally have each group diagram their slide that was successful but took the longest and put the time up. Be sure that you are circulating while the activity is going on to be sure that they are successful and truthful. Feel free to give an award for the best.

Extensions:

This lab can be further extended to include or can be preceded or followed up with readings, discussions and/or activities relating to the different types of energy and the law of conservation of energy. Possible ideas include:

- Have the students visit the roller coaster websites listed below to read and learn more about roller coasters and to work at designing their own coasters and testing them.

  Roller Coaster sites:
  - http://www.learner.org/interactives/parkphysics/coaster/
  - http://www.funderstanding.com/k12/coaster/
  - http://dsc.discovery.com/games/coasters/interactive.html
  - http://www.fearofphysics.com/Roller/roller.html
  - http://virtual.questacon.edu.au/rollercoaster/main.html
  - http://virtual.questacon.edu.au/rollercoaster/
  - http://www.abc.net.au/rollercoaster/games/games/s1307633.htm
  - http://www.fossweb.com/modulesK-2/BalanceandMotion/index.html
  - http://www.glenbrook.k12.il.us/gbssci/phys/mmedia/energy/ce.html
  - http://www.britannica.com/coasters/ride.html
    - good site to show where forces in a coaster are

- As an extension and to incorporate math you may incorporate timing the droplets and experimenting with slope and distance. You can also bring speed calculations into the activity as well.

- Have students diagram a roller coaster and label the different sections on it. Then have them write how/what they or other people might feel (excited, scared, butterflies, etc) in each of those sections and what, if anything, they might be doing while gliding through them (eyes open/closed, screaming, holding hands up, etc).

- Writing exercise: Have the students write a personal reflection or an essay that would include their personal reaction/opinion of roller coasters with an explanation for their position. Students could also include personal anecdotes of their experiences with roller coasters, reviews of those experiences and what are their favorite and least favorite coasters.