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## Lab Activities:

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Introduction

The purpose of this packet is to provide the Comprehensive Science 1 teachers with a list of basic laboratory and hands-on activities that students should experience in class. Each activity is aligned with the Comprehensive Science 1 Curriculum Guide and the Next Generation Sunshine State Standards (NGSSS). Emphasis should be placed on those activities that are aligned to the Annually Assessed benchmarks, which are consistently assessed in the Florida Comprehensive Assessment Test (FCAT).

All hands-on activities were designed to cover most concepts found in Comprehensive Science 1. In some cases, more than one lab was included to cover a specific benchmark. In most cases, the activities were designed as simple as possible without the use of advanced technological equipment to make it possible for all teachers to use these activities. All activities and supplements (i.e., Parts of a Lab Report) should be modified, if necessary, to fit the needs of an individual class and/or student ability.

This document is intended to be used by science departments in M-DCPS so that all science teachers can work together, plan together, and rotate lab materials among classrooms. Through this practice, all students and teachers will have the same opportunities to participate in these experiences and promote discourse among learners, forming the building blocks of authentic learning communities.

Acknowledgement:

M-DCPS Curriculum and Instruction (Science) would like to acknowledge the efforts of the teachers who worked arduously and diligently on the preparation of this document.
Materials List
Each list corresponds to the amount of materials needed per station (whether one student or a group of students uses the station). Safety goggles should be assigned to each student and lab aprons on all labs requiring mixtures of chemicals.

Showing off the Heat (page )
- wooden spoon
- plastic spoon
- metal spoon
- water
- hot plate
- safety gloves for handling hot objects
- beaker
- paper towels
- lab aprons
- safety goggles

Melting Ice (page 23)
- thermometers
- stirring rods
- two 400 mL beakers
- 300 mL water
- stop watch or clock with a second hand
- hot plate
- Safety goggles
- ice
- paper towels
- graph paper
- gloves for hot surfaces

Modeling the Greenhouse Effect (Page )
- 2 Clear plastic cups
- 2 Thermometers
- Potting soil
- Clear Plastic wrap
- 2 Rubber bands
- Lamp with 100 Watt light bulb
- Watch or clock

Solar Cooker (Page )
- Cardboard (boxes)
- Miscellaneous materials for insulation, conduction or reflection
- Watch or stop watch
- Plastic wrap
- Thermometer
- Tape
- Optional Materials for Cooking
- Aluminum foil
- Bag of mini marshmallows and chocolate chips
- Box of Graham Crackers
Tornado Movements (Page 64)
- 1-quart plastic or glass jar
- water
- 100 mL Beaker
- 10 mL graduated cylinder (2 per group)
- 10 mL of liquid dish soap
- a few drops of food coloring
- paper towels
- 10 mL of vinegar

The Many Forms of Energy (page 55)
- C, D, or 6V batteries 2/pair (power source)
- wires or alligator clips
- paper
- pencil
- small light bulbs
- energy signs

The Hydroelectric Lab
- several pieces of Rotelle (wagon-wheel) pasta
- paper clips
- 4 cups
- water-proof clay
- water
- materials provided by instructor e.g. popsicle sticks
- Lab data sheet

Building a Roller Coaster
- Marbles (2 marbles with different masses)
- pipe insulation (flexible foam cut in half, 4 meters per group – Buy from hardware stores.)
- masking tape (1 meter per team)
- plastic cup to be placed at the end of the coaster (to collect the marbles after each trial)
- stop watch

Rocket Car
- 4 Pins
- Styrofoam meat tray
- Masking tape
- Flexible straw
- Scissors
- Drawing compass
- Marker pen
- Small, round party balloon
- Ruler
- String
**Balloon Rocket**
- 4 students
- Balloon, 9 in. (23 cm)
- Meterstick
- Drinking straw (10 cm piece)
- Scissors
- String (4.5 m)
- Masking tape
- Stopwatch

**Weight Mass Relationship**
- “New” Weight Chart
- Calculator
- Bathroom scale

**Using the Microscope**
- Microscope
- Microscope slide
- Cover slip
- Newspaper
- Scissors
- Medicine dropper
- Water
- Forceps or pin

**Comparing Plant and Animal Cells (page 45)**
- forceps
- microscope slides
- medicine Droppers
- cover slips
- onion skin
- toothpicks
- water
- methylene blue stain
- microscope
- paper towel
Grade 6 Science Next Generation of Sunshine State Standards Benchmarks included in the Essentials Labs

SC.6.E.7.1 Differentiate among radiation, conduction, and convection, the three mechanisms by which heat is transferred through Earth's system.

SC.6.E.7.2 Investigate and apply how the cycling of water between the atmosphere and hydrosphere has an effect on weather patterns and climate.

SC.6.E.7.4 Differentiate and show interactions among the geosphere, hydrosphere, cryosphere, atmosphere, and biosphere.

SC.6.E.7.7 Investigate how natural disasters have affected human life in Florida.

SC.6.E.7.9 Describe how the composition and structure of the atmosphere protects life and insulates the planet.

SC.6.L.14.2 Investigate and explain the components of the scientific theory of cells (cell theory): all organisms are composed of cells (single-celled or multi-cellular), all cells come from pre-existing cells, and cells are the basic unit of life.

SC.6.L.14.4 Compare and contrast the structure and function of major organelles of plant and animal cells, including cell wall, cell membrane, nucleus, cytoplasm, chloroplasts, mitochondria, and vacuoles.

SC.6.N.1.1 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.

SC.6.N.1.3 Explain the difference between an experiment and other types of scientific investigation, and explain the relative benefits and limitations of each.

SC.6.N.1.4 Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.

SC.6.N.1.5 Recognize that science involves creativity, not just in designing experiments, but also in creating explanations that fit evidence.

SC.6.N.3.4 Identify the role of models in the context of the sixth grade science benchmarks.

SC.6.P.11.1 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.

SC.6.P.13.1 Investigate and describe types of forces including contact forces and forces acting at a distance, such as electrical, magnetic, and gravitational.

SC.6.P.13.2 Explore the Law of Gravity by recognizing that every object exerts gravitational force on every other object and that the force depends on how much mass the objects have and how far apart they are.

SC.6.P.13.3 Investigate and describe that an unbalanced force acting on an object changes its speed, or direction of motion, or both.
LAB ROLES AND THEIR DESCRIPTIONS

Cooperative learning activities are made up of four parts: group accountability, positive interdependence, individual responsibility, and face-to-face interaction. The key to making cooperative learning activities work successfully in the classroom is to have clearly defined tasks for all members of the group. An individual science experiment can be transformed into a cooperative learning activity by using these lab roles.

**Project Director (PD)**
The project director is responsible for the group.
Roles and responsibilities:
- Reads directions to the group
- Keeps group on task
- Is the only group member allowed to talk to the teacher
- Shares summary of group work and results with the class

**Materials Manager (MM)**
The materials manager is responsible for obtaining all necessary materials and/or equipment for the group.
Roles and responsibilities:
- The only person allowed to be out of their seat to pick up needed materials
- Organizes materials and/or equipment in the work space
- Facilitates the use of materials during the investigation
- Assists with conducting lab procedures
- Returns all materials at the end of the lab to the designated area

**Technical Manager (TM)**
The technical manager is in charge of recording all data.
Roles and responsibilities:
- Records data in tables and/or graphs
- Completes conclusions and final summaries
- Assists with conducting the lab procedures
- Assists with the clean up

**Safety Director (SD)**
The safety director is responsible for enforcing all safety rules and conducting the lab.
Roles and responsibilities:
- Assists the PD with keeping the group on-task
- Conducts lab procedures
- Reports any accident to the teacher
- Keeps track of time
- Assists the MM as needed.

When assigning lab groups, various factors need to be taken in consideration;
1. Always assign the group members, preferably trying to combine in each group a variety of skills.
2. Evaluate the groups constantly and observe if they are on task and if the members of the group support each other in a positive way. Once you realize that a group is not performing up to expectations, re-assign the members to another group.
LABORATORY SAFETY RULES:

Know the primary and secondary exit routes from the classroom.

Know the location of and how to use the safety equipment in the classroom.

Work at your assigned seat unless obtaining equipment and chemicals.

Do not handle equipment or chemicals without the teacher’s permission.

Follow laboratory procedures as explained and do not perform unauthorized experiments.

Work as quietly as possible and cooperate with your lab partner.

Wear appropriate clothing, proper footwear, and eye protection.

Report all accidents and possible hazards to the teachers.

Remove all unnecessary materials from the work area and completely clean up the work area after the experiment.

Always make safety your first consideration in the laboratory.

Safety Contract:

I will:

Follow all instructions given by the teacher.

Protect eyes, face and hands, and body while conducting class activities.

Carry out good housekeeping practices.

Know where to get help fast.

Know the location of the first aid and fire fighting equipment.

Conduct myself in a responsible manner at all times in a laboratory situation.

I, ______________________, have read and agree to abide by the safety regulations as set forth above and also any additional printed instructions provided by the teacher. I further agree to follow all other written and verbal instructions given in class.

Student’s Signature: ____________________________  Date: _________________

Parent’s Signature: ____________________________  Date: _________________
PRE-LAB SAFETY WORKSHEET AND APPROVAL FORM

This form must be completed with the teacher’s collaboration before the lab.

Student Researcher Name: _________________________________________ Period # ____
Title of Experiment: _______________________________________________

Place a check mark in front of each true statement below:
1. □ I have reviewed the safety rules and guidelines.
2. □ This lab activity involves one or more of the following:
   □ Human subjects (Permission from participants required. Subjects must indicate
     willingness to participate by signing this form below.)
   □ Vertebrate Animals (requires an additional form)
   □ Potentially Hazardous Biological Agents (Microorganisms, molds, rDNA,
     tissues, including blood or blood products, all require an additional form.)
   □ Hazardous chemicals (such as: strong acids or bases)
   □ Hazardous devices (such as: sharp objects or electrical equipment)
   □ Potentially Hazardous Activities (such as: heating liquids or using flames)
3. □ I understand the possible risks and ethical considerations/concerns involved in
   this experiment.
4. □ I have completed an Experimental/Engineering Design Diagram.

Show that you understand the safety and ethical concerns related to this lab by responding to the
questions below. Then, sign and submit this form to your teacher before you proceed with the
experiment (use back of paper, if necessary).

A. Describe what you will be doing during this lab.

B. What are the safety concerns with this lab that were explained by your teacher?
   How will you address them?

C. What additional safety concerns or questions do you have?

D. What ethical concerns related to this lab do you have?
   How will you address them?

Student Researcher’s Signature/Date: ____________________________
Teacher Approval Signature: __________________________________

Human Subjects’ Agreement to Participate:

Printed Name/Signature/Date

Printed Name/Signature/Date

Printed Name/Signature/Date
PARTS OF A LAB REPORT
A STEP-BY-STEP CHECKLIST

Good scientists reflect on their work by writing a lab report. A lab report is a recap of what a scientist investigated. It is made up of the following parts.

Title (underlined and on the top center of the page)

**Benchmarks Covered:**
Your teacher should provide this information for you. It is a summary of the main concepts that you will learn about while conducting the experiment.

**Problem Statement:**
Identify the research question/problem and state it clearly in the form of a question.

**Potential Hypothesis (es):**
State the hypothesis carefully. Do not just guess, but also try to arrive at the hypothesis logically and, if appropriate, with a calculation.
Write down your prediction as to how the independent variable will affect the dependent variable using an “if” and “then” statement.
If (state the independent variable) is (choose an action), then (state the dependent variable) will (choose an action).

**Materials:**
Record precise details of all equipment used.
For example: a balance that measures with an accuracy of +/- 0.001 g.
Record precise formulas and amounts of any chemicals used
For example: 5 g of CuSO₄ or 5 mL H₂O

**Procedure:**
1. Do not copy the procedures from the lab manual or handout.
2. Summarize the procedures in sequential order; be sure to include critical steps.
3. Give accurate and concise details about the apparatus and materials used.

**Variables and Control Test:**
Identify the variables in the experiment. State those over which you have control. There are three types of variables.
1. **Independent variable:** (also known as the manipulated variable) the factor that can be changed by the investigator (the cause).
2. **Dependent variable:** (also known as the responding variable) the observable factor of an investigation that is the result or what happened when the independent variable was changed.
3. **Constant variables:** the other identified independent variables in the investigation that are kept or remain the same during the investigation.
Identify the control test. A control test is the separate experiment that serves as the standard for comparison to identify experimental effects, changes of the dependent variable resulting from changes made to the independent variable.

**Data:**
Ensure that all data is recorded.
a) Pay particular attention to significant figures and make sure that all units are stated.

Present your results clearly. Often it is better to use a table or a graph.
b) If using a graph, make sure that the graph has a title, each axis is labeled clearly, and the correct scale is chosen to utilize most of the graph space.
Record qualitative observations. Also list the environmental conditions.
c) Include color changes, solubility changes, and whether heat was released or absorbed.

**Results:**
1 Ensure that you have recorded your data correctly to produce accurate results.
2 Include any errors or uncertainties that may affect the validity of your result.

**Conclusion and Evaluation:**
A conclusion statement answers the following 7 questions in at least three paragraphs.

I. **First Paragraph: Introduction**
1. What was investigated?
   a) Describe the problem or state the purpose of the experiment.
2. Was the hypothesis supported by the data?
   a) Compare your actual result to the expected result (either from the literature, textbook, or your hypothesis)
   b) Include a valid conclusion that relates to the initial problem or hypothesis.
3. What were your major findings?
   a) Did the findings support or not support the hypothesis as the solution to the restated problem?
   b) Calculate the percentage error from the expected value.

II. **Middle Paragraphs: These paragraphs answer question 4 and discuss the major findings of the experiment using data.**
4. How did your findings compare with other researchers?
   a) Compare your result to other students’ results in the class.
      i) The body paragraphs support the introductory paragraph by elaborating on the different pieces of information that were collected as data that either supported or did not support the original hypothesis.
      ii) Each finding needs its own sentence and relates back to supporting or not supporting the hypothesis.
      iii) The number of body paragraphs you have will depend on how many different types of data were collected. They will always refer back to the findings in the first paragraph.

III. **Last Paragraph: Conclusion**
5. What possible explanations can you offer for your findings?
   a) Evaluate your method.
   b) State any procedural or measurement errors that were made.
6. What recommendations do you have for further study and for improving the experiment?
   a) Comment on the limitations of the method chosen.
   b) Suggest how the method chosen could be improved to obtain more accurate and reliable results.
7. What are some possible applications of the experiment?
   a) How can this experiment or the findings of this experiment be used in the real world for the benefit of society.
## EXPERIMENTAL DESIGN DIAGRAM
This form should be completed before experimentation.

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<th>Null Hypothesis:</th>
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<th>Research Hypothesis:</th>
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<th>Manipulated Variable (MV): or Independent Variable (IV)</th>
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<th>Number of Tests: Subdivide this box to specify each variety.</th>
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EXPERIMENTAL DESIGN DIAGRAM HINTS:

Title: A clear, scientific way to communicate what you’re changing and what you’re measuring is to state your title as, "The Effect of ____________ on__________." The manipulated variable is written on the first line above and the responding variable is written on the second line.

Problem Statement: Use an interrogative word and end the sentence with a question mark. Begin the sentence with words such as: How many, How often, Where, Will, or What. Avoid Why.

Null Hypothesis: This begins just like the alternate hypothesis. The sentence should be in If .........., then.......... form. After If, you should state the MV, and after the then, you should state that there will be no significant difference in the results of each test group.

Research Hypothesis: If ____________ (state the conditions of the experiment), then ____________ (state the predicted measurable results). Do not use pronouns (no I, you, or we) following If in your hypothesis.

Manipulated Variable (MV): This is the condition the experimenter sets up, so it is known before the experiment (I know the MV before). In middle school, there is usually only one MV. It is also called the independent variable, the IV.

Number of Tests: State the number of variations of the MV and identify how they are different from one another. For example, if the MV is "Amount of Calcium Chloride" and 4 different amounts are used, there would be 4 tests. Then, specify the amount used in each test.

Control Test: This is usually the experimental set up that does not use the MV. Another type of control test is one in which the experimenter decides to use the normal or usual condition as the control test to serve as a standard to compare experimental results against. The control is not counted as one of the tests of the MV. In comparison experiments there may be no control test.

Number of Trials: This is the number of repetitions of one test. You will do the same number of repetitions of each variety of the MV and also the same number of repetitions of the control test. If you have 4 test groups and you repeat each test 30 times, you are doing 30 trials. Do not multiply 4 x 30 and state that there were 120 trials.

Responding Variable(s): This is the result that you observe, measure and record during the experiment. It’s also known as the dependent variable, DV. (I don’t know the measurement of the DV before doing the experiment.) You may have more than one DV.

Variables Held Constant: Constants are conditions that you keep the same way while conducting each variation (test) and the control test. All conditions must be the same in each test except for the MV in order to conclude that the MV was the cause of any differences in the results. Examples of Constants: Same experimenter, same place, time, environmental conditions, same measuring tools, and same techniques.
ENGINEERING DESIGN PROCESS

1. Identify the need or problem
2. Research the need or problem
   a. Examine current state of the issue and current solutions
   b. Explore other options via the internet, library, interviews, etc.
   c. Determine design criteria
3. Develop possible solution(s)
   a. Brainstorm possible solutions
   b. Draw on mathematics and science
   c. Articulate the possible solutions in two and three dimensions
   d. Refine the possible solutions
4. Select the best possible solution(s)
   a. Determine which solution(s) best meet(s) the original requirements
5. Construct a prototype
   a. Model the selected solution(s) in two and three dimensions
6. Test and evaluate the solution(s)
   a. Does it work?
   b. Does it meet the original design constraints?
7. Communicate the solution(s)
   a. Make an engineering presentation that includes a discussion of how the solution(s) best meet(s) the needs of the initial problem, opportunity, or need
   b. Discuss societal impact and tradeoffs of the solution(s)
8. Redesign
   a. Overhaul the solution(s) based on information gathered during the tests and presentation

Source(s): Massachusetts Department of Elementary and Secondary Education
SHOWING OFF THE HEAT

Benchmarks:
SC.6.E.7.1 Differentiate among radiation, conduction, and convection, the three mechanisms by which heat is transferred through Earth’s system.
SC.6.N.1.1 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
SC.6.N.1.4 Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation

Objective/Purpose:
1. Compare and contrast how heat passes through different materials.
2. Demonstrate that different materials contain varying amounts of thermal energy.
3. Describe that heat moves from a warmer object to a cooler one when the substances are in direct contact and identify this process as heat transfer by conduction.

Background Information:
Heat energy may be transferred by conduction, convection or radiation When heat energy moves from one object to another by direct contact (from one molecule contacting another) the method of heat transfer is known as conduction. An example of conduction is the heat transfer from a stove surface burner to the bottom of a cooking pot. The transfer of heat as a result of the movement of molecules in a fluid (ex., liquid, gas) is called convection. An example of this process would be the rising of hot air and the sinking of cold air. Radiation is energy that travels through space from a source. For example, bread in a toaster. If watched closely, the bread does not touch the hot, glowing coils. The Sun is a great source of radiant energy.

Heat energy transfers more easily through some materials than others. These materials that attract heat are called conductors. The materials that do not conduct heat well are called insulators. In this experiment you will find out which materials conduct heat better.

Teacher Notes:
The teacher should engage students with a demo and prompt them to discuss the engagement question. Each student should then form a hypothesis in response to the problem statement. Students should be made aware that there could be more than one hypothesis in the class because a hypothesis is an educated guess and could be either supported or not supported by the results from an experiment. In the closure activity, students should explain the different types of materials that can serve as heat conductors and discuss how we use them in our homes or for developing new products or inventions.

Engage: Teacher will lead class into discussion by asking the lead question: When cooking, why does the handle of a metal frying feel hot in spite of the fact that the handle is not touching the stove? Why do some frying pans have wooden or metal handles? Why does a kitchen glove prevent you from burning your hand?

Problem statement:
Will a wooden spoon, plastic spoon or a metal spoon transfer more heat?
Materials:
- metal spoon
- wooden spoon
- plastic spoon
- beaker
- water
- thermometers
- hot plate
- safety gloves for handling hot objects
- paper towels
- lab aprons
- safety aprons

Explore
1. Designing the Experiment
   a. Based on both, the materials given by your teacher and the problem statement of this activity, you and your team will design an experiment that will help you to find out which spoon will absorb the most heat (will be the best conductor of heat).
   b. Your experimental design should include the Parts of a Lab Report.
      Note: Be sure to obtain your teacher’s approval before setting up your experiment. Your teacher’s approval will be based on your experimental design.
2. Set up your experiment using the given materials.
3. Collect, record, and analyze your results; then, form conclusions.
4. Present your findings to your classmates. Be ready for a class discussion based on the following questions:
   a. What happened to each spoon when placed in the hot water?
   b. What were the temperatures of each spoon?
   c. Was your hypothesis supported by the data? Why or why not?
   d. How could you demonstrate that thermal energy tends to flow from a system of high temperature to a system of lower temperature?
   e. What would happen if you used hot water instead of warm water?
   f. Is heat ever transferred when objects are not touching one another? If so, give examples and identify the other methods of heat transfer (label as radiation or conduction – refer to background information for help).
   g. Compare your findings with other lab groups. Did you all get similar results?

Evaluate:
1. Complete discussion questions.
2. Prepare a class data table on the board and calculate the mean, median and mode of the results. A member from each group will contribute to a discussion about their findings.
3. Explain similarities and/or differences in results between groups.
4. Identify and provide evidence of heat transfer demonstrated in the experiment.

Extension:
Students can design their own lab experiment by testing different materials such as aluminum and newspaper. Jars are easy to obtain and could be used for this experiment. Students will write lab reports using all parts of the experimental design. They will include problem statement, hypothesis, materials, procedures, data table, data analysis, and conclusion.

Students could also complete an Experimental Design Diagram to review the necessary components of an experiment and identify those parts in this lab activity.
Parts of a Lab Report Reminder

Step 1: Stating the Purpose/Problem
- What do you want to find out? Write a statement that describes what you want to do. It should be as specific as possible. Often, scientists read relevant information pertaining to their experiment beforehand. The purpose/problem will most likely be stated as a question such as:

  “What are the effects of _________ on ___________?”

Step 2: Defining Variables
- INDEPENDENT VARIABLE (IV) (also called the test or manipulated variable) – The variable that is changed on purpose for the experiment; you may have several levels of your independent variable.
- DEPENDENT VARIABLE (DV) (also called the outcome or responding variable) – The variable that acts in response to or because of the manipulation of the independent variable.
- CONSTANTS (C) – All factors in the experiment that are not allowed to change throughout the entire experiment. Controlling constants is very important to assure that the results are due only to the changes in the independent variable; everything (except the independent variable) must be constant in order to provide accurate results.

Step 3: Forming a Hypothesis
- A hypothesis is an inferring statement that can be tested.
- The hypothesis describes how you think the independent variable will respond to the dependent variable. (i.e., If….., then……)
- It is based on research and is written prior to the experiment. Never change your hypothesis during the experiment.
- For example: If the temperature increases, then the rate of the reaction will increase.
- Never use “I,” “we,” or “you” in your hypothesis (i.e. I believe or I think that…)
- It is OK if the hypothesis is not supported by the data. A possible explanation for the unexpected results should be given in the conclusion

Step 4: Designing an Experimental Procedure
- Select only one thing to change in each experimental group (independent variable).
- Change a variable that will help test the hypothesis.
- The procedure must tell how the variable will be changed (what are you doing?).
- The procedure must explain how the change in the variable will be measured.
- The procedure should indicate how many trials would be performed (usually a minimum of 3-4 for class experiments).
- It must be written in a way that someone can copy your experiment, in step by step format.

Step 5: Results (Data)
- Qualitative Data is comprised of a description of the experimental results (i.e. larger, faster…).
- Quantitative Data is comprised of results in numbers (i.e. 5 cm, 10.4 grams)
- The results of the experiment will usually be compiled into a table/chart for easy interpretation.
- A graph of the data (results) may be made to more easily observe trends.
- Refer to “Making a Data Table” and “Making a Graph” skill sheets.

Step 6: Conclusion
The conclusion should be written in paragraph form. It is a summary of the experiment, not a step-by-step description. Does the data support the hypothesis? If so, you state that the hypothesis is accepted. If not, you reject the hypothesis and offer an explanation for the unexpected result. You should summarize the trend in data in a concluding statement (ex: To conclude, the increase in temperature caused the rate of change to increase as shown by the above stated data.). Compare or contrast your results to those from similar experiments. You should also discuss the implications for further study. Could a variation of this experiment be used for another study? How does the experiment relate to situations outside the lab? (How could you apply it to real world situations?)
MELTING ICE

Benchmarks:
SC.6.E.7.2 Investigate and apply how the cycling of water between the atmosphere and hydrosphere has an effect on weather patterns and climate.
SC.6.E.7.1 Differentiate among radiation, conduction, and convection, the three mechanisms by which heat is transferred through Earth's system.
SC.6.N.1.1 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
SC.6.N.1.4 Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.
SC.6.N.3.4 Identify the role of models in the context of the sixth grade science benchmarks.

Objective/Purpose:
- Students will be able to describe the states of matter and explain that the transfer of heat energy may produce a change in the state of matter.
- Students should be able to explain that as water cycles between the atmosphere and hydrosphere, a change in water’s state of matter occurs. This change is produced as a result of the addition of heat energy. Radiant energy from the sun is absorbed by Earth’s waters and causes water to change from a liquid to its gas form, water vapor. Water vapor will rise as a result of convection and will eventually condense on atmospheric dust particles as it cools in the upper atmosphere.
- Students will identify the different states of matter: solid, liquid, and gas.

Background Information:
There are 3 states of matter. In the solid state of matter, the particles or molecules are tightly packed and they vibrate in place. In the liquid state of matter, the molecules are loose, moving freely, and they take the shape of any container. The third state is the gas form, where the molecules are very loose, moving rapidly, and they expand freely to completely occupy any space.

Teacher Notes:
The teacher should present the engagement question for discussion. Each student should form a hypothesis in response to the problem statement. Students should be made aware that there could be more than one hypothesis in the class because a hypothesis is an educated guess which may be either accepted or rejected after conducting an experiment. In the closure activity, the teacher should discuss how being biased could have an effect on the results of an experiment. Students should discuss why the increase of temperature increases the rate of melting of the ice cubes. Finally, the teacher should explain to students that there are 2 main types of energy, kinetic and potential. Students should be able to explain that kinetic energy is being added to the water via the hot plate and that this energy of motion makes molecules move faster. To help demonstrate to them that temperature is a measure of the average kinetic energy of the particles in a substance, you could have them stand and then, assign each student to be a number 1, 2, or 3. Then, tell the number ones to jump once every 3 seconds, the number 2’s to jump once every 2 seconds and the number 3’s to jump once every second. Tell them that they represent water molecules in a lake and that the temperature of the water would be the average of all of their speeds of motion.

Engage:
Ask the students the following question: Have you noticed that water exists on Earth in all three states of matter – solid, liquid, and gas. Can you explain how that is possible? Does temperature affect the melting rate of ice? We will conduct an experiment to find an answer to this. Have students consider the problem statement below and then, write a hypothesis.
Problem statement:
How does the addition of heat energy affect the rate at which water changes from a solid to a liquid?

Materials:
- thermometers
- stirring rods
- two 400 mL beakers
- 300 mL water
- stop watch or clock with a second hand
- hot plate

- gloves for hot surfaces or beaker tongs
- goggles
- lab aprons
- paper towels
- ice
- graph paper

Procedure:
1. Students will work in groups of 4.
2. Review Safety Symbols and Precautions. Students need to wear protective gear: goggles, gloves to handle hot objects.
3. Decide which student will be the timekeeper, who will read the thermometer, stir the water in the beaker, record the observations, and who will keep an eye on the process of experiment.
4. Label the first beaker, Beaker A.
5. Label the second beaker, Beaker B.
6. Turn on hot plate to number 3. Wait for the hot plate to get warmed up. Use safety precautions when handling hot objects.
7. Fill Beaker A and Beaker B with ice cubes.
8. Place Beaker A on one part of the science lab table. Beaker A will be at room temperature.
9. Place Beaker B on the hot plate.

Use safety precautions when handling hot objects and glass objects!
10. Take initial temperature of Beaker A and Beaker B. Record the initial temperature in the appropriate Data Log for each beaker.
11. Start the stop watch.
12. Read and record (in the Trial #1 column) the temperature of the thermometers at 5 minute intervals, for a total of 30 minutes.
13. Repeat the whole experiment again, from step 6 to step 12 and record the results for trial 2 in the appropriate column.

Data (Log and Observations):

<table>
<thead>
<tr>
<th>Elapsed Time (min.)</th>
<th>Trial #1 Temperature (°C)</th>
<th>Qualitative Observations</th>
<th>Trial #2 Temperature (°C)</th>
<th>Qualitative Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial)</td>
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</tbody>
</table>
**Time vs. Temperature**

**Beaker B**

<table>
<thead>
<tr>
<th>Elapsed Time (min.)</th>
<th>Trial #1 Temperature (°C)</th>
<th>Qualitative Observations</th>
<th>Trial #2 Temperature (°C)</th>
<th>Qualitative Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial)</td>
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</tbody>
</table>

14. After all data is gathered, have one student in group to be in charge of returning all lab equipment. Other group members should put goggles away, fold aprons, and wipe off the lab table.

**Safety Reminder:** Use safety precautions when handling hot objects and glass objects.

**Data Analysis (calculations):**
- Create a line graph from which you may determine at which temperature the ice cube melted the fastest.
- Use your own graph paper and label the x-axis and y-axis. Hint: Time on X-axis and temperature on Y-axis.
- Be sure to include a title for the graph. There will be two lines of different colors; one line will represent the mean data for water at room temperature and the other line will represent the line for the mean temperature readings from the beaker on the hot plate (Remember to prepare a Key).

**Explain: Results and Conclusions:**
1. Was your hypothesis supported by the data?
2. What were the states of matter that you observed while doing the experiment?
3. At which temperature did the ice cubes melt the fastest?
4. Does adding heat to ice water affect the rate of melting? Explain.
5. What are 2 constants in this experiment (things kept the same)?
6. Look at the graph. What information can you learn from the data you gathered?
7. What is the most interesting discovery you made from the graph?
8. List 3 questions that you can answer using the graph (make believe you are the teacher).

**Evaluate:**
Create a class data table, determine the mean results of each condition for the class, and compare and contrast all the data collected from different groups.
- Discuss why some data are the same and why some data are different. Analyze whole class data and share each group’s observations.
- Explain how water cycles between the hydrosphere and atmosphere as a result of radiation and convection

**Extension:**
Research to find a location in the world you could see the different states of matter in one geographic location. For example: mountain ranges. Students could draw a free form map of a mountain or other areas they found in their research and label where the different states of matter occur in the picture.
MODELING THE GREENHOUSE EFFECT

Benchmarks:
SC.6.E.7.4 Differentiate and show interactions among the geosphere, hydrosphere, cryosphere, atmosphere, and biosphere.
SC.6.E.7.9 Describe how the composition and structure of the atmosphere protects life and insulates the planet.
SC.6.N.1.1 - 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.
SC.6.N.3.4 Identify the role of models in the context of the sixth grade science benchmarks.

Background Information for the teacher:
Greenhouse gases are carbon dioxide, methane, nitrous oxide, ozone (in the lower atmosphere), water vapor and CFCs. One greenhouse gas that has been increasing in the past 50 years is carbon dioxide. Loss of rainforests that take in carbon dioxide and the burning of fossil fuels by cars, factories and plants which releases carbon dioxide are part of the causes.

Teacher’s notes:
This activity could be divided into 2 sessions. One session for the Engage and Explore with testing then Explain and allow students to return with more materials or work on at home then retest and evaluate.

Purpose:
In this investigation students will:
• Create models of Earth with and without heat-reflecting greenhouse gases.
• Relate a greenhouse to how the Earth’s atmosphere traps heat. Identify the gases in the atmosphere that “act” like the glass in a greenhouse.

Materials
• 2 Clear plastic cups
• 2 Thermometers
• Potting soil
• Lamp with 100 Watt light bulb

Engage:
Read or write on the board: Explain how a greenhouse is able to maintain a temperature at which plants are able to grow even though the temperature outside the greenhouse sometimes will not support plant life. Accept all responses and indicate that responses will be accepted or modified after the experiment

Explore:
Based on both, the materials given by your teacher and the main purpose of this activity you and your team will design an experiment that will measure the different amount of heat retained in a glass jar beneath a heat lamp. This activity will model how the greenhouse effect influences the temperatures in our Earth’s atmosphere. You will investigate “How does the greenhouse effect influence temperature on Earth”. Include: Write your problem statement for this activity. Formulate a hypothesis. Using the given materials design and complete an experiment to test your hypothesis. Explain how you tested your hypothesis. It should be as specific as possible. Often, scientists read relevant information pertaining to their experiment beforehand.
Explain and Re-design the Experiment:
Students will share their findings from the explore activity. Summarize the results of your activity. What happened to the temperature of the jar over time? Relate how the setup of the glass jar beneath a heat lamp models the greenhouse effect on Earth. Can you identify the independent (manipulated), and dependent (responding) variables in your activity? Did you only change (test) only one variable? Identify what you could do to improve this activity.

After discussion, have students complete the following investigation: Have students write a problem statement and form a hypothesis before testing.
Basically, during this investigation, the students should perform the following procedures:
1. Place equal volume of soil in the bottom of each plastic cup.
2. Place the thermometer inside of each container at the same height relative to the soil. Record the initial temperature in degrees Celsius (°C).
3. Seal the top of one container with plastic wrap held in place with the rubber band while leaving the second container open.
4. Place the lamp with the exposed 100 watt bulb between the two containers. The light bulb should be kept on during the whole experiment.
5. Record the temperature in each container every 2 minutes for the next 20 minutes.
6. Construct a multiple line graph with both sets of data on the same axes (temperature on Y, time on X).
7. A possible format of data table:

**Data Table: Changes in Temperature**

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Temperature in open container (°C)</th>
<th>Temperature in sealed container (°C)</th>
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<tbody>
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Evaluate:
1. Interpret the graph and identify a trend for the change in temperature for each container during the experiment? Did both jars show the same change in temperature? Calculate the change in temperature for each jar.
2. Did your results support your hypothesis?
3. Explain why the temperature of the covered jar showed an increase in temperature. What part of this setup contributed to the increase in temperature?
4. Explain how the covered jar setup represents an experimental model of the influences of the greenhouse effect on the temperature of the Earth’s atmosphere. Identify what the light bulb and plastic wrap represent in this experimental model.

5. Identify the independent (manipulated), dependent (responding) and constant variables in this experiment.

6. In this experiment we only tested each setup one time (20 minute interval), explain why this will affect the validity of the data. How can we change this experiment so the data will be more valid?

7. Based on what you learned in this activity, can you connect this knowledge to the environmental issue of the dangers of the greenhouse effect? Explain

8. Think about what humans do that increases the amount of greenhouse gases released into the atmosphere and develop a list of ways that we can reduce the level of these gases.

9. How does the set-up model the greenhouse effect?

**Optional Extensions:**

1. **Activity # 1.** Students may want to continue the experiment and record the two temperatures every day at the same time for a week. Graph the data and discuss how the temperatures fluctuate from day to day.

2. **Activity # 2.** Green House Gases.

There is no scientific dispute about the presence of "greenhouse gases" (including carbon dioxide--CO₂) in the earth’s atmosphere that function to trap heat from the sun. There is also no dispute that the amount of CO₂ in the atmosphere has increased 25%. Does this mean that global warming is occurring? Nobody knows for certain, but many atmospheric scientists are becoming concerned about the increasing amount of CO₂ in the atmosphere.

**What does this mean to you?** Despite the uncertainties, if global warming does occur (or if it has already begun), it will profoundly affect human societies. Global warming may result in severe droughts, reducing crop production necessary to feed billions of people. Rising sea levels will threaten beaches, coastal cities, and people. The migration of millions of people would strain economic, health, and social services. Conflicts over remaining resources could escalate. Wildlife habitat will be destroyed, with countless species facing extinction. With the potential devastating effects of global warming, it is reasonable and prudent to examine alternatives to fossil fuels to decrease the amount of CO₂ in the atmosphere. The transportation sector is one area that can, generally speaking, use alternative methods of fuel, since there are already a variety of alternate fuels available. The good news is that this transition can be done relatively easily, cheaply, and painlessly.

**Activity: With a parental supervision,** students will visit two parking lots in different areas, and list the types of cars present to determine the amounts of CO₂ these cars release.

(1) Select two areas in your town with substantial parking lots. These parking lots can be in different parts of town, surrounding different types of stores (food stores, clothing stores, discount stores), or can be of different sizes (shopping malls, "mom and pop" stores, specialty shops).

(2) Walk through each parking lot, writing down the following information for 10 cars (it helps if at least one person knows about cars):

- Car type (Be specific! For example: Ford F350 pickup truck)
- The condition of the car (new, used but excellent, badly used, etc.)
- The size of the car (very big, large, medium, compact, etc.)
• Approximately weight of the car in tons. Since CO₂ emissions are tied to the weight of the car, assume that each car emits as much CO₂ per year as it weighs. Record this amount for each car.

Questions:
(1) Were there significant differences in the types and ages of the cars you saw in the different parking lots? Why or why not?
(2) Did there seem to be a correlation between the cars and the type of store?
(3) Did there seem to be a correlation between the size and age of the cars?
(4) Which parking lot had the cars with the most estimated CO₂ emissions? Why might this be?
(5) Look up the weight information for your car. What type of CO₂ emissions does it have?
(6) Would you consider emissions of air pollutants in the purchase of your next car? Why or why not?

Sources:
• http://www.enviroliteracy.org/pdf/labge1.pdf
• http://www.myteacherpages.com/webpages/SBrenneman/files/EXPERIMENTAL%20DESIGN11.doc
• http://www.climatechangenorth.ca/section-lp/LP_06_1_B_greenhouse.html
• http://highered.mcgraw-hill.com/sites/dl/free/0072315474/26241/pollution_1.htm
USING A SOLAR COOKER TO DEMONSTRATE ENERGY TRANSFER

Benchmarks:
SC. 6.N.1.1 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.
SC.6.E.7.1 Differentiate among radiation, conduction, and convection, the three mechanisms by which heat is transferred through Earth's system.
SC.6.E.7.9 Describe how the composition and structure of the atmosphere protects life and insulates the planet.
SC.6.N.1.5 Recognize that science involves creativity, not just in designing experiments, but also in creating explanations that fit evidence.
SC.6.N.1.4 Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.
SC.6.N.3.4 Identify the role of models in the context of the sixth grade science benchmarks.

Background Information:
Common fuel sources used for cooking include gas, electricity, microwaves, or wood. What if we ran out of all of these sources or if they were unavailable for use? What could we use instead?

In this lab we will investigate how to use solar power as a cooking fuel.
The sun may shine all day, but is it warm enough to cook something? Can we simply put the food outside in the sunshine to cook it? These questions should be considered as you build your solar cooker.
The idea is simple. If you have ever started a fire with a magnifying glass, you have used an uncontrolled solar cooker. The solar cooker you will build will concentrate the sun's rays in order to achieve a temperature suitable for cooking food. This heat from the sun must be stored or trapped, in order to reach cooking temperature. In order to trap the heat efficiently, reflectors, a glass or Plexiglas window, and insulation around the perimeter will be used. As you build your solar cooker, think about how it would fit into your lifestyle and how this technology could be used as an alternative fuel source.

After performing this experiment, you will be able to design an apparatus to cook food with energy from the sun. You also be able to will explain the energy changes that take place during the process of cooking or warming some foods.

Lesson Overview
Students will use the design of a solar cooker to demonstrate energy transfer. An engineering design will also be used to determine the best design for increasing the efficiency of a solar cooker that could be sent to a family that does not have electricity to cook food.

Unit Outcome(s)
Describe and demonstrate the three methods energy transfer involved in the operation of a solar cooker. Implement the engineering design to increase efficiency of energy transfer. Students will also infer how a solar cooker is a model for demonstrating the greenhouse effect.

Materials:
- Cardboard (boxes)
- Tape
- Miscellaneous materials for insulation, conduction or reflection
- Aluminum foil
- Watch or stop watch
- Box of Graham Crackers
- Plastic wrap
- Bag of mini-marshmallows
- Thermometer
- Bag of chocolate chips
Engage the Learner
1. Read the first paragraph of the background information for teacher
2. Think about families who are not able to afford electricity.
3. Have you ever cooked food without electricity?
4. Are there countries that currently do not use electricity to cook their food?
5. Do you think that you could use only the materials listed above and the sun’s energy to cook food?

Alternate Engage:
1. Elicit from students the two primary types of energy and place the energy signs on the board with either magnets or tape. (Find these signs in “The Many forms of Energy” essential lab.)
2. Elicit from students all the different forms of energy and place these signs on the board with either magnets or tape.
3. Have students classify which category (KE or PE) each form of energy should be placed. Note each form could be placed in either category.
4. Ask students which forms of energy are involved in the operation of a solar cooker.

Explore
Use materials to create a solar cooker (limit and keep time, there will be opportunity for redesign)

Test the Prototype
Have students create a data log that begins with a safety statement: Caution: Do not look directly at the sun or at reflected sunlight. They should sketch their design and then list:
1. the general environmental conditions (outdoor temperature, cloud conditions),
2. the starting temperature inside their cooker,
3. the starting time, and
4. a place to record the ending time
5. a place to record the final temperature.
If using the optional food materials, students should place the cracker with marshmallow and 1 chip in the cooker, place the thermometer inside, close the cooker, position it and then start the timer. If the class is competing for the highest temperature, they should all be limited to the same cooking time.

Explain the Concept and Define the Terms
Students should use a concept map, figure, foldable, or expository writing to describe and explain what they think occurred.
Review: thermal energy, heat, temperature, reflection, conduction, radiation, convection, and insulation – use demonstrations, images. Refer to Reverences for article “Principles of Solar Box Cooker Design”. (http://solarcooking.org/sbcdes.htm) then continue to add or update concept map, figure, foldable, or writing.

Elaborate on the Concept
Small group discussion of how they have experienced or know of other examples of solar energy transfer. Students should identify and record improvements that should be made. Students should discuss and infer how a solar cooker is a model that demonstrates the greenhouse effect. Report out to whole group

Evaluate students' Understanding of the Concept
Use engineering design to improve solar cooker: students should bring additional materials to improve solar cooker’s ability to transfer solar energy and retain heat.
If they are successful, what should increase? Explain how and why.

Additional questions to evaluate (with possible answers below):
1. Identify the collector, storage, and controls on your solar cooker.
2. How does the sunlight cook the food? Which energy transformation occurred during the process of warming or cooking the food?

3. In which parts of the world would a solar cooker work the best? The worst?

4. What are some disadvantages of using a solar cooker?

5. What are some advantages of using a solar cooker?

6. What are some health benefits of using a solar cooker in developing countries?

7. How are solar cookers beneficial to the environment?

8. What other types of materials could be used in the construction of a solar cooker?

9. Would cost have to be a consideration for question #9?

Teacher’s note:
Students will measure the temperature inside the cooker and also the ambient temperature. They should discuss the possible causes of the differences in temperature.

This lab may be done in groups or as an individual project for solar cooker design. Students could experiment with different insulation materials (do not use Styrofoam, they may emit toxic fumes at high temperatures), reflector angles, and general design materials. This could also be a good science fair project, or it might make a fun project for a class competition to see whose cooker can most completely cook a certain type of food in a given time.

Possible Answers to the questions mentioned above:

1. Identify the collector, storage and controls on your solar cooker. a. collector: the transparent cover that lets the sunlight in the cooker. b. storage: the newspaper/insulation prevents heat from escaping and the food also will absorb the heat. c. controls: the reflectors direct the sun's rays into the cooking area.

2. How does the sunlight cook the food? The sun's rays are absorbed by the cooker's inside surface and transformed into thermal energy.

   Which energy transformation occurred during the process of warming or cooking the food? The thermal energy transfers as heat by convection which is absorbed by the food. If food is touching the pan, then heat is also transferred by conduction.

3. What parts of the world would a solar cooker work the best? The worst?

   Areas that get lots of sunshine on a consistent basis would be the best. Areas where the sunlight is less intense such that it takes a long time to collect the same amount of energy as from a sunny place would be the worst. Research Miami Herald June 2008 “Solar energy still a tough sell” http://www.miamiherald.com/519/story/561858.html

4. What are some disadvantages of using a solar cooker?

   Need a lengthy span of available sunlight, longer cooking times, and smaller portions.

5. What are some advantages of using a solar cooker?

   There isn't any waste product, and you can cook in the summer without heating the entire house.

6. What are some health benefits of using a solar cooker in developing countries?

   a. temperatures can reach the point to purify water and to kill bacteria and dangerous diseases, but only on sunny days.
   b. eliminates disease caused by inhaling toxins common to food cooked over wood.
   c. decrease health problems related to constant exposure to smoke and fire.
   d. decrease malnutrition due to the decreased availability of firewood

7. How could solar cookers be beneficial to the environment?

   They could reduce the need of fuel gathering (wood, coal, or gas) that can lead to the destruction of forest and agricultural lands. In addition, much of the waste products from
burning fossil fuels would be reduced. However, remember that the majority of our energy is consumed for transportation, not cooking food.

8. What other types of materials could be used in the construction of a solar cooker? Would cost have to be a consideration?
   **Answers may vary. Materials should be capable of providing insulation, absorption, storage and reflection.**

9. **Answers may vary**

**Extension:** Students can build the same design of solar oven but change one variable such as type of insulation or material used for the window. Identify the independent (manipulated) variable, dependent (responding or outcome variable) and constant variables in this experiment. Explain why constant variables are important in a controlled experiment.

Source: [http://matse1.mse.uiuc.edu/energy/g.html](http://matse1.mse.uiuc.edu/energy/g.html)

**References**

**URLs used in this lesson plan**

- [http://solarcooking.org/sbcdes.htm](http://solarcooking.org/sbcdes.htm)
- [http://www.uwsp.edu/cnr/wcee/keep/Mod1/Rules/EnTransfer.htm](http://www.uwsp.edu/cnr/wcee/keep/Mod1/Rules/EnTransfer.htm)
TORNADO MOVEMENTS

Benchmarks:
SC.6.N.3.4 Identify the role of models in the context of the sixth grade science benchmarks.
SC.6.N.1.4 Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation.
SC.6.E.7.7 Investigate how natural disasters have affected human life in Florida.

Purpose
Explain how a tornado is one of the processes that shapes Earth’s surface.

Background Information:
A tornado is a violent storm made of a column of air that starts from the cloud to the ground. Most tornadoes form because of wind shear in a cloud. The meaning of wind shear is that the wind is moving at different directions at different heights. The wind shear can then cause the air to move around in circles. If the spinning occurs and the wind shear goes down then a tornado can form.

Engagement:
Show a video clip or pictures of tornados, focusing on Florida. Ask them to describe any evidence of property or environmental destruction shown in the images. Have them describe the shape of the wind pattern and infer what makes the wind in a tornado visible.
Discuss the lead question: How does the air move in a tornado?

Problem Statement:
How does air move in a tornado?

Materials:
- 1 one quart plastic or glass jar
- water
- 100 mL beaker
- 10 mL graduated cylinder (2 per group)
- 10 mL of liquid dish soap
- 10 mL of vinegar
- a few drops of food coloring
- paper towels
Explain

Procedures:
1. Have students work in groups of 3-4 students.
2. Gather all necessary materials for the experiment.
3. Make sure that students are wearing lab aprons and safety goggles.
4. One student in the group will measure 10 mL of liquid soap using the graduated cylinder.
5. Another student in the group will measure 10 mL of vinegar using the graduated cylinder.
6. A third student will measure 100 mL of water in a beaker.
7. Start by putting the liquid dish soap, vinegar, and water in the 1-quart plastic or glass jar.
8. Add just a few drops of food coloring to the mix.
9. In your group, decide on how you will model the movement of a tornado.
10. Decide on the procedure you will use to make a tornado in a jar.
11. After approval from teacher, perform experiment and record observations in a chart.
12. One group member should clean and return all lab materials. Others should fold aprons, clean the lab table and return goggles.
13. After completing clean up, student should complete lab write up.

Data (table and observations)

<table>
<thead>
<tr>
<th>Tornado Motion Observation Chart</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action</td>
</tr>
<tr>
<td>-------------------------------</td>
</tr>
</tbody>
</table>

Explain

Data Analysis:
1. Draw what you observed and explain what happened.
2. Explain how the model of the tornado in a jar is similar to a tornado. Explain how it is different.

Evaluate:
Students can discuss each group’s findings and how each group’s procedure of creating a tornado in a jar may have been different or similar. Each group can discuss what worked well and what didn’t work.

Extend:
Have students research and write a report that includes the frequency of tornadoes in Florida, how they form, and the mechanisms of a tornado, including wind speed, duration, and speed of movement over land.
THE MANY FORMS OF ENERGY

**Benchmarks:**

**SC.6.P.11.1** 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.

**SC.6.E.7.1** Differentiate among radiation, conduction, and convection, the three mechanisms by which heat is transferred through Earth's system.

**SC.6.N.1.3** Explain the difference between an experiment and other types of scientific investigation, and explain the relative benefits and limitations of each.

**Engage**

1. Elicit from students the two types of energy (Kinetic and Potential) and place the energy signs on the board with either magnets or tape.
2. Elicit from students all the different forms of energy, i.e. mechanical, solar, nuclear, sound, thermal, heat, light, chemical, electrical, geothermal, hydroelectric and wind. Place these signs on the board with either magnets or tape.
3. Discuss with students under which category (KE or PE) each form of energy should be placed. Note each form could be placed in either category.

**Materials:**

- *Forms of Energy in Our Everyday Lives* poster or image
- Energy Signs

**Student Directed Procedure:**

1. You will receive a photocopy of the poster related to forms of energy use in our everyday lives. Before beginning these activities, you may need to review with your teacher the definition of energy (the ability to do work—e.g., move things, change things, heat them) and discuss the forms of energy listed below to help prepare you for the activities that follow.

2. Study the poster to find examples of *potential energy* (stored energy) and kinetic energy (the energy of movement).

3. Draw a chart with six columns—one for each form of energy. Label the columns mechanical, chemical, radiant, nuclear, thermal, and electrical. List and classify examples of each form.
Forms of Energy Use in Our Everyday Lives
On the Trail of Energy

(Based on an article in Science & Children Magazine, Published by the National Science Teachers Association, May 2002, developed by the Bureau of Land Management, found at the following URL: http://www.blm.gov/education/00_resources/articles/energy/energy4.html.)
**Mechanical Energy:** the energy of position and motion.

**Chemical Energy:** the energy that bonds molecules together. Chemical energy is released from a chemical reaction such as burning wood, coal, or oil. Our digested food releases chemical energy for use by the body.

**Radiant Energy:** energy that travels in waves, such as sunlight, radio waves, and X-rays.

**Nuclear Energy:** the kind of energy produced when the nuclei of atoms split or join together. Nuclear power plants split the nuclei of uranium atoms in a process called fission. The sun combines the nuclei of hydrogen atoms in a process called fusion. (Note: Other than the sun itself, no examples of nuclear energy are shown in the poster.)

**Thermal Energy:** heat, the energy of moving and vibrating molecules. Geothermal energy is an example of thermal energy.

**Electrical Energy:** the energy of moving electrons. Electricity is electrons moving through a wire. Lightning is another example of electrical energy.

**Explain**
Circle and label examples of different types of energy sources depicted in the poster, such as solar, gas, electric, wind. (Note: Some sources may not actually be shown, but implied, such as the gasoline in the car.)

Work in small groups to identify examples of energy transformations. Then, explain to others in the class the ones you've found.
KINETIC ENERGY

POTENTIAL ENERGY

SOUND ENERGY
Thermal ENERGY

LIGHT

ENERGY

CHEMICAL

ENERGY
Solar Energy

ELECTROMAGNETIC ENERGY
Wind Energy

Geothermal Energy

Hydroelectric Energy
HYDROELECTRIC ENERGY
(adapted from National Geographic JASON Project)

Benchmarks:
SC.6.N.3.4 Identify the role of models in the context of the sixth grade science benchmarks.
SC.6.N.1.4 Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation
SC.6.P.11.1 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

Objective:
- Construct a Water Wheel
- Analyze the energy transformations that occur in a water wheel.

Background information:
Hydroelectric power plants use turbines to produce electrical energy. These power plants convert the mechanical energy of a spinning turbine into electrical energy by using the mechanical energy provided by water. A water wheel is a very simple device which when set in motion demonstrates the concept of hydroelectric energy production as the wheel is driven by the flow of water through its paddles. The efficiency of the entire process is dependent upon the design of the wheel. Wheels that are able to harness more of the water’s energy are able to meet higher energy demands. In this activity, you will have the opportunity to explore water wheel designs. You will construct a simple water wheel. From your observations, you will suggest and evaluate new designs.

Materials:
- several pieces of Rotelle (wagon-wheel) pasta
- paper clips
- 4 cups
- water-proof clay
- water
- materials provided by instructor e.g. popsicle sticks
- Lab data sheet (registration is free)

Engage:
a) Use print and online resources to learn about the history of water wheels.
b) Use “The Modern Portfolio: Hydroelectric Energy”

Ask Students:
- a) How were water wheels used by ancient cultures?
- b) What tasks did they accomplish?
- c) How are historic water wheels different from the turbines found in today’s hydroelectric plants?

Explore
Students will use materials provided to build their own water wheel.
Procedures:

a) Roll out a thin strip of waterproof clay. Firmly press this strip along the outer rim of a piece of rotelle (wagon-wheel) pasta. Make sure that the rim is completely covered with a thick layer of clay.

b) Along the length of the clay, insert materials provided by your instructor to form a pattern of paddle-like extensions.

c) Open and straighten a paper clip.

d) Insert the straightened paper clip into the center of the pasta wheel so that the paper clip acts as an axle.

e) Use two lumps of clay to anchor both ends of the axle to the rim of your wide mouth cup. The wheel should be positioned over the center of the cup. Spin the wheel. Adjust as needed to ensure that the wheel rotates freely.

Explain the Experiment:

1. Fill the other cup with water. Carefully pour the water onto the paddles of your water wheel.
2. What do you observe?
3. Explain your observations in terms of the potential and kinetic energy conversions occurring in the water-wheel model.

Elaborate/Extend:

1. Consider what will happen if you increase the height from which the water was poured. How might the change in height affect the spin?
2. Create a hypothesis. Then, test your hypothesis.
3. Create a list of factors that might affect the efficiency of the observed energy transformation.
4. When evaluating wheel efficiency, why do you think that it is critical to maintain the same height from which the water is poured?
5. Select one of the listed factors, and explain how you would measure its effect on the efficiency of the energy transfer and transformation.
6. With your teacher’s approval, create a new wheel design to improve efficiency of the transformation.
7. Compare your new design to your original design.
8. Is the new wheel more or less efficient? Explain.
9. Can you think of any other changes that can be made to further improve its operation? If so, how?
10. Once again, with your teacher’s approval, create a new design.
11. Is the new design more or less efficient? Explain.

Evaluate:

Journal Question:
How might using a denser liquid in place of water affect the wheel’s potential and kinetic energy and how could this relate to electrical energy generation?
BUILDING A ROLLER COASTER
(adapted from Glencoe Grade 7)

Benchmarks:
SC.6.P.11.1 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.
SC.6.P.13.3 Investigate and describe that an unbalanced force acting on an object changes its speed, or direction of motion, or both.
SC.6.P.13.1 Investigate and describe types of forces including contact forces and forces acting at a distance, such as electrical, magnetic, and gravitational.
SC.6.N.1.1 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.
SC.6.N.3.4 Identify the role of models in the context of the sixth grade science benchmarks.
SC.6.N.1.4 Discuss, compare, and negotiate methods used, results obtained, and explanations among groups of students conducting the same investigation

Objectives:
• Construct a model roller coaster.
• Analyze the energy transformations that occur in a roller-coaster car.
• Use the law of conservation of energy to explain observations.

Background information:
Riding a roller coaster can make your heart skip a beat. You speed up and slow down as you travel from hill to hill. The changes in speed occur as gravitational potential energy and kinetic energy are converted into each other.

Teacher’s Notes:
An interesting feature of this lab is that students should be allowed to use only the given material. Students should not ask for more masking tape or pipe. The challenge is to build the best coaster using the same amount of materials per team.

As a pre-lab preparation, teachers should obtain (buy from a local hardware storage) the pipe insulation (flexible foam). The pipes should be cut in half throughout its entire length. Each team should be given 2 halves of these pipes, which together total 4 meters.

Problem Statement:
How does the energy of a roller-coaster car change as it travels along a roller coaster?

Materials:
• Marbles (2 marbles with different masses)
• pipe insulation (flexible foam cut in half, 4 meters per group – Buy from hardware stores.)
• masking tape (1 meter per team)
• plastic cup to be placed at the end of the coaster (to collect the marbles after each trial)
• stop watch
Procedures:
1. On your paper, design your roller coaster. Your design should have at least 2 hills, one loop, and one turn.
2. Discuss with your team which design will make the best coaster.
3. Choose the best design within your team. Get your teacher’s approval before you start building your coaster.
4. Using the given materials build your team’s selected coaster.
5. Release the small marble from the top of the first hill, and observe how the speed of the marble changes as it travels along the roller coaster. Record your observations.
6. Repeat step 5 using the biggest marble. Record your observations.

Data and Observations:
Draw your design and label where the different forms of mechanical energy are illustrated. (The mechanical energy of an object is the sum of the object’s potential and kinetic energy).

Analysis and Conclusions:
1. Compare the kinetic energy of the marbles at the bottom of the second hill to its kinetic energy at the bottom of the first hill.
2. Compare the potential energy of the marbles at the top of the second hill to its potential energy at the top of the first hill.
3. How did the mechanical energy of the marbles change as it moved along your roller coaster?
4. Infer why the mechanical energy of the marbles changed.
5. Cite evidence from the roller-coaster that supports the Law of Conservation of Energy

Closure Activity:
Students will compare and contrast their conclusions with other students in the class.

Extension:
Students may develop an illustration of a more complex roller-coaster design and defend its efficiency.
ROCKET CAR

NGSSS
SC.6.P.13.3 Investigate and describe that an unbalanced force acting on an object changes its speed, or direction of motion, or both.
SC.6.N.1.1 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.

Background Information for the teacher:
The following activity is adapted from a NASA QUEST lesson found at the following URL: http://quest.arc.nasa.gov/space/teachers/rockets/act2.html Students construct a balloon-powered rocket car from a Styrofoam tray, pins, tape, and a flexible straw, and test it along a measured track on the floor. This activity can be done individually or with students working in pairs. The second part of the activity directs students to design, construct, and test a new rocket car based on the results of the first car. Styrofoam food trays are available from butchers in supermarkets. They are usually sold for a few cents each or you may be able to get them donated. Students can also save trays at home and bring them to class.

If drawing compasses are not available, students can trace circular objects to make the wheels or use the wheel and hubcap patterns on the student worksheets.
If using the second part of the activity, provide each group with an extra set of materials. Save scraps from the first Styrofoam tray to build the second car. You may wish to hold drag or distance races with the cars. The cars will work very well on tile floors and carpeted floors with a short nap. Several tables stretched end to end will also work, but cars may roll off the edges. Although this activity provides one car design, students may try any car shape and any number, size, and placement of wheels they wish. Long cars often operate differently than short cars.

The rocket car is a simple way to observe Newton's Third Law of Motion. While it is possible to demonstrate Newton's Law with just a balloon, constructing a car provides students with the opportunity to put the action/reaction force to practical use. In this case, the payload of the balloon rocket is the car. Wheels reduce friction with the floor to help cars move. Because of individual variations in the student cars, they will travel different distances and often in unplanned directions. Through modifications, the students can correct undesirable results, thereby improving their cars' efficiency.

Materials
4 Pins
Styrofoam meat tray
Masking tape
Flexible straw
Scissors
Drawing compass
Marker pen
Small, round party balloon
Ruler
String
Student Work Sheets (one set per group):
- How to Build a Rocket Car
- Rocket Car Wheel and Hubcap Patterns
- Rocket Car Design Sheet

10 Meter tapes or other measuring markers for track (one for the entire class)

Engage:
Ask Students:
- What is Newton’s Third Law of Motion?
- What happens to the motion of a boat when you jump from the boat to the dock? Identify the action and reaction forces.
- Describe the motion of an inflated balloon when you release the balloon. Identify the action and reaction forces.

Explore:
- Form groups or 3 – 4 students/group
- Read or write the following on the board “Construct a balloon-powered rocket car from a Styrofoam tray, pins, tape, and a flexible straw, and test it along a measured track on the floor”.
- Students should write a brief description about their design.
- Students should test the car three times and record how far their car traveled(cm) each time.

Explain:
1. Explain the design of your car
2. Describe the motion of your rocket car.
3. What provided the power to move your car?
4. Explain how the movement of your rocket car is related to Newton’s Third Law of Motion.
5. If your car traveled in a curved path instead of straight, what did you do to the car to get the car to travel in a straight path?
6. Did you blow up the balloon to the same size each time? How would this effect how far the car traveled?
7. How many different ways can you change your rocket car to improve its performance? Discuss at least 5 different variables or modifications that your students can make to your car.
8. Identify and describe each of the following parts:
   a. Engineering Goal
   b. Balanced forces
   c. Unbalanced forces
9. Explain how the unbalanced force affected the following:
   a. Speed of the car
   b. Direction of the car

Redesign:
1. Instruct groups to change one variable in order to improve the performance of their rocket car.
2. Submit your design pages before starting construction.
3. Formulate a hypothesis for the modification. How will this change effect the distance the car travels?
4. Take your car to the test track.
5. Measure a piece of string and mark it at a length of 32 cm.
6. Tie it into a loop.
7. Tie the loop of string around the partially inflated balloon.
8. Continue inflating the balloon through the straw until the balloon fills the inside of the string loop. Tightly squeeze the end of the straw.
9. Place the car on floor and let it go!
10. Measure the distance(cm) in that the car travels. Record this in the data table.
11. Repeat steps #6-9 for a total of 3 trials. Record all distance measurements in the data table.
12. Continue making modifications (three more) and testing until you are instructed to stop. Form a hypothesis for each modification.
13. Graph the distance traveled for the original car and each modified rocket car.

<table>
<thead>
<tr>
<th>CAR</th>
<th>DISTANCE TRAVELED (cm)</th>
<th>Average Distance (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
<td>Trial 2</td>
</tr>
<tr>
<td>Original</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modification #1 Variable Changed:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modification #2 Variable Changed:</td>
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<td></td>
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<tr>
<td>Modification #3 Variable Changed:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modification #4 Variable Changed:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ROCKET CAR DISTANCE DATA TABLE
How to Build a Rocket Car

1. Lay out your pattern on a styrofoam tray. You need 1 rectangle, 4 wheels, and 4 hubcaps. Use a drawing compass to draw the wheels or use one of the samples provided.

2. Blow up the balloon and let the air out. Tape the balloon to the short end of a flexible straw and then tape the straw to the rectangle.

3. Push pins through the hubcaps into the wheels and then into the edges of the rectangle.

4. Blow up the balloon through the straw. Place string around partially filled balloon. Continue inflating until the circumference of the balloon is the same size as the circle of string. Squeeze the end of the straw. Place the car on the floor and let it go!
Wheel Patterns (Crosses mark the centers.)

Evaluation:
1. For each modification, identify and describe each of the following parts:
   a. Independent variable
   b. Dependent variable
   c. Constants
2. Explain the importance of changing only one variable at a time.
3. Why did we test each car three times?
4. Analyze the data, compare and contrast the results for each modification.
5. In which test/modification did your car go the farthest?
   Explain why this modification was the most successful.
6. Apply Newton’s Third Law of Motion to the motion of the rocket car. Identify the action and reaction forces.
7. Describe the purpose of the 32 cm loop of string? What is the importance of the loop?
8. Describe how your rocket car ran during the first trial run. (straight or curved path?)
What change did you make so the car traveled in a straight path?

10. Armed with your new information, if you could change a different variable, which one would you choose to construct a rocket car which would travel the farthest distance? Explain your reasoning.

11. Complete an Engineering Design Process write-up

Assessment:
1. Students will create articles for Motor School Trend and School and Driver magazines with "Rocket Car Test Reports" to describe test runs and modifications that improved their car's efficiency. Use these reports for assessment along with the design sheet and new car.
2. Use a rubric such as one found in the appendix or at the following URL: [http://school.discovery.com/schrockguide/assess.html#rubrics](http://school.discovery.com/schrockguide/assess.html#rubrics)

Extensions:
1. Have students compute the speed and velocity of their cars. See which student can design and build the ‘fastest’ rocket car.
2. Have students compute the acceleration of their cars. See which student can design and build a rocket car that accelerates the most within 20 seconds. Note that you may have to increase the length of the track and also increase the size of the balloon.
3. Have students research and report on:
   a. Sir Isaac Newton
   b. Newton’s Three Laws of Motion
   c. The role of Laws of Motion and rocketry.
   d. Build a virtual balloon car at the following URL: [http://www.kidsdomain.com/down/pc/ballooncar.html](http://www.kidsdomain.com/down/pc/ballooncar.html)
A rocket in its simplest form is a chamber enclosing a gas under pressure. A small opening at one end of the chamber allows the gas to escape, and in doing so provides a thrust that propels the rocket in the opposite direction. A good example of this is a balloon. Air inside a balloon is compressed by the balloon's rubber walls. The air pushes back so that the inward and outward pressing forces balance. When the nozzle is released, air escapes through it and the balloon is propelled in the opposite direction.

When we think of rockets, we rarely think of balloons. Instead, our attention is drawn to the giant vehicles that carry satellites into orbit and spacecraft to the Moon and planets. Nevertheless, there is a strong similarity between the two. The only significant difference is the way the pressurized gas is produced. With space rockets, the gas is produced by burning propellants that can be solid or liquid in form or a combination of the two.

One of the interesting facts about the historical development of rockets is that while rockets and rocket-powered devices have been in use for more than two thousand years, it has been only in the last three hundred years that rocket experimenters have had a scientific basis for understanding how they work.

The science of rocketry began with the publishing of a book in 1687 by the great English scientist Sir Isaac Newton. His book, entitled *Philosophiae Naturalis Principia Mathematica*, described physical principles in nature. Today, Newton's work is usually just called the *Principia*. In the *Principia*, Newton stated three important
scientific principles that govern the motion of all objects, whether on Earth or in space. Knowing these principles, now called Newton's Laws of Motion, rocketeers have been able to construct the modern giant rockets of the 20th century such as the Saturn 5 and the Space Shuttle. Here now, in simple form, are Newton's Laws of Motion.

1. Objects at rest will stay at rest and objects in motion will stay in motion in a straight line unless acted upon by an unbalanced force.
2. Force is equal to mass times acceleration.
3. For every action there is always an opposite and equal reaction.

All three laws are really simple statements of how things move. But with them, precise determinations of rocket performance can be made. The third law states that every action has an equal and opposite reaction. If you have ever stepped off a small boat that has not been properly tied to a pier, you will know exactly what this law means.

A rocket can lift off from a launch pad only when it expels gas out of its engine. The rocket pushes on the gas, and the gas in turn pushes on the rocket. The whole process is very similar to riding a skateboard. Imagine that a skateboard and rider are in a state of rest (not moving). The rider jumps off the skateboard. In the Third Law, the jumping is called an action. The skateboard responds to that action by traveling some distance in the opposite direction. The skateboard's opposite motion is called a reaction. When the distance traveled by the rider and the skateboard are compared, it would appear that the skateboard has had a much greater reaction than the action of the rider. This is not the case. The reason the skateboard has traveled farther is that it has less mass than the rider. This concept is explained through the understanding of the Second Law.

With rockets, the action is the expelling of gas out of the engine. The reaction is the movement of the rocket in the opposite direction. To enable a rocket to lift off from the launch pad, the action, or thrust, from the engine must be greater than the weight of the rocket. While on the pad the weight of the rocket is balanced by the force of the ground pushing against it. Small amounts of thrust result in less force required by the ground to keep the rocket balanced. Only when the thrust is greater than the weight of the rocket does the force become unbalanced and the rocket lifts off. In space where unbalanced force is used to maintain the orbit, even tiny thrusts will cause a change in the unbalanced force and result in the rocket changing speed or direction.

One of the most commonly asked questions about rockets is how they can work in space where there is no air for them to push against. The answer to this question comes from the Third Law. Imagine the skateboard again. On the ground, the only part air plays in the motions of the rider and the skateboard is to slow them down. Moving through the air causes friction or as scientists call it, drag. The surrounding air impedes the action—reaction. As a result rockets actually work better in space than they do in air. As the exhaust gas leaves the rocket engine it must push away the surrounding air; this uses up some of the energy of the rocket. In space, the exhaust gases can escape freely.
BALLOON ROCKET
Adapted from:
http://www.sciencebob.com/experiments/balloonrocket.html

Benchmarks:
SC.6.P.13.3 Investigate and describe that an unbalanced force acting on an object changes its speed, or direction of motion, or both.
SC.6.N.1.1 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.

Objective/purpose:
- Demonstrate how unbalanced forces produce motion.

Background Information:
Newton’s Third Law of Motion (Action and Reaction) states that when an object is pushed, it pushes back. When the opening of the balloon was released, the walls of the balloon pushed the air out. When the balloon pushed against the air, the air pushed back and the balloon moved forward, dragging the straw with it. The string and straw keep the balloon rocket on a straight course.

Teacher’s Notes:
The basic principle behind a balloon zooming across a string is exactly the same principle behind a space rocket launching into space. When the fuel burns, gas escapes from the rocket's bottom, pushing the rocket upward.

Engage:
Say: Balloons are considered to be the simplest rockets. Tell students to think about why someone would describe a balloon as a rocket. Students should pair-up and discuss their thoughts, then share their ideas with the class, their explanation of how a balloon is like a rocket.

Materials:
- Meterstick
- Drinking straw (10 cm piece)
- Scissors
- String (4.5 m)
- Safety goggles
- 4 students
- Balloon, 9 in. (23 cm)
- Masking tape
- Stopwatch
Procedures:
1. Measure and cut a 10 cm piece from the drinking straw.
2. Thread the end of the string through the straw piece.
3. Place two students about 4 meters apart.
4. Have the students hold each end of the string as tight as possible.
5. Have a third student inflate the balloon and twist the open end.
6. The fourth student will move the straw to one end of the string.
7. This student will also tape the inflated balloon to the straw.
8. The third student will release the balloon.
9. The fourth student will record the time that it takes for the balloon to stop.

Data:

<table>
<thead>
<tr>
<th>Trial #</th>
<th>Distance (m)</th>
<th>Time (s)</th>
<th>Speed (m/s)</th>
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Conclusions
1. How would Newton’s Third Law affect you if you threw baseballs away from you while standing on skates or sitting on a skateboard?
2. Suppose you are in a spacesuit drifting weightless in space some distance away from your spaceship. You have run out of compressed gas for your mini-thruster. Fortunately, you happen to have a bag of baseballs. What can you do to get back to your spaceship?

Extensions:
1. Test different variables and make it a real investigation:
   a. Which type of balloon (round, long, etc.) makes the rocket go the farthest?
   b. Does the size of the straw affect how long the rocket travels?
   c. Does the type of string affect how far the rocket travels? (try fishing line, nylon string, cotton string, etc.)

2. Use the *Engineering Design Process* to make a better Balloon Rocket Party Game
WEIGHT MASS RELATIONSHIP

Benchmarks:
SC.6.P.13.1 Investigate and describe types of forces including contact forces and forces acting at a distance, such as electrical, magnetic, and gravitational.
SC.6.P.13.2 Explore the Law of Gravity by recognizing that every object exerts gravitational force on every other object and that the force depends on how much mass the objects have and how far apart they are.

Objective:
• Discuss how weight is a measure of gravitational attraction.
• Explain that this force is not the same on each planet/satellite.

Background:
Gravity is a universal, natural force that attracts objects to each other. Gravity is the pull toward the center of an object—let's say, of a planet or a satellite. When you weigh yourself, you are measuring the amount of gravitational attraction exerted on you by Earth. The Moon has a weaker gravitational attraction than Earth. In fact, the Moon's gravity is only 1/6 of Earth's gravity, so you would weigh less on the Moon.

Engagement:
How much would you weigh on the Moon and on the other planets?

Materials:
“New” Weight Chart
Calculator
Bathroom scale

Procedures:
1. Write your weight (or an estimate) here: ___________________
2. For a different planet, multiply your weight by the number given in the "New" Weight Chart
   Example for the Moon - for a person weighing 60 pounds on Earth:
   \[ 60 \times \frac{1}{6} = 10 \]
   A 60-pound person would weigh 10 pounds on the Moon!
   Convert that fraction into a decimal so that it is easier to calculate
   \[ \frac{1}{6} = 1.0 \div 6 = 0.17, \text{ so} \]
   
   \[ 60 \text{ pounds} \times 0.17 \text{ gravitational pull of Earth} = 10 \text{ pounds} \]
3. Follow the example and fill in the blanks in the "New" Weight Chart. Show your work.
**Data:**

**Table 1: My Weight Around the Solar System**

<table>
<thead>
<tr>
<th>Planet/Satellite/Star</th>
<th>Multiply your Earth weight by:</th>
<th>Your &quot;new&quot; weight on the planet/satellite/star</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Venus</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Earth</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Moon</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>Mars</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Jupiter</td>
<td>2.5</td>
<td></td>
</tr>
<tr>
<td>Saturn</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>Uranus</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Neptune</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Pluto</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Sun</td>
<td>28</td>
<td></td>
</tr>
</tbody>
</table>

**Results/Conclusions:**

1. Where do the multiplication factors represent (refer to procedure #2 for a hint)?
2. Which planet has the lowest gravity? Which one has the highest gravity?
3. What has been affected by the difference in gravity?
4. What relation exists between weight and gravity? Does gravity have that same effect on mass?
5. Using what you learn in this activity, explain the relation that exists between the planets and their satellites, the sun and its satellites?
6. What is the difference between mass and weight?
7. Suppose that on a planet you weigh two-thirds as much as you do on Earth. Is the planet’s mass greater than or less than Earth’s? Explain.
8. Explain the Moon’s motion if the Earth had no gravity.

**Extensions:**

Take a look at a poster of the Solar System and think about another factor that affects the gravity between two celestial bodies.
USING THE MICROSCOPE

Benchmarks:
The proper use of the microscope will enable students to study some of the standards covered in the NGSSS Life Science Body of Knowledge.

SC.6.L.14.2 Investigate and explain the components of the scientific theory of cells (cell theory): all organisms are composed of cells (single-celled or multi-cellular), all cells come from pre-existing cells, and cells are the basic unit of life.

Objectives:
• correctly prepare a wet-mount slide
• observe an object under the microscope
• properly use a scientific tool used to observe cells

Background Information: In the science laboratory, the microscope is used to examine organisms and objects that are too small to be seen with the unaided eye. The objects to be viewed are placed on a glass slide. The glass slide may be either a dry-mount or a wet-mount slide. In a dry-mount slide, the object to be examined is placed on the slide and covered with a cover slip. In a wet-mount slide, a drop of the liquid containing the object to be examined is placed on the slide and then covered with a cover slip.

Problem:
• How do you prepare an object to be viewed under the microscope?
• How do you see the microscope to observe an object?

Materials:
- Microscope
- Microscope slide
- Cover slip
- Newspaper
- Scissors
- Medicine dropper
- Water
- Forceps or pin
Procedures:

1. Cut a small letter “d” from the newspaper and place it in the center of a clean microscope slide so that it is in the normal reading position. **Note:** For you to observe any specimen with a compound microscope, the specimen must be thin enough for light to pass through it.

2. To make a wet-mount slide, use the medicine dropper to carefully place a small drop of water over the specimen (letter “d”) to be observed.

3. Place one side of a clean cover slip at the edge of the drop of water at a 45° angle. Using forceps or a pin, carefully lower the cover slip over the letter “d” and the drop of water. Try not to trap air bubbles under the cover slip, since these will interfere with your view of the specimen. Now you have a wet-mount slide.

4. In Figure 2, draw a picture of the letter “d” as you see it on the slide.

5. Clip the slide into place on the stage of the microscope and position it so that the letter “d” is directly over the center of the stage opening.

6. Look at the microscope **from the side** and use the coarse adjustment knob to lower the body tube until the low-power objective lens almost touches the slide.

7. Looking through the eyepiece, use the coarse adjustment knob to raise the body tube until the specimen comes into view.

8. Turning no more than one-fourth of a turn, use the fine adjustment knob to focus the letter clearly.

9. Tilt the mirror and adjust the diaphragm until you get the best light for viewing the specimen.

10. In Plate 1, draw a picture of the letter “d” as viewed through the microscope. Note the magnification.

11. While looking through the eyepiece, move the slide to the left. Notice which way the letter seems to move. Now move the slide to the right. Again, notice which way the letter seems to move.

12. To switch to the high-power objective lens, look at the microscope from the side. Revolve the nosepiece so that the high-power objective lens clicks into place. Using the fine adjustment knob only, bring the specimen into focus.

13. In Plate 2, draw a picture of the letter “d” as seen with the high-power objective lens. Note the magnification.

Observations:

Figure 2
Conclusions:
1. Briefly describe how to make a wet-mount slide.

2. How does the letter “d” as seen through the microscope differ from the way a “d” normally appears?

3. When you move the slide to the right, in what direction does the letter “d” appear to move?

4. When you move the slide to the left, in what direction does the letter “d” appear to move?

5. How does the ink that was used to print the letter differ in appearance when you see it with the unaided eye from the way it appears under the microscope?

Critical Thinking and Application
Explain why a specimen to be viewed under the microscope must be thin.
COMPARING PLANT AND ANIMAL CELLS

Benchmarks:

SC.6.L.14.4 Compare and contrast the structure and function of major organelles of plant and animal cells, including cell wall, cell membrane, nucleus, cytoplasm, chloroplasts, mitochondria, and vacuoles.

SC.6.N.1.3 Explain the difference between an experiment and other types of scientific investigation, and explain the relative benefits and limitations of each.

Engage
Have students examine pictures in a text or projected pictures of plant and animal cells. Ask them to identify the most notable differences between the two.

Background Information:
All living things are made up of cells. Cells are the basic units of structure and function of living things. There are many types of cells. Whether they are plant or animal cells, most cells share certain characteristics.

In this investigation, students will compare the structures of a typical cell (onion skin cell) and a typical animal cell (human cheek cell, muscle cell, etc.).

Problem:
Are there similarities or differences between plant and animal cells?

Materials
- Medicine Droppers
- Onion skin
- Water
- Microscope
- Forceps
- Methylene blue
- Image of an animal cell (cheek cell or muscle cell)

Students’ Procedure:
Part A: Examining Plant Cells
1. Put a drop of water in the center of a clean slide.
2. With the forceps, remove a small piece of onion skin and place it on the slide. Make sure that the skin is flat. If it is folded, straighten it with the forceps.
3. Carefully place a cover slip over the drop of water and onion skin.
4. Place the slide on the stage of the microscope with the onion skin directly over the opening in the stage.
5. Using the low-power objective lens, locate the leaf under the microscope. Turn the coarse adjustment knob until the onion skin comes into focus. When you have focused the leaf, have your teacher check to see if it is focused correctly.
6. Switch to the high-power objective lens. CAUTION: When turning to the high-power objective lens, you should always look at the objective from the side of your microscope so that the objective lens does not hit or damage the slide.
7. Observe the cells of the onion skin. Draw and label what you see in Plate 1.
8. Carefully clean and dry your slide and cover slip.

**Part B. Examining Animal Cells**
Sketch the image of the animal cell in plate 2.

**Observations:**
Plate 1 High-power objective
Magnification ___________
Plate 2 Comparison Animal Cell
Magnification ___________

Onion Skin Cell
(Plant cells)

Cheek/Muscle Cell
(Animal cells)

**Conclusions:**
1. Describe the shape of the onion cells and the cheek/muscle cells.
2. How are plant and animal cells similar in structure?
3. How are plant and animal cells different?
4. Why are stains such as methylene blue used when observing cells under the microscopes?

**Critical Thinking and Applications:**
1. How is the cell wall different from the cell membrane?
2. Explain why you could not use an oak leaf in place of an onion skin in this investigation.
3. If you were given a slide containing living cells, how would you identify the cells as either plant or animal?
   4. How was this lab different from an experiment? Explain your answer.

**Extension:**
Remove the skin from some fruits and vegetables, such as tomatoes and leeks. Prepare wet-mount slides for each fruit or vegetable skin and observe them under the low-power objectives of your microscope. Sketch and label what you see. How do these cells compare with animal cells?
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