SCIENCE THROUGH GADGETRY

Theme: Technology – 4-5, Middle School

6th grade – Earth Science
7th Grade – Life Science
8th Grade – Physical Science

Developed by
Creative Out-of-School Learning
kat@hypersurf.com
# Science through Gadgetry

## Table of Contents

1. How to use this unit .................................................3
2. Scheduling Worksheet..............................................4
3. Materials List.......................................................5
4. Shopping List.......................................................7
5. General Overview
   - List of Scholastic Books ........................................8
   - Suggested Culminating Events ..................................8
   - Other Helpful References .......................................8
   - Suggested Field Trips, Guest Speakers, Movies ..............8
   - Outline of Activities ..........................................8
6. Overview of Academic Skill Development
   - List of literacy tasks ..............................................9
   - List of Math tasks integrated into activities .................9
   - Academic Standards supported in Unit .......................10
7. Activities
   - Science Questions ...............................................12
   - Egg Drop ..........................................................13
   - Earth Science
     - Panning for Gold ............................................16
     - Weather Barometer ..........................................18
     - Book of Weather Sayings ....................................20
     - Solar Ovens ..................................................21
   - Life Science - Forensics
     - 2 Minute Mysteries ..........................................24
     - Physical Evidence ..........................................25
     - Fingerprints ..................................................26
   - Physical Science
     - Paper Airplanes ..............................................28
     - Boomerangs ..................................................30
     - Marshmallow Catapult ......................................32
     - Balloon Powered Cars ......................................34
   - Putting it all Together
     - Engineering Competition ...................................36
8. Appendix
How to use the “Science through Gadgetry” Unit

The activities in this book are designed for middle school participants. Many of the projects take longer than one session and require a great deal of independent planning and execution. Many activities are group activities. Groups of four are optimal in encouraging participation and decreasing the amount of sitting around time that often leads to disruption.

The goal of the unit is to expose the participants to the process of scientific inquiry, not to necessarily teach science facts or concepts. The initial activity introduces the key questions in the scientific process. Make sure you intentionally keep repeating the questions throughout the unit. Get the participants use to thinking scientifically.

The shopping list is priced to cover enough consumable materials for at least 20 participants.

**Time needed:** 6 weeks with two 1-1½ hour sessions per week with a culminating activity on the Friday of the last week of the unit. Before you start the unit, use the scheduling worksheet to organize your activities. If you are going to do a culminating activity, plan backwards from that activity. Also, make a list of any extra material that you will need for the unit, and gather them before beginning. Be sure to include any movies, field trips or guest speakers.

Recommended scheduling:
- First session: Start with the Scientific Questions activity and practice asking the questions during the EGG DROP exercise.
- The activities are not interconnected. You can pick and choose different activities. The three categories, EARTH SCIENCE, LIFE SCIENCE and PHYSICAL SCIENCE correspond with the 6th, 7th and 8th grade curriculum.
- Select your culminating activity at the beginning of your unit. If you plan to invite family, community members, other program participants to the Engineering Competition, have the participants make the posters and send the invitations out at least two weeks ahead of time.

Most activities include literacy or math reinforcement opportunities. There are direction sheets for many of the experiments. Give those out to the participants and have them read them and work independently as much as possible. It is very tempting to demonstrate what to do, but this takes away the opportunity to practice literacy skills.
## SCHEDULING WORKSHEET

<table>
<thead>
<tr>
<th>Activity</th>
<th>Date</th>
<th>Time</th>
<th>Group</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Supplies Needed:**

-------------------------------------------------------------------------
-------------------------------------------------------------------------
-------------------------------------------------------------------------
-------------------------------------------------------------------------
-------------------------------------------------------------------------
-------------------------------------------------------------------------
-------------------------------------------------------------------------
Unit Materials

Non-Consumable materials
- Science question poster
- Master copy of the Egg Drop Instruction Sheet
- Master copy of Making a Balloon Barometer Works
- Master Copy of the 2-5 minute mystery Handouts
- Master Copy of the Physical Analysis Sheet
- Master Copy of the Finger Print Analysis Sheet
- Master copy of Directions for Marshmallow Catapult
- Master copy of Directions for the Balloon Powered Race Cars
- Master Copy of the Paper Plane Instruction Sheet
- List of the weather sayings
- Five 8-inch aluminum pie plates
- 5 Large-mouth jar
- Various pieces of fibers such as cotton, nylon thread, silk etc
- 10 Magnifying glasses
- “Evidence” fiber (sets of different types of thread or fibers)
- 5 Fine brushes
- Picture of Boomerang Designs
- Measuring Tape
- 3 Hole Punches
- Water tubs, wide enough to swirl pie plates and 6 to 10 inches deep
- Pails/small garbage cans
- Glue
- Paper
- Pen/Pencil
- Rulers
- Scissors
- More 2 minute mysteries
- Clear drinking glasses

Consumable materials
- Heavy construction paper
- 5 packages of Cardboard
- One bag of cotton balls
- 20 Styrofoam trays
- 20 each of flexible and non flexible straws
- Index Cards
- Bags of small brass nuts and bolts
- Large balloons and regular balloons
- 10 Large rubber bands
- Box of Toothpicks
- Glitter Pens
- Aluminum foil
- One package of black construction paper
- Clear plastic wrap
☐ 5 Thermometers
☐ Cocoa powder
☐ Poster Board
☐ Small bag of Styrofoam Peanuts
☐ Different color copy paper
☐ Rubber bands
☐ Dried Beans
☐ Package of dozen sharpened pencils
☐ Small nails/pins
☐ Masking Tape
☐ Eggs
☐ Tape
☐ White paper
☐ Markers
☐ Toilet paper
☐ Garbage bags
☐ Dirt/sand
☐ Large Pizza boxes
☐ Food to be cooked
☐ Two 1-quart plastic bottles per pair (make sure they are heavy duty bottles)
☐ Marshmallows
☐ Wheels
☐ Straws
☐ Newspapers

**Optional**
☐ Access to the Internet
☐ Participant hair samples with one chosen to be the piece of evidence
# Science through Gadgetry Shopping List

Note: Does not include list of handouts found in the binder, recipe ingredients and common items such as paper, staplers, scissors etc. *Prices do not include shipping cost and 2009 prices.*

<table>
<thead>
<tr>
<th>Item</th>
<th>Supplier</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small nails/pins</td>
<td>Orchard’s Hardware</td>
<td>1.19</td>
</tr>
<tr>
<td>5 bags of brass nuts/1 box of brass bolts</td>
<td>Orchard</td>
<td>16.39</td>
</tr>
<tr>
<td>Measuring Tape</td>
<td>Orchards</td>
<td>2.99</td>
</tr>
<tr>
<td>Large-mouth jars (canning jars)</td>
<td>Lucky</td>
<td>12.49</td>
</tr>
<tr>
<td>Quality Clear plastic wrap</td>
<td>Lucky</td>
<td>-</td>
</tr>
<tr>
<td>Dried Beans</td>
<td>Lucky</td>
<td>4.75</td>
</tr>
<tr>
<td>Bamboo Skewers</td>
<td>Big Lots</td>
<td>2.00</td>
</tr>
<tr>
<td>One bag of cotton balls</td>
<td>Dollar Store</td>
<td>1.00</td>
</tr>
<tr>
<td>Box of Toothpicks</td>
<td>Dollar Store</td>
<td>1.00</td>
</tr>
<tr>
<td>Flexible straws</td>
<td>Dollar Store</td>
<td>1.00</td>
</tr>
<tr>
<td>Aluminum foil</td>
<td>Dollar Store</td>
<td>1.00</td>
</tr>
<tr>
<td>Dozen non-sharpened pencils</td>
<td>Dollar Store</td>
<td>2.00</td>
</tr>
<tr>
<td>Cocoa powder</td>
<td>Dollar Store</td>
<td>1.00</td>
</tr>
<tr>
<td>9 Inch Balloons</td>
<td>Dollar Store</td>
<td>3.00</td>
</tr>
<tr>
<td>Five 8-inch aluminum pie plates</td>
<td>Dollar Store</td>
<td>3.00</td>
</tr>
<tr>
<td>5 Fine brushes</td>
<td>Dollar Store</td>
<td>5.00</td>
</tr>
<tr>
<td>Mini Plastic Wheels</td>
<td>Kelvin Company</td>
<td>13.99</td>
</tr>
<tr>
<td>Heavy construction paper</td>
<td>Discount School Supplies</td>
<td>.89</td>
</tr>
<tr>
<td>Glitter Pens</td>
<td>Discount School Supplies</td>
<td>6.49</td>
</tr>
<tr>
<td>Black construction paper</td>
<td>Discount School Supplies</td>
<td>.79</td>
</tr>
<tr>
<td>Colored News Paper Print (500 sheets)</td>
<td>Discount School Supplies</td>
<td>5.99</td>
</tr>
<tr>
<td>Magnifying glass</td>
<td>Educational Innovations</td>
<td>5.00</td>
</tr>
<tr>
<td>Food thermometer</td>
<td>Nasco</td>
<td>5.15</td>
</tr>
<tr>
<td>Poster Board</td>
<td>Staples</td>
<td>4.28</td>
</tr>
<tr>
<td>Large rubber bands</td>
<td>Staples</td>
<td>1.49</td>
</tr>
<tr>
<td>Styrofoam trays</td>
<td>Smart and Final</td>
<td>-</td>
</tr>
<tr>
<td>Non-flexible straws</td>
<td>Smart and Final</td>
<td>-</td>
</tr>
<tr>
<td>Large Balloons</td>
<td>Target</td>
<td>-</td>
</tr>
</tbody>
</table>

**Total: 101.88**

- **Kelvin Company**: [www.kelvin.com/](http://www.kelvin.com/)  (Note: There are many different styles and types of wheels at various price range offered at this website. There are also axles that can be purchased.)
- **Educational Innovations**: [www.teachersource.com](http://www.teachersource.com)
- **Nasco**: [www.enasco.com](http://www.enasco.com)
General Overview

Aligned with the following Scholastic Books:
- *Awesome Science* by Katherine Gleason
- *High-Tech Inventions* by Mary Packard
- *Space* by Rosanna Hansen
- *Extraordinary Blogs and Ezines* by Lynn Rominger
- *Up Close* by Louise Gikow

Suggested Culminating Activities:
- Inventions Festival – displaying and demonstrating inventions to other program participants and leading an engineering competition

Other Helpful References
- *Gizmos and Gadgets: Creating Science Contraptions that Work and Knowing Why* by Jill Frankel Hauser, A Williamson Kids Can Book
- *Science Crafts for Kids: 50 Fantastic Things to Invent and Create* by Gwen Diehn and Terry Krautwurst, Sterling Publishing Co., Inc.

Suggested guest speakers, field trips and movies
- Field trip to the Exploratorium
- Visit a Computer Assisted Design (CAD) Studio or ask someone who works with CAD systems to come in and demonstrate how they work.
- Movies:
  - *Weird Science*
  - *Real Genius*
  - *October Boys*

Activities

<table>
<thead>
<tr>
<th>Key Activities:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Science Questions</td>
</tr>
<tr>
<td>2. Egg Drop</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science Questions</td>
</tr>
<tr>
<td>Egg Drop</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Earth Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panning for Gold</td>
</tr>
<tr>
<td>Weather Barometer</td>
</tr>
<tr>
<td>Book of Weather Sayings</td>
</tr>
<tr>
<td>Solar Ovens</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Life Science</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forensics</td>
</tr>
</tbody>
</table>
|                         | ■ 2 minute mysteries  
|                         | ■ Physical Evidence  
|                         | ■ Fingerprints       |
| Physical Science        | ■ Paper Airplanes    
|                         | ■ Boomerangs         
|                         | ■ Marshmallow Catapult  
|                         | ■ Balloon Powered Cars |
| Putting it all Together | ■ Engineering Competition |

**Overview of Academic Skill Development**

**Specific Language Arts Activities**
- Reading the directions and writing the conclusions in *Egg Drop*
- Reading the directions on how to pan for gold in *Panning for Gold*
- Reading the directions and scientific explanation in *Balloon Barometer*
- Reading, analyzing and describing the weather saying in *Book of Weather Sayings*
- Reading the instructions in *Pizza Box Solar Oven*
- Reading the *Minute Mysteries*
- Writing conclusions in *Physical Analysis*
- Reading the direction to make the planes and writing the squadron cheer in *Paper Plane Squadron*
- Reading directions in *Boomerangs*
- Reading directions and writing conclusions in *Marshmallow Catapult*
- Reading directions and writing conclusions in *Balloon Powered Race Cars*
- Writing invitations or flyers, direction cards for competition events and display cards for exhibits in the *Engineering Competition*

**Specific Math Activities**
- Averaging, recording and analyzing data in *Balloon Barometer*
- Reading thermometers in the *Pizza Box Solar Oven*
- Recording data on the worksheet in *Physical Analysis*
- Recording data on the worksheet in *Fingerprinting*
- Measuring, converting from measurement, averaging in *Paper Plane Squadron*
- Measuring distances in *Marshmallow Catapult*
- Measuring distances in *Balloon Powered Race Cars*
Embedded Content Standards
Language Arts/Reading

Reading:
Vocabulary and Concept development
Comprehension
- Interpret information from diagrams, charts and graphs
- Follow simple multiple-step written instructions
- Understand how text features (e.g., format, graphics, sequence, diagrams, maps) make information accessible and usable

Writing
Writing Strategies
- Create readable documents with legible handwriting
- Understand the purpose of various reference materials
- Revise original drafts to improve sequence and provide more descriptive detail
Written and Oral English Language Conventions
- Write with a command of standard English conventions appropriate to grade level
Writing Applications
- Write descriptions that use concrete sensory details to present and support unified impressions of people, places, things or experiences

Mathematic Content Standards
Number Sense
- Adding, subtracting, dividing and multiply whole numbers
- Determining average
Measurement and Geometry
- Understand that measurement is accomplished by identifying a unit of measure, iterating (repeating) that unit and comparing it to the item to be measured
- Determine the duration of intervals of time
Statistics, Data Analysis, and Probability
- Collect, organize, represent, and compare data by category on graphs and charts
Activities
Science Questions

Material

☐ Science Question Poster

Directions

Introduce the theme of the unit by introducing the basic questions of science. Put up the poster and quickly go over the questions. Refer to them throughout the unit. Make it fun, but be consistent.

Questions

1. What happened?

2. Why do you think that happened?

3. What facts do you have to support why you think that?

4. What would happen if you ________________?
Egg Drop

Materials

☐ Master Copy of the Egg Drop Instruction sheet
☐ Heavy construction paper
☐ Cardboard
☐ Cotton Balls
☐ Styrofoam peanuts
☐ Straws
☐ Index Cards
☐ Masking tape
☐ Eggs
☐ Tape
☐ Toilet paper
☐ Garbage bags

Directions

Break up the group into teams of four. Give out the direction sheets found in the appendix and give them the following time allowances:

- 5 minutes – Brainstorming
- 15 minutes – Construction
- 10 minutes – Composing their cheer

Bring them over to the “drop zone,” to test out their egg drop craft. Before each drop, the team will do their cheer. After the drop, have each team complete their Drop Report. Bring the groups back together, letting each group report their findings. While they are reporting out, make sure to ask the Science Questions.
The Amazing Egg Drop

Instructions:
Your team will design a container that would protect a raw egg as it falls to the ground from the second floor. Your team will receive an egg and a bag of materials. You will be given time to brainstorm how you might construct a protective mechanism for dropping your egg without breaking it. You can only use the materials in your bag within the time allotted. It will be important to work well with your teams in analyzing how to use the materials and predicting which materials will safely protect your egg during its descent. You cannot change the egg in any way (no tape on the egg, no nail polish on the egg, no hollow eggs).

You are also responsible for developing a Team Cheer to use at the time of the egg drop. When all teams have completed their craft, bring them to the “drop” site.

MATERIAL

Each team will receive
- One egg
- Newspapers
- Masking tape

Other material available will be
- Heavy construction paper
- Cardboard
- Cotton Balls
- Styrofoam peanuts
- Toilet paper
- Straws
- Tape
- Garbage bags

AFTER THE DROP
As a team, discuss why your egg drop craft performed well or badly. Complete the following questions and be ready to report to the group:

How did you craft do in its drop from the height?
What was successful in the design of the craft?
What would you change about your craft if you did the experiment again?
Earth Science
Panning for Gold

Material
☐ Master copy for “Panning for Gold”
☐ 8-inch aluminum pie plates
☐ Bag of brass nuts and bolts
☐ Water tubs, wide enough to swirl pie plates and 6 to 10 inches deep
☐ 5 Pails/small garbage cans
☐ Dirt/sand

Directions

Scientific Principle:
Panning works because the weight and density of gold is more than the dirt and sand where it is found. The water carries away the dirt and sand and leaves the gold rocks.

- Fill the pails with dirt or sand and mix the brass washers evenly in the dirt. These washers will be the gold nuggets.
- Together, read the directions for “Panning for Gold.” Talk about how they can change the method described in the directions to pan for gold in the tubs.
- Divide the participants into small groups. Each group gets a pail with a mixture of sand/dirt and gold. The goal is to pan for the gold the fastest.
- Fill the pails with dirt and sand. The participants take turns scooping out material from the pail and placing it in the pie plate. Set a time limit for each member of the team, but allow the team member to empty the pie plate except for the gold pieces before turning it over to the next member.
- Before changing, stop and have the team members share strategies that seemed to work. Be sure to ask the Science Questions.
- After each turn, have the participants count the gold nuggets they found and record the result. They cannot count or retrieve any gold that falls into the tub. Continue the process until the groups have “panned” all the contents of their pail.
- The team retrieving the most gold in the least amount of time, wins.
Gold Panning Instructions
Anyone can learn how to pan for gold. Follow these simple gold panning instructions and start panning for gold today.

Step #1 - Find where the gold is
There is no use panning for gold in a stream where there is no gold so go to a stream where people have found gold before. Since gold is much heavier than water (about 19 times heavier), the gold stays on the bottom and gets caught in the sand in slow moving areas around bends of the stream and along the shore. It also tends to get stuck in small crevices in rocks and wedged in pieces of wood. Try to find places like this along the stream.

Step #2 - Submersion
Put about 4 handfuls of material into your gold pan. Submerge the pan in the stream. While holding the gold pan under water, move the pan in a circular motion so that the lighter materials will be carried out of the gold pan. Don't move it too rapidly or you may lose gold along with the rocks and sand. Keep doing this until about half of the material in the gold pan is gone.

Step #3 - Panning
Lift the pan out of the water and begin swirling it around with it tipped slightly to the side where the riffles are. When all the water is gone dip the pan into the water again, bring it back out, and start swirling again. Keep doing this until nearly all the material in the pan is gone.
Weather Barometer

Material
- Master copy of *How a Barometer Works*
- Master copy of directions for *Making a Balloon Barometer*
- Drinking straw
- Large-mouth jar
- Large balloon (11 inch diameter or larger)
- Large Rubber Bands
- Heavy construction paper
- Toothpick
- Tape
- Paper
- Pen/Pencil
- Rulers
- Scissors

Directions

*Literacy Reinforcement*
- Read the description of how a barometer works as a large group.
- Divide the group into teams of four, and have each group use the direction sheet to make a barometer.

*Math Reinforcement*
- Have the participants record their daily readings for at least 10 days using the worksheet provided. After the ten days, discuss the following:
  - What is the correlation between the barometric pressure reading and the weather?
  - What is the average daily barometric pressure reading of all the barometers?
  - Was there a difference between different groups’ barometers? If there is a difference, what could explain those differences?

*Making the Barometer*
- Blow up a balloon stretch it, and then let the air out.
- Cut off the neck portion of the balloon and stretch the remaining balloon across the top of the jar.
- Seal the balloon to the jar with duct tape or by using the large rubber bands. Make certain not to leave leaks between the balloon and jar.
- Tape a toothpick to one end of the drinking straw. Tape the other end of the straw to the center of the top of the balloon.
- Fold a piece of construction paper into thirds to make a triangular column. Make a measuring scale on the column.
- Stand the column next to but not touching the tip of the straw with the toothpick acting as the pointer.
- Use this scale to monitor changes in the air pressure.
- Have each group take readings periodically during the unit using the worksheet provided. Compare data between barometers and the relationship with the readings and weather patterns.

**How a Balloon Barometer Works**

Since the air inside the jar is held by the balloon, no air can escape and no extra air can enter. The air molecules are constantly pressing against all sides of the jar. Of course, air also surrounds and presses on the outside surface of the jar. When the pressure inside the jar is less than the pressure outside of the jar, the balloon sinks and causes the straw to rise. When pressure on the inside of the jar is greater than the outside pressure, the balloon will bulge, causing the straw to tilt downward. High pressure is associated with sunny and dry weather (the straw tilts upward). Low pressure is associated with dark cloud cover and precipitation (the straw tilts downward).
Book of Weather Sayings

Material
- Master copy of the list of the weather sayings
- Construction paper
- Glitter pens
- White paper
- Markers
- Optional: Access to the Internet

Directions

Literacy Reinforcement:
Have each participant choose one of the following sayings. Have them design a page that illustrates its meanings. If you have access to the computer, investigate the meaning and its origin. Make a book of the pages putting a blank page between each saying, and making a cover with construction paper. Decorate the covers also. Use the blank pages as a log to keep track of whether their sayings accurately forecast the weather.

Have them keep track whether their saying provides an accurate forecast to the weather.

- If crows fly low, winds going to blow; if crows fly high, winds going to die.
- No weather is ill, if the wind is still.
- A sunshiny shower won’t last half an hour.
- From twelve ‘til two tells what the day will do.
- When sea birds fly to land there truly is a storm at hand.
- If cats lick themselves, fair weather.
- The chill is on, near and far, in all the months that have an ‘R’.
- Rainbow at noon, more rain soon.
- The south wind brings wet weather...the north wind, wet and cold together; the west wind always brings us rain...the east wind blow sit back again.
- When a cow tries to scratch her ear it means a shower is very near.
- Onionskin is very thin, mild winter is coming in. Onionskin is thick and tough, winter will be cold and rough.
- Ice in November to walk a duck, the winter will be all rain and muck.
- Rain before seven, quit by eleven.
- A cow with its tail to the west, makes weather the best; A cow with its tail to the east, makes weather the least.
- Evening red and morning gray speed the traveler on his way; Evening gray and morning red bring down rain upon his head.
- Rainbow in the east, sailors at peace; rainbow in the west, sailors in distress.
- Pale moon doth rain, red moon doth blow, white moon doth neither rain nor snow.
- When the dew is on the grass, rain will never come to pass.
- Rainbow in the morning, shepherds take warning; rainbow at night, shepherds’ delight.
- If the groundhog sees his shadow, we will have six more weeks of winter.
Pizza Box Solar Oven

The basic solar oven is very simple and does not get very hot. Have the participants experiment with modifications but make sure that you measure the temperature inside the oven and only cook things that are safe to eat at that temperature.

Material

- Aluminum foil
- Black construction paper
- Clear plastic wrap
- Thermometers
- Large size pizza boxes (Ask for donations from your local pizza place)
- Scissors
- Ruler
- Glue
- Food to be cooked

The following definitions are taken from New Mexico Solar Energy Association:

Scientific Concepts:

The ovens utilize the concept of passive solar design. Passive solar design refers to the use of the sun's energy for the heating and cooling of living spaces. Two main principles of passive solar design that are demonstrated by the pizza box solar ovens are solar gain and insulation.

Explain these three concepts using the definitions below:

- **Solar Gain** - arranging for sunlight to enter a device as a source of energy. In this case, the gain is accomplished both by reflection and direct gain. This principle also includes using dark colored surfaces to absorb the solar energy that enters a device.

- **Insulation** - containing heat by trapping air inside and around a device to contain heat, and reflecting thermal radiation back into a device.

- **Thermal Mass** - Thermal mass is material that stores energy. The thermal storage capacity of a material is a measure of the material's ability to absorb and store heat. Large amounts of food will provide some thermal mass, therefore, causing the oven to heat up more slowly.

Directions

Divide into small groups and give each group a set of materials and the following directions. Encourage the groups to experiment with different designs to raise the temperature in their oven.
Pizza Box Solar Oven Instructions

1. Assemble the pizza box and open it up.
2. Glue aluminum foil to all inside surfaces of the sides except the top of the box, with the shiny surface facing in. This will create a "radiation trap" that will trap, by reflection, invisible (low-frequency) radiation that is given off by the food and air inside the box.
3. On the top flap of the pizza box draw a square with a marker with edges spaced 1" from the four sides of the box.
4. Cut along three of the lines, on the sides and on the front edge of the box, leaving the fourth line along the box's hinge uncut. Then fold open the flap, making a crease on the fourth line.
5. Glue the aluminum foil to the inside surface of the top flap, with shiny side visible! This will form a reflector, to reflect sunlight into the oven. Be careful to make as few wrinkles as possible and smooth out whatever wrinkles occur.
6. Tape the black construction paper to the bottom of the box. This will help to absorb the incoming sunlight.
7. Carefully stretch the plastic wrap over the opening of the box, sealing the edges with tape to seal the air in.
8. Cover any air leaks around the box edges with tape, making sure that the box can still be opened.
9. Go outside in the sunlight and place oven on a flat, level surface.
10. Place the thermometer into the box and see how hot it gets. This will determine what food you should cook.
11. Place food on some foil (or a paper plate) and place inside the oven.
12. Use a pencil or ruler to hold up the reflector, so that sunlight is reflected into the oven, and especially onto the foil holding the food. Be sure to keep watching the angle of the reflector so that there is the greatest degree of sunlight being reflected into the oven.
13. Let food cook, and check reflector angle now and then to make sure sunlight is getting inside the oven.

Optional Features
1. Add additional flaps to reflect sunlight into the oven. This can substantially increase the gain of the oven. This will require some extra cardboard (from some old boxes, for example) and extra foil, glue, and string to adjust the flaps.
2. Crumple up some sheets of newspaper and stuff them around the inside of the box to provide extra insulation.
3. Add an additional layer of saran wrap across the box opening attaching it to the inside surface of the top flap, such that an air space is created between the layers of wrap (the plastic is bound to stick together in some places: don't worry about this too much).
Life Science

The activities in this section stress the scientific process of careful observation and comparison.
Forensic Science Activities

Minute Mysteries

Material

☐ 2-5 minute mystery handouts
☐ More mysteries  (See references for books and other sources of mysteries)

Directions

Solve a mystery with the whole group. Then, divide the participants into teams of three. Give each of the groups a set of short mysteries to solve. See which group can solve the most mysteries in the shortest period of time.

Solutions to the mysteries:

The Case of the Mayor's Murder: Mr. Orwell said that he saw the Mayor face down the ground. The detective found him on his back. So, Mr. Orwell killed the Mayor.

The Case of the Cell Phone: How could John Wilson use his cell phone if he lived way up in the mountains? The lines would have bad connection because of the mountains getting in the way.

The Case of the Stolen Feline: Ellen's sister was having an allergic reaction in the house. Gary was believable and Keray's allergies would rule her out as a suspect. So that left Ellen as the likely culprit.
Physical Evidence

Unit material
- □ Various pieces of fibers such as cotton, nylon thread, silk etc
- □ Magnifying glasses
- □ “Evidence” fiber (one of the types of thread or fibers from the samples)
- □ Index Cards
- □ Optional: participant hair samples with one chosen to be the piece of evidence
- □ Optional: Access to the Internet

Directions:
- ▪ Break up the group into pairs. Hand out the different fibers and have the participants look at them under the magnifying glass.
- ▪ Have them draw what they see including what the edges looks like, whether the fiber is tubular, flat, smooth or bumpy.
- ▪ If you have access to the internet, they can try to identify what kind of fiber it might be by looking up the different fabrics and then label their drawings.
- ▪ Using the Physical Analysis Worksheet, record their observations and select the fiber that matches the “evidence” fiber. Some of the characteristics that they should look for in both fibers:
  - ▪ color
  - ▪ length
  - ▪ texture
  - ▪ size
- ▪ Write up the conclusions on an index card.
Fingerprinting

Taking Fingerprint Records

Material
- ☐ Finger Print Analysis sheet
- ☐ Magnifying glass
- ☐ Pencils
- ☐ White paper

Directions
Have the participants do the following:
- Rub the side of the sharpened end of a soft pencil on a sheet of paper, transferring some graphite onto the paper.
- Rub the last digit of your finger firmly back and forth on the graphite.
- Place a strip of clear, three-quarter-inch-wide plastic tape sticky side down on the graphite-coated finger.
- When you peel the tape off the finger the fingerprint pattern will come with it. Place the tape on the proper place in the worksheet.
- Repeat the process for each finger. Using the magnifying glass, analyze your fingerprints.

Lifting Fingerprints

Material
- ☐ Cocoa powder
- ☐ Fine brush
- ☐ Magnifying glass
- ☐ Finger Print Analysis sheet
- ☐ Tape
- ☐ Glasses

Directions
- Give participants glasses and have them place their fingerprints on them.
- Have them find the fingerprints by brushing a small amount of cocoa powder over the print and lightly brushing off any access powder.
- Press a piece of tape over the print and peel it away with the powdered fingerprint on it. Stick the tape on the light paper so they can be more easily seen.

For added fun, ask one participant to volunteer to be the criminal, and lift a copy of their fingerprints before hand. This set of fingerprints will serve as evidence. After everyone has lifted their fingerprints, mix everyone’s fingerprint pages up and if they can find the one that matches the evidence.
Physical Science
Paper Plane Squadrons

Material
- Different color copy paper
- Master Copy of the Paper Plane Instruction Sheet
- Measuring tape

Directions
- Divide the participants into equal groups to form “squadrons.” Each group will get different colored paper.

Literacy Reinforcement:
- Each member of the group will individually make his or her own paper airplane following the instruction sheet.
- Have the members determine a name for their squadron and a squadron cheer.

Math Reinforcement:
- Have the squadrons take turns flying their planes. Each group will measure and record the distance on their individual flights. Decide on whether the distances will be recorded in feet or inches, and convert the measurements accordingly. After recording all the measurements, average the distance for each squadron. The squadron with the highest average is the winner.

Extension Activity
- The squadron members select one plane from the group to use in the competition, either by selecting one member or working together to integrate the best aspects of all the plane designs.
- The final competition between squadrons will then commence. You can have them compete for distance, accuracy such as landing in a hula-hoop, height, etc.

The following are websites that have great paper plane designs:
Best Paper Airplanes: http://www.bestpaperairplanes.com/
Paper Airplanes (lots of different links): http://www.cdli.ca/CITE/paper.htm
The most amazing thing about a paper airplane is that all you need to make one is a sheet of paper—nothing more. You don't need scissors, glue, tape, or paper clips. A few folds, a couple of adjustments, and you have a superb paper flyer. The properties of paper give the airplane all the attributes it needs. If you've ever made a paper airplane, you've probably just folded the paper into a simple dart—as people have done for at least a hundred years. But in the last two decades, paper airplane designers have imported techniques from origami. Perhaps the best innovation was the addition of one fold to the classic dart design to create a plane called the "Nakamura lock" after the origami artist who designed it.

1. Fold a sheet of paper in half lengthwise. Unfold so that the crease is 'valley' side up.

2. Fold the top corners down to the center fold.

3. Fold the tip down.

4. Fold about one inch of the tip up; unfold.

5. Fold the top corners down to the center fold so that the corners meet above the fold in the tip. (Note that the top—the nose of the plane—should be blunt.)

6. Fold the tip up. This is the Nakamura lock.

7. Fold the entire plane in half so that the tip is on the outside.

8. Fold the wings down. Trim and fly!

Once you've made all of your folds and the plane looks symmetrical, it's time to trim it, or adjust it, for flight. Give it a gentle toss forward. Your goal is to have it glide smoothly and gently to the ground, either flying straight or in a gradual curve.

Make these adjustments, if necessary:

- If the nose drops and the plane dives into the ground, bend up the back of the wings. A little bend goes a long way.
- If the nose rises first and then drops, the plane is stalling. Bend down the back of the wing. Keep your adjustments small.
- When you get the plane to balance on the air and float down gently, then you can give it faster tosses.
Boomerangs
Remember to ask the SCIENCE QUESTIONS

Material
- Master Copy of the Pictures of Boomerang Designs
- Poster Board
- Styrofoam trays
- Scissors
- Markers
- White paper
- Pencils
- Optional: Other materials such as heavy construction paper

Directions:
Prep: Cut the large poster boards into four smaller pieces. Give the participants the following instructions and the picture of boomerang designs.

Draw the pattern of your choice on plain white paper until you are satisfied with the shape. Remember, rounded edges help lower the wind resistance. Cut out your pattern and trace onto the poster board. Cut the heavy construction paper or other material. (See pictures for suggested patterns.) Try out different designs including adding more arms etc. Experiment with different ways of throwing, weight of material, shapes etc.

Throwing a Boomerang
To throw, hold one end of the boomerang between your index finger and thumb, keeping it vertical. Throw it as if you were throwing overhand like a baseball, never side arm. If you are throwing it correctly, the boomerang should return to you.

Hold contests for length of flight, accuracy of returns etc. Have them decorate their finished designs.

Scientific Principle
Adapted from Gizmos and Gadgets pg. 102
The arms of the boomerang act like airplane wings, giving it lift or an upward force. When thrown correctly, you add torque, the force you add to make something rotate or spin. When you fling it, the spin causes it to move like a top in the air. A boomerang spins rapidly away from the thrower, until drag, or air friction slows it down. Its special shape causes it to move in a circular path back to its starting point.
Possible Boomerang Shapes
Marshmallow Catapult
Pictures scanned pg. 120-121 from Gadgets and Gizmos

Material
☐ Master Copy of Directions for Marshmallow Catapult
☐ Rubber bands
☐ Hole Punch
☐ Tape
☐ Dried Beans
☐ Index Cards
☐ Pencils
☐ Rubber bands
☐ Two 1-quart plastic bottles per pair (Bring in a case of quart size water or soda into your next staff meeting or an activity with your kids, and you will have enough. Save the tops for the balloon powered car activity. The tops make great wheels.)
☐ Scissors
☐ Marshmallows

Directions
- Have the participants work in pairs using the following directions and pictures to guide them.
- Hold a contest to see whose catapult is the most successful for distance and accuracy. Use the debriefing report to lead a discussion.
Marshmallow Catapult

Directions

1. Cut the tops off two plastic soda bottles, and cut what you have cut off into the shapes shown in the pictures below.

2. Punch three holes in the smaller section as shown. Poke a pencil through the two side holes.

3. Loop a rubber band through the bottom hole. Catch a pencil through the loop. Twist other rubber bands on either side of the loop to hold it in place. Place this pencil across the other pencil, and secure them to each other with rubber bands as shown.

4. Create a marshmallow hold by folding and taping the sides of an index card into a lid shape. Tape the hold to the top of the pencil so that the tip sticks out.

5. Fill the large bottom section of the bottle with beans to stabilize the catapult. Jam the other section into the weighted bottom.

6. Place a marshmallow in the holder. Push down on the pencil while holding onto the base. Then release it, and watch it fly.

Remember the energy to send the marshmallow is stored in the elastic bands.

After the Fling

Complete the following questions and be ready to report to the group:

How did your marshmallow catapult perform? ____________________________

What was successful in the design of the catapult? ____________________________

What would you change about the design if you could do it over?

________________________________________
Balloon Powered Race Cars

If you want to check out some examples check out the following website for great pictures.  http://www.mrg-online.com/car.htm

Materials

- 9 inch balloons
- Flexible straws
- Styrofoam trays
- Construction paper
- Small nails/pins
- Bamboo Skewers
- Yardstick
- Look around your site for anything that the participants could use to make their cars, including cardboard, plastic plates, pins, cork, etc.
- Masking Tape
- Markers
- Optional: Check out Kelvin supplies for wheels and axles varying in price http://www.kelvin.com/Merchant2/merchant.mv?Screen=CTGY&Category_Code=LRPPWHFW

Directions:

Divide the group up into teams. Explain the rules for the competition as listed below. Give them time to make, test and refine their car design. As a group, they must come up with a name for their car and decorate it. Set up the racing track and let the races begin. After the race, have them complete the Design Analysis sheet. Compete for the longest distance and straightest run.

Hint: To get the greatest distance, the wheels should be attached to the base by an “axle.” Glue or tape a straw to the front and back of the bottom of the body of the car, and put a bamboo skewer or other object that allows for free movement. Attach the wheels to the axle in a way that lets them move freely.
Balloon Powered Car Race

Picture taken from the following website: http://www.middleschoolscience.com/balloonracers.htm

Your team must build a car that runs by the escaping air of a balloon. After designing your car, you can test drive it and modify it. Name and decorate your car.

Background Information:
The rocket car is propelled along the floor according to the principle stated in Newton's Third Law of Motion. The escaping air is the action and the movement of the car in the opposite direction is the reaction. The car's wheels reduce friction and provide some stability to the car's motion. A well designed and constructed car will travel several meters in a straight line across a smooth floor. Newton's Third Law of Motion states: For every action, there is an equal and opposite reaction.

Rules:
- The car must be powered by no more than 2 balloons, and must have at least three wheels. Wheels are defined as anything that is round and goes around.
- The wheels can not be wheels from a toy car. They must be made out of something that was not originally meant to be used as wheels.
- The car may not leave the ground.
- The car must be capable of traveling at least 5 meters.
- No external sources of energy are permitted including, push starts, blowing on the car, batteries, solar cells, etc.
- The balloons may only be blown up using lung power by the car operator.
- During the initial release of the air (at the starting line), care should be taken to not enhance or diminish the performance of the car.
- No part of the car may be in front of the start line when starting car.

AFTER THE RACE
As a team, discuss why your balloon power car performed well or badly.
Complete the following questions and be ready to report back to the group:

How did your balloon powered car perform? _____________________________
What was successful in the design of the car?

________________________________________________________________________
________________________________________________________________________

What would you change about your car if you could design it again?

________________________________________________________________________
________________________________________________________________________
Engineering Festival

The participants host a festival where they display all the different gadgets they made during the unit. They will also hold two engineering competitions. Make sure the participants do the activities before the festival, so they will know how to lead them.

Unit materials:

- 3” x 5” inch index cards
- Toothpicks
- Construction paper
- Masking tape
- Markers
- Marshmallows
- Lots of Newspapers
- Snacks and drinks
- White paper

Directions

At the end of the unit, have the participants invite either another group from your program, parents or 4th or 5th graders from a feeder program to an engineering festival. Have the participants make the invitations or flyers.

Have them make displays of the different gadgets they made during the unit by having them write descriptions on index cards and placing them in front of the gadget on a table. The descriptions can include the materials used, how they worked and what kind of activities for which they were used.

The participants will lead the guests in the Newspaper Tower and Marshmallow and Toothpick Towers Event. Decide on the following

- Who will explain the rules,
- Who will keep time,
- Who will measure the towers

Make posters listing the rules for both competitions, and post them around the room.

End the events with refreshments.
Competition Events

**Toothpick and Marshmallow Towers**
This activity can be done individually or pairs. Provide the participants with the marshmallows and toothpicks. Give the participants the following directions and a time limit of 15 minutes.

*Build the tallest tower you can using toothpicks and marshmallows. There is only one rule: The base of your tower must fit on the index card.*

Call time, measure the towers and applaud the winners. Talk about the shapes that seemed to provide the greatest stability.

**Newspaper Towers**

**Directions:**
Divide the participants into groups of no more than four. Provide each group with a stack of newspapers and a roll of masking tape. Give them the following directions and tell them that they have 10 minutes to complete it:

*As a group, build the tallest freestanding tower (you can not lean it or tie it up to anything) using only the newspapers and masking tape. The only rule is that your tower cannot lean or be tied up to anything.*

Call time, measure the towers and applaud the winners. Talk about the shapes that seemed to provide the greatest stability.
Appendix
The Amazing Egg Drop

Instructions:
Your team will design a container that would protect a raw egg as it falls to the ground from the second floor. Your team will receive an egg and a bag of materials. You will be given time to brainstorm how you might construct a protective mechanism for dropping your egg without breaking it. You can only use the materials in your bag within the time allotted. It will be important to work well with your teams in analyzing how to use the materials and predicting which materials will safely protect your egg during its descent. You can not change the egg in any way (no tape on the egg, no nail polish on the egg, no hollow eggs).

You are also responsible for developing a Team Cheer to use at the time of the egg drop. When all teams have completed their craft, bring them to the “drop” site.

MATERIAL

Each team will receive
- One egg
- Newspapers
- Masking tape

Other material available will be
- Heavy construction paper
- Cardboard
- Cotton Balls
- Styrofoam
- Toilet paper
- Straws
- Tape
- Garbage bags

AFTER THE DROP

As a team, discuss why your egg drop craft performed well or badly. Complete the following questions and be ready to report back to the group:

How did you craft do in its drop from the height?
What was successful in the design of the craft?
What would you change about your craft if you did the experiment again?
Gold Panning Instructions
Anyone can learn how to pan for gold. Follow these simple gold panning instructions and start panning for gold today.

Step #1 - Find where the gold is

There is no use panning for gold in a stream where there is no gold so go to a stream where people have found gold before. Since gold is much heavier than water (about 19 times heavier), the gold stays on the bottom and gets caught in the sand in slow moving areas around bends of the stream and along the shore. It also tends to get stuck in small crevices in rocks and wedged in pieces of wood. Try to find places like this along the stream.

Step #2 - Submersion

Put about 4 handfuls of material into your gold pan. Submerse the pan in the stream. While holding the gold pan under water, move the pan in a circular motion so that the lighter materials will be carried out of the gold pan. Don't move it too rapidly or you may lose gold along with the rocks and sand. Keep doing this until about half of the material in the gold pan is gone.

Step #3 - Panning

Lift the pan out of the water and begin swirling it around with it tipped slightly to the side where the riffles are. When all the water is gone dip the pan into the water again, bring it back out, and start swirling again. Keep doing this until nearly all the material in the pan is gone.
Making a Balloon Barometer

1. Blow up a balloon stretch it, then let the air out.
2. Cut off the neck portion of the balloon and stretch the remaining balloon across the top of the jar.
3. Seal the balloon to the jar with duct tape or by using the large rubber bands. Make certain not to leave leaks between the balloon and jar.
4. Tape a toothpick to one end of the drinking straw. Tape the other end of the straw to the center top of the balloon.
5. Fold a piece of construction paper into thirds to make a triangular column. Make a measuring scale on the column.
6. Stand the column next to but not touching the tip of the straw with the toothpick acting as the pointer.
7. Use this scale to monitor changes in the air pressure.
8. Have each group take readings periodically during the unit using the worksheet provided. Compare data between barometers and the relationship with the readings and weather patterns.

How a Balloon Barometer Works
Since the air inside the jar is held by the balloon, no air can escape and no extra air can enter. The air molecules are constantly pressing against all sides of the jar. Of course, air also surrounds and presses on the outside surface of the jar. When the pressure inside the jar is less than the pressure outside of the jar, the balloon sinks and causes the straw to rise. When pressure on the inside of the jar is greater than the outside pressure, the balloon will bulge, causing the straw to tilt downward. High pressure is associated with sunny and dry weather (the straw tilts upward). Low pressure is associated with dark cloud cover and precipitation (the straw tilts downward).
<table>
<thead>
<tr>
<th>Day</th>
<th>Barometer Readings</th>
<th>Weather Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Traditional Weather Sayings

- If crows fly low, winds going to blow; if crows fly high, winds going to die.
- No weather is ill, if the wind is still.
- A sunshiny shower won’t last half an hour.
- From twelve ‘til two tells what the day will do.
- When sea birds fly to land there truly is a storm at hand.
- If cats lick themselves, fair weather.
- The chill is on, near and far, in all the months that have an ‘R’.
- Rainbow at noon, more rain soon.
- The south wind brings wet weather...the north wind, wet and cold together; the west wind always brings us rain…the east wind blow sit back again.
- When a cow tries to scratch her ear it means a shower is very near.
- Onionskin is very thin, mild winter is coming in. Onionskin is thick and tough, winter will be cold and rough.
- Ice in November to walk a duck, the winter will be all rain and muck.
- Rain before seven, quit by eleven.
- A cow with its tail to the west, makes weather the best; A cow with its tail to the east, makes weather the least.
- Evening red and morning gray speed the traveler on his way; Evening gray and morning red bring down rain upon his head.
- Rainbow in the east, sailors at peace; rainbow in the west, sailors in distress.
- Pale moon doth rain, red moon doth blow, white moon doth neither rain nor snow.
- When the dew is on the grass, rain will never come to pass.
- Rainbow in the morning, shepherds take warning; rainbow at night, shepherds’ delight.
- If the groundhog sees his shadow, we will have six more weeks of winter.
Pizza Box Solar Oven Instructions

1. Glue aluminum foil to the *inside* surfaces of the sides of a pizza box except the top of the box, with the shiny surface facing *in*. This will create a "radiation trap" that will trap, by reflection, invisible (low-frequency) radiation that is given off by the food and air inside the box.

2. On the top flap of the pizza box, draw a square with a marker with edges spaced 1" from the four sides of the box.

3. Cut along *three* of the lines, on the sides and on the front edge of the box, leaving the fourth line along the box's hinge uncut. Then fold open the flap, making a crease on the fourth line.

4. Glue the aluminum foil to the inside surface of the top flap, with shiny side visible! This will form a reflector, to reflect sunlight into the oven. Be careful to make as few wrinkles as possible and smooth out whatever wrinkles occur.

5. Tape the black construction paper to the bottom of the box. This will help to absorb the incoming sunlight.

6. Carefully stretch the plastic wrap over the opening of the box, sealing the edges with tape to seal the air in.

7. Cover any air leaks around the box edges with tape, making sure that the box can still be opened.

8. Go outside in the sunlight and place oven on a flat, level surface.

9. Place the thermometer into the box and see how hot it gets to determine what food you should cook.

10. Place food on some foil (or a paper plate) and place inside the oven.

11. Use a pencil or ruler to hold up the reflector, so that sunlight is reflected into the oven, and especially onto the foil holding the food. Be sure to keep watching the angle of the reflector so that the greatest degree of sunlight is reflected into the oven.

12. Let food cook, and check reflector angle now and then to make sure sunlight is getting inside the oven.

**Optional Features**

- Add additional flaps to reflect sunlight into the oven. This can substantially increase the gain of the oven. This will require some extra cardboard (from some old boxes, for example) and extra foil, glue, and string to adjust the flaps.
- Crumple up some sheets of newspaper and stuff them around the inside of the box to provide extra insulation.
- Add an additional layer of plastic wrap across the box opening attaching it to the inside surface of the top flap, such that an air space is created between the layers of wrap (the plastic is bound to stick together in some places: don't worry about this too much).
Two Minute Mysteries

The Case of the Mayor's Murder

Mayor Goodman was found lying on his back in his office with two bullets in his chest. His assistant was waiting for him to get dressed, wondered why it was taking so long, and finally knocked and opened the door and went in, finding the Mayor’s body. Today was the day that he was supposed to be making a speech about his idea of how to end world hunger and thousands of people were awaiting his arrival at Silver Pond Park. Detective Casey was on the case.

The paramedics arrived on scene. After proclaiming the mayor as dead, Detective Casey rolled the mayor over, looking for exit wounds. He found none, only a void where the body had been laying. Blood had gushed from his chest and made puddles on either side of his body. After seeing this, Detective Casey went to interview family and friends.

The former Mayor, Gregory Orwell, claims that he heard the gunshots go off. “I never really liked the man, especially since he took my job, but I never wanted him dead. I heard two loud bangs, and then I saw a man dressed in all black with a mask rush by. I tried to call the police, but I realized I didn’t have my phone on me. So then I rushed through the open door into his office, finding him there, dead, face down on the floor. That’s all.” “I don’t believe you,” said Detective Casey. Officers, arrest this man!”

Why did the detective think it was Mr. Orwell?

The Case of the Cellular Phone

"Dr. Dawson, you must go to Brent Abbott's house immediately! I think he's been shot!" John Wilson explained. "I'll meet you at his house then," Dr. Dawson replied. Dr. Dawson and an ambulance arrived at Mr. Abbott's house soon after he got off the phone with Mr. Wilson. One hour later John arrived just in time to see the body of his best friend being carried out of his house. "What took you so long to get here?" Dr. Dawson asked. "Um, I needed to pick up a birthday cake for my wife. There was a big line-up at the store. So, is he dead?" John asked slowly. "I'm afraid he is." Dr. Dawson informed him, "You live way up in the mountains, don't you?" "Yes I do," Mr. Wilson answered. "Can you please tell me how you knew he was shot?" Dr. Dawson asked. "Certainly. I was driving out of my driveway when I decided I'd better call him on my cell phone to tell him that I was coming over to drop off some tools I borrowed a couple weeks ago. He picked up the phone. He seemed a little uneasy when he said hello. I was just about to tell him I was on my way over when he suddenly screamed and I heard three gun shots. I called his name a couple times, then I hung up and quickly and called you!" "Why don't you just admit killing him," Dr. Dawson said. "What are you talking about? He's my best friend!" John exclaimed, a little surprised. "Well then, why did you kill him?"

How did Dr. Dawson know that Mr. Wilson murdered his best friend?
The Case of the Stolen Feline

I was at my uncle's farm for a visit when a little girl came up to me and said, "Dr. Jones are you a detective?" "Yes, I am a detective. How can I help you?" I said to the little girl. "Well, you see Dr. Jones, my cat disappeared last week and I have a sneaking suspicion that my neighbor stole her because he has always hated cats. Can you help me? Can you?" "Well, I don't usually take pet cases, I am not a pet detective." I explained to the young girl. "Oh, please, please, you are my only hope, please!" she pleaded. "Well...... I guess I can help you. What's your name? And please tell me what your cat looks like." "My name is Katie and my cat's name is Bob, he has light grey hair and a white chest." "Okay, maybe I should go talk to your neighbor. What is his name? "His name is Gary and he is really mean and grouchy." Well, if you want me to find your cat, then I will have to put up with a mean neighbor. Now does he live in the house to the right or left of you?" "He lives to the right, and he has two children, Keray and Ellen. Keray is seven years old and Ellen is five." So, I set off to talk to Gary. When I got to his house he denied ever seeing Katie's cat. He told me he knew Katie had a cat but he would never dream of stealing it and I believed him. "Well, can I talk to Keray or Ellen? Maybe they know happened to Katie's cat." I asked. "Well, if you really want to, but it won't be worth your while," Gary said in a dry voice which made me suspicious, so I decided to go talk to Keray. I went to talk to Keray in her room and when I got there she sounded like she had a cold. "Keray, do you know anything about Katie's missing Cat? Katie thinks someone in your family might have taken him." "I-I wouldn't (Sniffle) steal her cat (cough) I am (sneeze) allergic to cats." Well, thank you for your time Keray, maybe I will go talk to Ellen. Bye." So I went to talk to Ellen and when I went in to her room I asked her if she knew anything about Katie's cat and of course she said no. She said her dad would let her buy a cat any time she wanted to, so why would she want to steal a cat. With that I went back to Gary and told him what I thought. Well, Gary, you better search Ellen's room for the cat and return it to Katie, I know the cat is around here somewhere." I explained to Gary.

How did Dr. Jones know that Ellen had Katie's cat?
Classifying Fingerprints

1. Use a magnifying glass to look at the fingerprints.
2. Using the fingerprint patterns sheet categorize the fingerprints of your group and complete the following chart for the members of your group.

<table>
<thead>
<tr>
<th>Name</th>
<th>RT</th>
<th>RI</th>
<th>RM</th>
<th>RR</th>
<th>RL</th>
<th>LT</th>
<th>LI</th>
<th>LM</th>
<th>LR</th>
<th>LL</th>
</tr>
</thead>
</table>

Some abbreviations that you can use: A = arch, L = loop, W = whorl, C = Combination

[Arch] [Loop] [Whorl]
Physical Analysis

Hair Analysis

<table>
<thead>
<tr>
<th>Sample #</th>
<th>COLOR</th>
<th>LENGTH</th>
<th>THICKNESS</th>
<th>OTHER FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sample #</td>
<td>COLOR</td>
<td>SIZE</td>
<td>ARRANGEMENT OF THREADS</td>
<td>OTHER FEATURES</td>
</tr>
<tr>
<td>----------</td>
<td>-------</td>
<td>------</td>
<td>------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Possible Boomerang Shapes
**Marshmallow Catapult**

**Directions**

1. Cut the tops off two plastic soda bottles, and cut the cut off sections into the shapes shown in the pictures below.
2. Punch three holes in the smaller section as shown. Poke a dowel stick through the two sides holes.
3. Loop a rubber band through the bottom hole. Catch a dowel stick through the loop. Twist other rubber bands on either side of the loop to hold it in place. Place this dowel stick across the other pencil, and secure them to each other with rubber bands as shown.
4. Create a marshmallow hold by folding and taping the sides of an index card into a lid shape. Tape the hold to the top of the dowel stick so that the tip sticks out.
5. Fill the large bottom section of the bottle with beans to stabilize the catapult. Jam the other section into the weighted bottom.
6. Place a marshmallow in the holder. Push down on the pencil tip while holding onto the base. Then release it, and watch it fly.

*Remember the energy to send the marshmallow is stored in the elastic bands.*

**After the Fling**

**Complete the following questions and be ready to report to the group:**

How did your marshmallow catapult perform? _______________________
What was successful in the design of the catapult? _______________________
_____________________________________________________________

What would you change about the design if you could do it over?
_____________________________________________________________
Balloon Powered Car Race

Picture taken from the following website: http://www.middleschoolscience.com/balloonracers.htm

Your team must build a car that runs by the escaping air of a balloon. After designing your car, you can test drive it and modify it. Name and decorate your car.

**Background Information:**
The rocket car is propelled along the floor according to the principle stated in Newton's Third Law of Motion. The escaping air is the action and the movement of the car in the opposite direction is the reaction. The car's wheels reduce friction and provide some stability to the car's motion. A well designed and constructed car will travel several meters in a straight line across a smooth floor. Newton's Third Law of Motion states: For every action, there is an equal and opposite reaction.

**Rules:**
- The car must be powered by no more than 2 balloons, and must have at least three wheels. Wheels are defined as anything that is round and goes around.
- The wheels **can not** be wheels from a toy car. They must be made out of something that was not originally meant to be used as wheels.
- The car may not leave the ground.
- The car must be capable of traveling at least 5 meters.
- No external sources of energy are permitted including, push starts, blowing on the car, batteries, solar cells, etc.
- The balloons may only be blown up using lung power by the car operator.
- During the initial release of the air (at the starting line), care should be taken to not enhance or diminish the performance of the car.
- No part of the car may be in front of the start line when starting car.

**AFTER THE RACE**
As a team, discuss why your balloon power car performed well or badly. Complete the following questions and be ready to report back to the group:

How did your balloon powered car perform? __________________________

What was successful in the design of the car?
______________________________________________________________
______________________________________________________________

What would you change about your car if you could design it again?
______________________________________________________________
______________________________________________________________
______________________________________________________________
Science Questions

1. What happened? What did you observe?

2. Why do you think that happened?

3. What facts do you have to support why you think that?

4. What would happen if you .....?