# Finding the Trail

**Eighth Grade**
**Activity: 1**
**Time: 1 Class Period**

## General Description
Students will use the process skills of observation, questioning, measuring and prediction to determine the make up of a bag of matter

## Objectives
Students will use process skills to determine the make up of a bag of matter

## Arizona State Standards
SC08 S1C1 PO1 Formulate questions based on observations that lead to the development of a hypothesis
SC08 S1C2 PO1 Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry

S1C2 PO4 Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers)
S1C2 PO5 Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs

S1C3 PO1 Analyze data obtained in a scientific investigation to identify trends

S1C4 PO1 Communicate the results of an investigation

W08 S3C3 Write a variety of functional text (e.g., directions, recipes, procedures, rubrics, labels, poster, graphs/tables)

M08 S1C1 PO9 Calculate the missing value in a percentage problem
M08 S2C1 PO1 Determine the appropriate type of graphical display for a given data set
M08 S2C1 PO5 Answer questions based on box and whisker plots, circle graphs, and scatter plots

## Teacher Information
Mixtures are found everywhere in nature. In order for students to have a better understanding of the world around them they will need to understand the difference between compounds and mixtures. This is a good activity to start with. Students will find the percentage of the ingredients of their mixture. To calculate the percentage use the formula: $\frac{\text{Mass of substance}}{\text{Mass of mixture}} \times 100$

## Materials
Small Ziploc bags
Mixture of a minimum of 5 ingredients, prepare some to be heterogeneous and some to be homogenous
For example: cheerios, M&M chocolate candies, skittles, raisins, pretzel pieces

Hand lens
Filter paper or small cup
Triple bean scales
Activity Card 8-1
Science Journal

## Procedures/Exploration

1. Give each student a bag with the mixture in it.
2. Have students journal their observations or use Activity Card 8-1 (if you use the activity card you can skip most of the directions below).
3. Students will also write as many questions as they can about what they see.
4. Students will predict whether the mixture is heterogeneous and homogenous.
5. Determine the total mass of the mixture and record in their science journal.
6. Separate the parts of the mixture and find the mass of each ingredient and record the information in your science journal or on the Activity Card 8-1.
7. Find the percentage of each ingredient.
8. Graph your results.
9. Write a sentence or two about whether the mixture is heterogeneous or homogenous using your data to support your answer.

# Where is the Trail?

Eighth Grade
Activity: 1
Activity Card: 8-1

**Student's Name:** **Dates:**

Answer the following questions with complete sentences.

1. Look at the mixture in the bag and describe what you see.

2. Write as many questions as you can about the mixture in the bag.

3. Write a prediction as to whether this is a heterogeneous and homogenous mixture.

4. What is the total mass of the mixture?

5. Record the mass of each ingredient here
   a. Name of substance_____ mass_____ % of the mixture_____
   b. Name of substance_____ mass_____ % of the mixture_____
   c. Name of substance_____ mass_____ % of the mixture_____
   d. Name of substance_____ mass_____ % of the mixture_____
   e. Name of substance_____ mass_____ % of the mixture_____

6. Graph the results on the back of this paper.

# How Long Will It Take?

**Eighth Grade**
**Activity: 2**
**Time: 1 Class Period**

## General Description
Students will use the process skills of observation, questioning, and measuring to determine the solute and solvent in a basic activity

## Objectives
Students will use process skills to determine the solvent and solvent using every day candy

## Arizona State Standards
SC08 S1C1 PO1 Formulate questions based on observations that lead to the development of a hypothesis.
SC08 S1C2 PO1 Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry.

S1C2 PO4 Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers)
S1C2 PO5 Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs

S1C3 PO1 Analyze data obtained in a scientific investigation to identify trends

S1C4 PO1 Communicate the results of an investigation

W08 S3C3 Write a variety of functional text (e.g., directions, recipes, procedures, rubrics, labels, poster, graphs/tables)

## Teacher Information
In solutions there are two parts; the solute and the solvent. The solute is the item that is usually in the smallest amount and is being dissolved by the solvent. A formal definition might be; a substance dissolved in another substance, usually the component in the lesser amount. A solvent is a substance, usually a liquid, capable of dissolving another substance. The students will also be manipulating the solution to increase the rate in which the solute dissolves.

## Materials
Three beakers or clear plastic cups (per student group)
Water
Selection of candies, M&Ms, Skittles, Hard Candy, Life Savers (one type for each student group)
Two stop watches
Stirring rod
Small hammer
Plastic bag
Science journal
Activity Card 8-2

## Procedures/Exploration

1. Give each student group three pieces of the same type of candy. For example: Group A will get three pieces of Life Savers.
2. Place one piece of candy in a beaker/plastic cup with room temperature water. Using one stop watch record how long it takes for the candy to dissolve completely. You will want to go on to the rest of the activity as this may take some time. Either use Activity Card 8-2 to record your data or use the science journal.
3. Taking another piece of the same candy put it in beaker/plastic cup with room temperature water. Using one stop watch record how long it takes for the candy to dissolve while another person is stirring. Either use Activity Card 8-2 to record your data or use the science journal.
4. Taking another piece of the same candy, place it in a plastic bag and crush it using the hammer. Be sure to put as much of the crushed candy into the beaker/plastic cup with room temperature water. Using one stop watch record how long it takes for the candy to dissolve while another person is stirring. Either use Activity Card 8-2 to record your data or use the science journal.
5. In each of the activities identify the solvent and the solute.
6. If using your journal, answer the following question there, otherwise answer on Activity Card 8-2
    a. Explain the results of your experiment by relating the dissolving rate to the method you used to dissolve the solution.
    b. Identify the solute and solvent in each of the following solutions.
        i. Ocean water- salt and water
        ii. Antifreeze- water and ethylene glycol
        iii. Soda- Syrup, water and $CO_2$
        iv. Gold jewelry- Gold and copper
        v. Kool aid- Powder, sugar, and water
        vi. Lemonade- Water, Lemon juice, sugar
    c. Which would have a higher amount of solute? A weak glass of lemonade or a strong glass of lemonade?
7. Have the students compare the different types of candies and the rates in which their dissolved. Have them explained why the rates were different.

# How Long Will It Take

**Eighth Grade**
**Activity: 2**
**Activity Card: 8-2**

**Student's Name:** **Date:**

Use the table to record your data.

| Piece of Candy | Dissolving Time |
|---|---|
| | |
| | |
| | |

Answer the following questions

1. Explain the results of your experiment by relating the dissolving rate to the method you used to dissolve the solution.

2. Circle the solute and solvent in each of the following solutions.
   i. Ocean water- salt and water
   ii. Antifreeze- water and ethylene glycol
   iii. Soda- syrup, water and $CO_2$
   iv. Gold jewelry- gold and copper
   v. Kool aid- powder, sugar, and water
   vi. Lemonade- water, lemon juice, sugar

3. Which would have a higher amount of solute? A weak glass of lemonade or a strong glass of lemonade?

4. Have the students compare the different types of candies and the rates in which their dissolved. Have them explain why the rates were different.

# Is Black Really Black?

**Eighth Grade**
**Activity: 3**
**Time: 1 Class Period**

## General Description
Students will use the process skills of observation, questioning while investigating what solvents and solutes make up black ink

## Objectives
Students will use process skills to determine what colors of ink make up black ink
Students will identify the solvent and the solute in this activity

## Arizona State Standards
SC08 S1C1 PO1 Formulate questions based on observations that lead to the development of a hypothesis
SC08 S1C2 PO1 Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry
SC08 S1C2 PO4 Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers)
SC08 S1C2 PO5 Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs
SC08 S1C3 PO1 Analyze data obtained in a scientific investigation to identify trends
SC08 S1C4 PO1 Communicate the results of an investigation

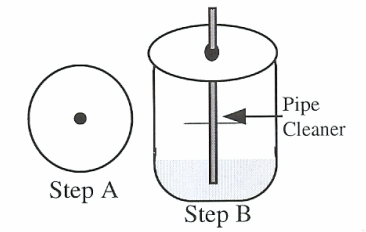
W08 S3C3 Write a variety of functional text (e.g., directions, recipes, procedures, rubrics, labels, poster, graphs/tables)

## Teacher Information
Make sure that you model the correct procedure to the students. Allow them plenty of time to make observations and predictions. Warn students that if the ink gets on their clothes it will stain the clothes. You could do this activity with ball point pens and finger nail polish but it is recommended that the teacher do this as a demonstration and not allow the students to work with the solvents.

## Materials
Several different brands of washable black markers
Coffee filters or filter paper
Pipe cleaners, color does not matter
Small beakers or clear plastic cups
String for a clothes line
Clothes pins or large paper clips
Activity Card 8-3
Science Journal

## Procedures/Exploration

1. Look at the diagram to the right as you read the directions.
2. Use one brand of marker and draw a dark circle in the center of the filter paper; the circle should be the size of a dime.
3. Insert one end of the pipe cleaner into the center of the ink mark. Have the opposite end long enough that it will reach the water.
4. Place the long end of the pipe cleaner into the water.
5. Do this for all three brands of markers.
6. Give all three types time to soak up the water and the pigments to separate.
7. Record your observations in your science journal or on Activity Card 8-3.
8. If you are not using Activity Card 8-3, answer the following questions in your journal.
    a. What did you observe about the black ink?
    b. What colors did you observe for each pen
    c. Identify the solute and the solvent for this activity.
    d. What will happen if you use a permanent marker? Explain why you believe that will happen using evidence from this activity.



# Is Black really Black?

Eighth Grade
Activity: 3
Activity Card: 8-3

**Student's Name:** **Date:**

Answer the following questions using complete sentences.

1. What did you observe about the black ink?

2. What colors did you observe for each pen?
   a.
   b.
   c.

3. Identify the solute and the solvent for this activity.

4. What will happen if you use a permanent marker? Explain your reasoning based on the evidence in this activity.

# Chemical or Physical Change

**Eighth Grade**
**Activity: 4**
**Time: 1 Class Period**

## General Description
Students will use the process skills of observation, questioning, measuring to determine if there has been a chemical or physical change at each station

## Objectives
Students will use process skills to determine the whether a physical or chemical change has occurred

## Arizona State Standards
SC08 S1C1 PO1 Formulate questions based on observations that lead to the development of a hypothesis
SC08 S1C2 PO1 Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry
SC08 S1C2 PO4 Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers)
SC08 S1C2 PO5 Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs
SC08 S1C3 PO1 Analyze data obtained in a scientific investigation to identify trends
SC08 S1C4 PO1 Communicate the results of an investigation
SC08 S5C1 PO1 Identify different kinds of matter based on the following physical properties:
- states
- density
- boiling point
- melting point
- solubility

SC08 S5C1 PO2 Identify different kinds of matter based on the following chemical properties:
- reactivity
- pH
- oxidation (corrosion)

## Teacher Information
This activity should be done as a follow up to all other activities that help students understand chemical and physical changes. You may want to set these different activities as stations or do as a whole class.

## Materials
Hot plate/source of heat
Crucible/heat resistant container
Eye dropper
Water

Epsom salts
Mothballs
Rubbing alcohol
Sugar
Baking soda
Baking powder
Vinegar
Activity Card 8-4

## Procedures/Exploration

1. Activity One: Heat Epsom salts. Give students time to make observations. Answer the questions on Activity Card 8-4.
2. Activity Two: mix water and baking powder. Give students time to make observations. Answer the questions on Activity Card 8-4.
3. Activity Three: heat Mothballs but only outside or in a well ventilated area. Give students time to make observations. Answer the questions on Activity Card 8-4.
4. Activity Four: heat sugar. Give students time to make observations. Answer the questions on Activity Card 8-4.
5. Activity Five: mix vinegar with baking soda. Do this in a safe area, well ventilated area. Give students time to make observations. Answer the questions on Activity Card 8-4.
6. Activity Six: heat alcohol. Give students time to make observations. Answer the questions on Activity Card 8-4.

# Chemical and Physical Changes

Eighth Grade
Activity: 4
Activity Card: 8-4

**Student's Name:** **Date:**

**Activity 1: Heat the unknown in a crucible**
In this activity, heat the unknown compound in a crucible until you see a change take place.

Was it a chemical or physical change?

What evidence do you have to back up your guess?

**Activity 2: Combine the two solutions**
In this Activity, add one dropper full of compound A into a 50 mL beaker followed by one dropper full of compound B. Make sure you use different droppers for each solution.

Was it a chemical or physical change?

What evidence do you have to back up your guess?

**Activity 3: Heat the unknown in a crucible**
In this Activity, heat two large pieces of the unknown in a crucible until you see a change take place.

Was it a chemical or physical change?

What evidence do you have to back up your guess?

**Activity 4: Heat the unknown in a crucible**
In this Activity, heat one small scoopful of the unknown in a crucible until you see a change take place.

Was it a chemical or physical change?

What evidence do you have to back up your guess?

**Activity 5: Combine the two solutions**

In this Activity, add one dropper full of compound A into a 50 mL beaker followed by one dropper full of compound B. Make sure you use different droppers for each solution.

Was it a chemical or physical change?

What evidence do you have to back up your guess?

**Activity 6: Heat the unknown in a crucible**

In this Activity, add ten drops of the unknown to a crucible and heat over a Bunsen burner.

Was it a chemical or physical change?

What evidence do you have to back up your guess?

# pH Lab Activity

**Eighth Grade**
**Activity: 5**
**Time: 1 Class Period**

## General Description
This is a great activity to do as a wrap up to studying acids and bases. Students will use their prior knowledge to make predictions about common household products placement on the pH scale.

## Objectives
Students will use process skills to predict and determine the pH of common household items

## Arizona State Standards
SC08 S1C1 PO1 Formulate questions based on observations that lead to the development of a hypothesis
SC08 S1C2 PO1 Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry
SC08 S1C2 PO4 Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers)
SC08 S1C2 PO5 Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs
SC08 S1C3 PO1 Analyze data obtained in a scientific investigation to identify trends
SC08 S1C4 PO1 Communicate the results of an investigation
SC08 S5C1 PO2 Identify different kinds of matter based on the following chemical properties:
- reactivity
- pH
- oxidation (corrosion)

## Teacher Information
This activity should be done as a wrap up to help students solidify their understanding of acids and bases.

## Materials
Litmus paper
Stain remover
Grape juice
Baking soda
Vinegar
Activity Card 8-5
Small cups

## Procedures/Exploration
1. Obtain samples of the four materials: vinegar, stain remover, grape juice, and baking soda.
2. Remove two strips of neutral litmus paper and rip in half so you have four strips.
3. Before testing any of the substances put your predictions on the chart on Activity Card 8-5
4. Carefully dip one half of the litmus paper into a substance. Record it if the substance was an acid or a base. Use the table on Activity Card 8-5 to determine if the substance was an acid or a base.
5. Answer the questions on the Activity Card 8-5 and share with classmates.

# pH Lab Activity

**Eighth Grade**
**Activity: 5**
**Activity Card: 8-5**

**Student's Name:** **Date:**

Fill out the table below as you complete the pH tests.

| Substance | Prediction Acid or Base | Prediction pH range | Actual Acid or Base | Actual pH range | Actual pH |
|---|---|---|---|---|---|
| Vinegar | | | | | |
| Stain Remover | | | | | |
| Grape Juice | | | | | |
| Baking Soda | | | | | |

Litmus paper turns red: Acid (pH range 1.0-6.9)
Litmus paper turns blue: Base (pH range 7.1-14.0)
pH 7.0 is neutral

Questions:

1. Which of the above acids would shine a dirty penny better? Explain why?

2. Why do you think bases make good cleaners?

3. Why is it necessary that our bodies maintain a blood pH as close to 7.0 as possible?

# Exothermic Or Endothermic? I

**Eighth Grade**
**Activity: 6**
**Time: 1 Class Period**

## General Description

Students will be making observations, measurements, estimations and predictions based on observations and current knowledge. This activity will also give them the opportunity to collect and record data using procedures designed to minimize error and finally analyze data and draw warranted inferences.

## Objectives

Students will use the process skills to describe chemical and physical changes and identify what factors caused the change.

## Arizona State Standards

SC08 S1C1 PO1 Formulate questions based on observations that lead to the development of a hypothesis
SC08 S1C2 PO1 Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry
SC08 S1C2 PO4 Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers)
SC08 S1C2 PO5 Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs.
SC08 S1C3 PO1 Analyze data obtained in a scientific investigation to identify trends
SC08 S1C4 PO1 Communicate the results of an investigation
SC08 S5C1 PO3 Identify the following types of evidence that a chemical reaction has occurred:

- formation of a precipitate
- generation of gas
- color change
- absorption or release of heat

W08 S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic
W08 S3C2 PO2 Write a summary based on the information gathered that include(s):

- a topic sentences
- supporting details
- relevant information

## Teacher Information

Whenever handling an unknown chemical it should be treated as potentially dangerous. In addition whenever working with any lab equipment you should take care and be aware of your surroundings. Posting Chemical Safety Rules and following those guidelines is a good habit to develop in your students.

## Materials

Activity Card 8-6
250 ml beaker or similar sized cup
Thermometer
One tablespoon quick rising dry yeast or one small envelope dry quick acting yeast
1/4 cup 3% hydrogen peroxide (type purchased at stores)
Spoon
Stop watch
Pencil
Science journal

## Procedures/Exploration

1. Find and record the starting temperature (i.e. room temperature).
2. Place the thermometer in the beaker.
   Put the yeast and peroxide in the beak and stir with a spoon.
   Record the temperature every 15 seconds.
3. Observe what happens over a period of time and record.
   Feel the outside of the beaker along the lower sides and bottom.
4. Record your findings.
5. Graph your temperature results.
6. Complete the analysis on Activity Card 8-6

# Exothermic or Endothermic? I



**Student's Name:** **Date:**

Use the following table to record the temperature change.

| Time | Temperature |
|---|---|
| Starting Temperature | |
| 15 seconds | |
| 30 seconds | |
| 45 seconds | |
| 60 seconds | |
| 75 seconds | |
| 90 seconds | |
| 105 seconds | |
| 120 seconds | |
| 135 seconds | |
| 150 seconds | |
| 165 seconds | |
| 180 seconds | |
| 205 seconds | |

Graph the results on a separate piece of graph paper

Answer the following questions using the evidence that you collected from this activity.

1. Based on your observations, what do you think was being produced when the hydrogen peroxide and yeast were mixed? Explain your answer.

2. Why did the temperature change?

3. Are the results of this activity an example of a physical or chemical change or both?

   Support your conclusions with evidence from your results.

4. Give at least one other example of an exothermic reaction you are familiar with.

   What evidence is there to prove that it is an exothermic reaction?

# Exothermic or Endothermic? II

**Eighth Grade**
**Activity: 7**
**Time: 1 Class Period**

## General Description

Students will be making observations, measurements, estimations and predictions based on observations and current knowledge. This activity will also give them the opportunity to collect and record data using procedures designed to minimize error and finally analyze data and draw warranted inferences.

## Objectives

Students will use the process skills to describe chemical and physical changes and identify what factors caused the change.

## Arizona State Standards

SC08 S1C1 PO1 Formulate questions based on observations that lead to the development of a hypothesis
SC08 S1C2 PO1 Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry
SC08 S1C2 PO4 Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers)
SC08 S1C2 PO5 Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs
SC08 S1C3 PO1 Analyze data obtained in a scientific investigation to identify trends
SC08 S1C4 PO1 Communicate the results of an investigation
SC08 S5C1 PO3 Identify the following types of evidence that a chemical reaction has occurred:

- formation of a precipitate
- generation of gas
- color change
- absorption or release of heat

W08 S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic
W08 S3C2 PO2 Write a summary based on the information gathered that include(s):

- a topic sentences
- supporting details
- relevant information

## Teacher Information

Whenever handling an unknown chemical it should be treated as potentially dangerous. In addition whenever working with any lab equipment you should take care and be aware of your surroundings. Posting Chemical Safety Rules and following those guidelines is a good habit to develop in your students.

## Materials

Activity Card 8-7
Thermometer
Water at room temperature
One tablespoons of Epsom salts
Spoon
Medium sized glass or jar (must be glass)

## Procedures/Exploration

1. Find and record the starting temperature (i.e. room temperature).
2. Put the thermometer in the jar. While you are waiting to take the water temperature, put your hand on the outside of the jar and notice how cool or warm it is. Record your observation.
3. Stir in the Epsom salts.
4. Record the temperature every 15 seconds.
5. Observe what happens over a period of time and record.
   Feel the outside of the beaker along the lower sides and bottom.
6. Record your findings.
7. Graph your temperature results.
8. Complete the Analysis on Activity Card 8-7

# Exothermic or Endothermic? II



**Student's Name:** **Date:**

Use the following table to record the temperature change.

| Time | Temperature |
|---|---|
| Starting Temperature | |
| 15 seconds | |
| 30 seconds | |
| 45 seconds | |
| 60 seconds | |
| 75 seconds | |
| 90 seconds | |
| 105 seconds | |
| 120 seconds | |
| 135 seconds | |
| 150 seconds | |
| 165 seconds | |
| 180 seconds | |
| 205 seconds | |

Graph the results on a separate piece of graph paper

Answer the following questions using the evidence that you collected from this activity.

1. What is the amount of temperature difference of the water before and after adding Epsom salt?

2. Why did the temperature of the water change?

3. Does mixing Epsom salts and water represent physical or chemical change or both?

4. Give at least one other example of an endothermic reaction you are familiar with. What evidence is there to prove that it is an exothermic reaction?

# Energy Transformation

**Eighth Grade**
**Activity: 8**
**Time: 1 Class Period**

## General Description
Students will be making observations and measurements in order to explain if heat is absorbed or given off by rubber. They will also describe the affects of heat on rubber.

## Objectives
Students will use observation and measurement to determine the affect of heat on rubber.

## Arizona State Standards
SC08 S1C1 PO1 Formulate questions based on observations that lead to the development of a hypothesis
SC08 S1C2 PO1 Demonstrate safe behavior and appropriate procedures (e.g., use and care of technology, materials, organisms) in all science inquiry
SC08 S1C2 PO4 Perform measurements using appropriate scientific tools (e.g., balances, microscopes, probes, micrometers)
SC08 S1C2 PO5 Keep a record of observations, notes, sketches, questions, and ideas using tools such as written and/or computer logs
SC08 S1C3 PO1 Analyze data obtained in a scientific investigation to identify trends
SC08 S1C4 PO1 Communicate the results of an investigation
SC08 S5C1 PO3 Identify the following types of evidence that a chemical reaction has occurred:
- formation of a precipitate
- generation of gas
- color change
- absorption or release of heat

SC08 S5C1 PO7 Investigation how the transfer of energy can affect the physical and chemical properties of matter

W08-S3C2 PO1 Record information (e.g., observations, notes, lists, charts, map labels and legends) related to the topic
W08-S3C2 PO2 Write a summary based on the information gathered that include(s):
- a topic sentences
- supporting details
- relevant information

## Teacher Information
When rubber is heated, it behaves differently than most familiar materials. Most materials expand when they are heated. Consider the liquid in a thermometer. The thermometer works because the liquid expands when its temperature increases. Similarly, a wire made of metal, such as copper, becomes longer as it gets hotter.

Whether a material expands or contracts when it is heated can be ascribed to a property of the material called its "entropy." The entropy of a material is a measure of the orderliness of the molecules that make up the material. When the molecules are arranged in an ordered fashion, the entropy of the material is low. When the molecules are in a disordered arrangement, the entropy is high. (An ordered arrangement can be thought of as coins in a wrapper, while a disordered one as coins in a tray.) When a material is heated, its entropy increases because the orderliness of its molecules decreases. This occurs because as a material is heated, its molecules move about more energetically. In materials made up of small, compact molecules, e.g., the liquid in a thermometer, as the molecules move about more, they push their neighboring molecules away.

Rubber, on the other hand, contains very large, threadlike molecules. When rubber is heated, the sections of the molecules move about more vigorously. In order for one part of the molecule to move more vigorously as it is heated, it must pull its neighboring parts closer. To visualize this, think of a molecule of the stretched rubber band as a piece of string laid out straight on a table. Heating the stretched rubber band causes segments of the molecules to move more vigorously, which can be represented by wiggling the middle of the string back and forth. As the middle of the string moves, the ends of the string get closer together. In a similar fashion, the molecules of rubber become shorter as the rubber is heated, causing the stretched rubber band to contract.

## Materials

Paper or Journal to keep records
Rubber band
Weights (fishing weights/sinkers work well)
Hair dryer

## Procedures/Exploration

1. Place two fingers through the heavy rubber band, one on each end. Do not stretch the rubber band and touch it to your forehead or cheek. Record how the rubber band feels (cool or warm or about the same as your skin).
2. Repeat the test several times.
3. Move the rubber band slightly away from your skin, so it is not touching you. Quickly stretch the band about as far as you can and while holding it in the stretched position, touch it again to your forehead or cheek. Record how it feels. (Warmer or cooler or about the same as it did).
4. Move the stretched rubber band away from you skin. Quickly let it relax to its original size and again hold it to your skin. Record how it feels.
5. Repeat the stretching and testing, and relaxing and testing several times.

   An object feels cool to you when heat flows from your skin to the object. Conversely, an object feels warm or hot when heat flows from the object into your skin. If the stretched rubber band feels cool, then it absorbs heat from your skin. If it feels warm, then it gives off heat to your skin. If the band feels neither warm nor cool, then there is no detectable heat flow.