Cooking with Chemistry

GRADE LEVELS:
Grades 4^{th} – 8^{th}

CONCEPTS:
- Chemical Change
- Physical Change

OBJECTIVES:
- Explore chemical and physical changes that are part of cooking, and eat some of your experiments. Peanut-free.

ACADEMIC CONTENT STANDARDS:
- **Science: Physical Sciences:** 4.1, 4.2, 4.3, 4.4, 6.1, 6.2, 6.3, 6.4

VOCABULARY/KEY WORDS:
Acid- a substance that ionizes in water to produce H+ ions.
Base-a substance that ionizes in water to produce OH- ions.
Neutral- A substance exhibiting neither acid nor base qualities
pH-a measure of the acidity or alkalinity of a solution.
Physical change- Physical changes occur when objects undergo a change that does not change their chemical nature. A physical change involves a change in physical properties.
Chemical change- Chemical changes are changes substances undergo when they become new or different substances.
Solid- the state in which a substance retains a definite size and shape; has no tendency to flow under moderate stress; resists forces (such as compression) that tend to deform it
Liquid- the state in which a substance exhibits a characteristic readiness to flow with little or no tendency to disperse and relatively high incompressibility
Gas- the state of matter distinguished from the solid and liquid states by: relatively low density and viscosity; relatively great expansion and contraction with changes in pressure and temperature; the ability to diffuse readily; and the spontaneous tendency to become distributed uniformly throughout any container

Mixture- a substance consisting of two or more substances mixed together (not in fixed proportions and not with chemical bonding)
Dissolve-to cause a substance to pass into a solution
Solution- a homogeneous mixture of two or more substances
Indicator- a substance that indicates the degree of acidity or basicity of a solution through characteristic color.
Solute- the dissolved matter in a solution
Solvent- a liquid substance capable of dissolving other substances

EXTENSIONS AT COSI:
Life
- Visit Labs In Life to get a nutritional view of food and energy.

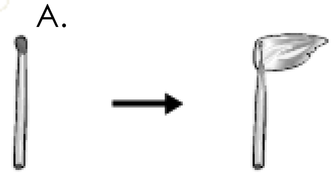
Chemistry Live
- Learn more about Chemical and Physical Change with this high energy live demonstration.

Gadgets
- Cafe – participate in hands-on activities that demonstrate the differences between chemical and physical changes. Please note: you must sign up in advance the day of your visit. A ratio of 1adult to 5 children is required to participate.

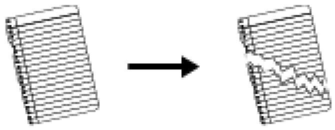
ADDITIONAL RESOURCES:
Basic explanations of chemical and physical changes
http://www.chem4kids.com/
Online exhibit from the Exploratorium
http://www.exploratorium.edu/cooking/
Teacher Vision
http://www.teachervision.fen.com/chemistry/printable/8482.html

SAMPLE TEST QUESTIONS:
Q. Which shows a chemical change?

○ A.

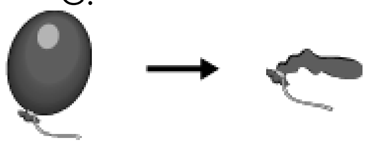

Match

○ B.



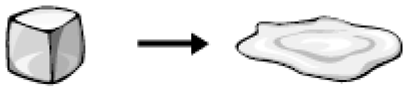
Paper

C.



Balloon

D.



Ice

Q. A tightly sealed glass box has a mass of 20,000 grams and contains a 5-gram cube of ice, making the total mass 20,005 grams. The box with the ice is placed in direct sunlight. After three hours the box appears to be empty, with just small droplets along the sides of the box.
Which statement describes the mass of the sealed box after sitting in the sun?

A.
The mass decreases because the ice melted into a liquid.

B.
The mass remains the same as the ice melts and then evaporates.

C.
The mass increases as the gases inside the box absorb energy and expand.

D.
The mass increases as the water vapor condenses into small droplets on the glass.

Q. Sharpening a pencil and tearing paper are examples of physical changes.
Which statement describes why these are physical changes?

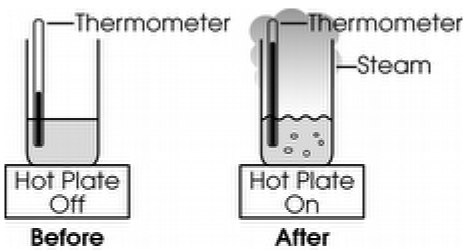
A.
There is a change in how the objects are used.

B.
There is a change in the appearance of the objects.

C.
There is a change in the materials from which the objects are made.

D.
There is a change in both the appearance of the objects and the materials from which they are made.

Q. A teacher put a beaker of water on a hot plate. The beaker is shown before and after the hot plate is turned on.



What is the evidence that water is changing state?

A.
The hot plate is turned on.

B.
The temperature increases.

C.
The water bubbles and the steam is visible.

D.
The mass of water in the beaker increases.

Cooking with Chemistry Pre Visit Activities

Magic Colored Milk

Objective: Using Chemical Change make a color wheel with milk and a few other basic ingredients.

Materials:

- 2% or whole milk
- Food coloring (use 4 colors)
- Dishwashing liquid
- Cotton swabs
- Plate (not paper)

Procedure:

1. Pour enough milk onto a plate to cover the bottom.
2. Drop food coloring onto milk.
3. Dip a cotton swab in dishwashing detergent liquid.
4. Touch the coated swab to the milk in the center of the plate.
5. Don't stir the milk. Watch what happens.

What is happening?

Milk consists of different types of molecules, including fat, protein, and sugars (to name a few). When you introduce detergent to the milk, it lowers the surface tension and allows the food coloring to flow throughout the milk. The detergent reacts with the protein in the milk, altering the shape of the molecules (Chemical change). The reaction between the detergent and the fat forms micelles (this is how the detergent cleans your greasy dishes). As the micelles form, the pigments on the food coloring get moved around. Eventually equilibrium is reached, but the swirling should continue for quite a while.

Academic Content Standards:

- Science: Physical Sciences 4.2. 6.2, 6.4

Rainbow Density Experiment

Description: Make a colorful density column by using different concentrations of sugar solutions.

Materials:
- Sugar
- Water
- Food coloring
- Tablespoon
- 5 glasses or clear plastic cups

Procedure:
1. Line up 5 glasses. Add 1 Tablespoon (15g) of sugar to the first glass, 2 Tablespoons (30g) of sugar to the second glass, 3 Tablespoons (45g) of sugar to the third glass, and 4 Tablespoons (60g) of sugar to the fourth glass. The fifth glass remains empty.
2. Add 3 Tablespoons (45 ml) of water to each of the first four glasses. Stir each solution. If the sugar does not dissolve in any of the 4 glasses, then add one more Tablespoon (15ml) of water to each of the four glasses.
3. Add 2-3 drops of red food coloring to the fist glass, yellow food coloring to the second glass, green food coloring to the third glass and blue food coloring to the fourth glass. Stir each.
4. To make the density column, fill the 5th glass about 1/4th full of the blue sugar solution.
5. Carefully layer some green sugar solution above the blue liquid. Do this by putting a spoon over the glass, just above the blue layer, and pouring the green solution slowly over the back of the spoon. If you do this right you won't disturb the blue solution much at all. Add the green solution until the glass is about half full.
6. Now, layer the yellow solution above the green liquid, using the back of the spoon. Fill the glass to ¾ full.
7. Finally, layer the red solution above the yellow liquid, using the spoon. Fill the glass the rest of the way.

What is going on?

The layers are made of different densities of sugar solutions. They are layered from the most dense on the bottom, to the least dense on the top. The colored sugar solutions are miscible, or mixable, and will eventually bleed into each other.

Academic Content Standards:

- Science: Physical Sciences: 4.1, 6.3

Cooking with Chemistry Post Visit Activities

Make your own Soda Pop

Objective: To identify the instances of Physical Change, Chemical change, and solutions while making homemade soda pop.

Materials:

- Empty 2 liter bottles with lids
- Gallon Jug
- Warm but not hot water
- 1/8 tsp of yeast
- 2 ¼ cups sugar
- 1tbs + 1tsp Flavoring extract

Procedures:

1. Pour the fresh yeast into a cup of warm water. The water should be 98–110 degrees F, a little warmer than body temperature. The water should not be too cold or the yeast will remain dormant. On the other hand, if the water is too hot, it will kill the yeast.
2. After five minutes pour the sugar, flavoring extract, and yeast solution into the gallon jug. Add enough warm water to fill the jug.
3. Shake the jug until the sugar dissolves (about two minutes).
4. Pour ½ of the mixture into each of the 2Ltr bottles and cap tightly.
5. Let the mixture sit for 4 to 6 days. You can even have the students check how well the carbonation is doing by gently squeezing the bottles. If there seems to be too much pressure, open the lid and let some of the carbon dioxide out.

Possible Interactive Questions:

- Why do we need to activate the yeast?
- What happened to the sugar when we poured the water in?
- Why wouldn't we want the water to be too hot or too cold?
- What is creating the carbon dioxide?

What Happened/What's Going On:

When the water and sugar are mixed together the sugar is broken down into molecules, or dissolved in the water. As the sugar and other ingredients are mixed with the water they also diffuse, creating an even mixture of molecules. Sugar dissolving in water is a physical change because the sugar molecules still exist within the water.

Yeast is a living life form. When you buy it from the grocery store it is in a dry, dormant state. When the yeast is introduced to the warm water it comes out of dormancy and becomes active. The activated yeast eats some of the sugar as food and produces carbon dioxide that creates the pressure and dissolves into the water. This is a chemical change because the sugar is taken in and a totally different substance, carbon dioxide, is produced.

Academic Content Standards:

- **Science, Physical Sciences, Nature of Matter 4.1, 4.2, 4.4, 6.2, 6.3, 6.4, 7.1**

Making Sodium Acetate (Hot Ice)

Objective: Using chemical change you will create an exothermic process by making Sodium Acetate.

Materials:

- 1 liter clear vinegar (weak acetic acid)
- 4 Tablespoons of baking soda (sodium bicarbonate)
- Saucepan or large beaker
- Hotplate
- Refrigerator
- Separate container and plastic wrap

Procedure:

1. In the saucepan/beaker add the baking soda to the vinegar, a little at a time and stirring between additions. Do not add the baking soda too quickly or you will get the baking soda and vinegar volcano. You have just made Sodium Acetate but it is very diluted.
2. Boil the solution to concentrate the sodium acetate. Boil until a crystal skin starts to form on the surface. On a stove at medium heat this can take about an hour. If you use a lower heat, it will take longer but there will be less discoloration. Discoloration is fine, just not pretty.
3. Remove boiled Sodium Acetate from the heat and pour into another container, immediately covering it with plastic wrap. If you have any crystals in your solution, add a very small amount of water or vinegar to dissolve the crystals.
4. Place the covered container into the refrigerator to chill.

Further activities:

1. Drop a crystal into the container of cooled sodium acetate. The sodium acetate will crystallize within seconds, working outward from where you added the crystal. The crystal acts as a nucleation site for rapid crustal growth. Although the solution just came out of the refrigerator, the container is now warm (hot ice).
2. Pour the solution onto a shallow dish. If the hot ice does not spontaneously crystallize, touch it with a crystal or the back of a

spoon. The crystallization will progress from the dish up toward where you are pouring the liquid. You can construct towers of hot ice.

3. You can re-melt the sodium acetate and reuse it for demonstrations later.

What is going on?:

The chemical reaction between the baking soda and the vinegar is:

$$Na^+[HCO_3]^- + CH_3\text{–}COOH \rightarrow CH_3\text{–}COO^- Na^+ + H_2O + CO_2$$

The sodium acetate in the solution in the refrigerator is an example of a supercooled liquid. That is, the sodium acetate exists in liquid form below its usual melting point. Heat is released as the "ice" crystals form. It is an exothermic reaction.

Academic Content Standards:

- Science: Physical Sciences: 4.1, 4.2, 4.4, 6.2, 6.4,