

# More Fun in the Food Science Classroom

**TEKS (14)** The student explains how food provides energy. The student is expected to: (A) discuss molecular motion and temperature. (D) compare various temperatures on rates of reaction.

**1) Objective:** The student will demonstrate and explain the effect temperature has on molecular motion.

Note: Although the following experiment has two different variables with the milk, valuable information about the molecular reaction can be found at the Web site **Color Changing Milk** <[www.stevespanglerscience.com/experiment/milk-color-explosion](http://www.stevespanglerscience.com/experiment/milk-color-explosion)>. The teacher may want students to read the information at this Web site after completing the experiment.

Show the PowerPoint slide **Molecular Motion**. Lead students to discuss the three ways in which molecules move and what affects molecular movement. Divide the class into groups of two to three students. Distribute the teaching aid **Molecular Motion Experiment** to each student. Read through the teaching aid with students and answer any questions. Have students develop a hypothesis before starting the experiment. Instruct students to complete the experiment and draw conclusions by answering the questions at the bottom of the teaching aid.

## Questions for Discussion:

(B) What properties of the dish soap caused the molecular reaction in the milk?

(C) What could be changed about this experiment to get a similar reaction and allow you to drink the milk?

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**TEKS (4)** The student analyzes the role of acids and bases in the food sciences. The student is expected to: (E) discuss ways pH is related to the properties of food, its safety, and its freshness. **(18)** The student describes the properties of proteins and amino acids. The student is expected to: (F) list factors that affect the stability of egg foam.

**2) Objective:** The student will assess how pH affects the physical properties of eggs.

Note: Approximately two weeks prior to using this strategy, purchase one to two dozen eggs (three eggs for each laboratory group); mark the carton *aged*, and leave at room temperature for the duration of the two weeks. Just prior to using this strategy, purchase an equal amount of eggs for this laboratory experience; mark these eggs *fresh*, and keep refrigerated. Remove the fresh eggs from the refrigerator approximately 30 minutes before the experiment. This experiment requires two mixers, electric or hand, or wire whisks for each lab group. As part of the experiment, the teacher may want to assign some groups rotary mixers and other electric mixers or wire whisks. Within each group, the type of mixing equipment should be the same.

Note: Over time, carbon dioxide, an acidic gas inside the egg, escapes through the porous shell, and raises the pH of the egg. This change in the pH level affects the texture of the egg whites and the

manner in which the eggs perform in baked items and during whipping. The yolks, on the other hand, remain relatively stable over time.

Divide the class into laboratory groups of four students. Two students within the group will work with *fresh* eggs, and two students within the group will work with the *aged* eggs. Assign a different mystery ingredient (i.e., ¼-teaspoon cream of tartar, ¼-teaspoon egg yolk, ½-teaspoon distilled vinegar, ¼-teaspoon lemon juice) to all but one group who will be the control group. Distribute the teaching aid **Creating Egg Foam**. Read through the teaching aid with the students and answer any questions. Instruct students to complete the experiment and record observations in the data table.

### Questions for Discussion:

- How did the different mystery ingredients affect the foam?
- Based on this experiment, what recommendations would you make about creating stable foam?
- What practical application does this experiment have for food scientists?

Explain to the students that one advantage older eggs have over fresh eggs is that the loss of carbon dioxide loosens the membrane around the egg and makes them easier to peel when hard cooked.

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**TEKS (6)** The student studies the chemical properties of food. The student is expected to: (H) analyze the occurrence of specific chemical reactions. (I) analyze chemical and physical changes in food.

**3) Objective:** The student will generate a physical change of a substance from a liquid state to a solid state.

Divide the class into laboratory groups. Distribute the teaching aid **Curds and Whey** to each student. Read through the teaching aid with the students, and answer any questions they may have. Instruct students to follow the procedure to complete the laboratory experience. Lead students to discuss their results.

### Questions for Discussion:

- Were the results similar for all laboratory groups? Why?
- Were there pH changes during the experiment? Why?
- What is the significance of the results for food science?

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**TEKS (6)** The student studies the chemical properties of food. The student is expected to: (H) analyze the occurrence of specific chemical reactions. (UI) analyze chemical and physical changes in food. **(10)** The student discusses how leavening agents are used in baking. The student is expected to: (A) describe the purpose of leavening agents in baked goods. (B) identify and describe major leavening agents. (C) explain why baking soda is used with an acid in baked goods. (F) discuss how air and steam act as leavening agents.

**4) Objective:** The student will assess the effectiveness of various types of leavening agents.

Explain to students that the purpose of this experiment is to evaluate the effects of various leavening agents in their ability to form the chemical reactions needed for bread products.

Supplies and equipment for this experiment include:

- 7 large eggs per lab group
- Baking soda
- Cream of tartar
- Agave nectar
- Honey
- Molasses
- Stevia powder
- Buttermilk
- 10 - 100mL spouted beakers for each lab group
- 7 stirring rods or long wooden skewers
- Forks for mixing
- Dutch oven for each lab group
- Masking tape for labeling

Divide the class into laboratory groups of two to three students. Distribute the teaching aids **Chemical Reactions Which Cause Products to Rise: A Leavening Agent Experiment** and **Chemical Reactions Which Cause Products to Rise Observation Chart**. Read over all instructions with students, and answer questions as needed.

#### Questions for Discussion:

- Which leavening agent combination worked the best? Why?
- Which leavening agent combination did not perform well? Why?
- Which of the leavening agents worked better when heat was added? Why?

Note: It helps the organization of the laboratory experience if all lab groups are being timed by the teacher's instruction instead of each lab group doing their own timing.

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**TEKS (6)** The student studies the chemical properties of food. The student is expected to: (H) analyze the occurrence of specific chemical reactions. (I) analyze chemical and physical changes in food. **(8)** The student understands the functions of enzymes. The student is expected to: (A) describe how enzymes act as catalysts in chemical reactions. (D) identify factors that affect enzyme activity. (E) explain how enzyme reactions are involved in food preparation. **(18)** The student describes the properties of proteins and amino acids. The student is expected to: (C) explain what happens during the denaturation of protein and how the process occurs.

**5) Objective:** The student will summarize the Maillard Reaction.

Explain to students that the Maillard Reactions are a series of reactions that take place between sugars and proteins when foods, such as meat, onions, and bread, are cooked or toasted. The reactions that take place produce a deep, rich color to the food and full flavor.

Have students watch the Internet video **The Maillard Reaction** <[www.onnetworks.com/videos/food-science/the-maillard-reaction](http://www.onnetworks.com/videos/food-science/the-maillard-reaction)>. Instruct students to write a summary of the science involved in the Maillard Reaction.

**Questions for Discussion:**

- What are the two types of enzymatic browning reactions?
- What is the cooking temperature for caramelization?
- What flavors are produced when caramelization takes place?
- How does the Maillard Reaction work?

As a follow-up activity, have students prepare caramelized onions or pan sear a steak to observe the Maillard Reaction

**Presenters:**

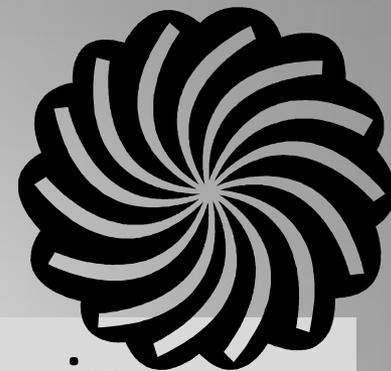
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# Molecular Motion



- Molecules constantly move and rotate in gases, liquids, or solids.
- Energy in the form of heat can speed up molecular movement and affect the physical properties of a substance.
- Three ways molecules move:
  - Rotational
  - Transitional
  - Vibrational

# Molecular Motion Experiment

**Objective:** To observe the effects of heat on molecular motion

**Supplies and equipment:** (for each laboratory group)

- 2 cups whole milk
- Four different colors of food coloring
- 2 dinner plates
- 1 small saucepan or microwave safe cup
- Food thermometer
- Dish soap

**Procedure:**

1. Record a hypothesis in the space provided.
2. Measure 1 cup of milk and heat to 110°F.
3. Pour 1 cup cold milk into a dinner plate; pour the heated milk into the remaining dinner plate.
4. Add one drop **each** of red, green, blue, and yellow food coloring in the center of each plate (but not on top of each other).
5. Describe the reaction for each temperature of milk in the appropriate space below.
6. Place one drop of liquid dish soap in the center of each plate.
7. Describe the reaction for each temperature of milk in the appropriate space below.
8. Describe the results.

**Hypothesis:**

	Cold Milk	Hot Milk (110°F)
Describe the reaction to the food coloring		
Describe the reaction to the dish soap		

Explain the results of both dishes of milk.

Did you confirm your hypothesis? Explain.

# Creating Egg Foam

**Objective:** To assess how the pH level of *fresh* and *aged* eggs affect the physical properties of eggs when producing foams

**Supplies and equipment needed:** (for each laboratory group)

- 3 *aged* eggs
- 3 *fresh* eggs, refrigerated
- pH test strips
- Two small plates
- Four small mixing bowls
- Two electric or hand mixers, or wire whisks
- Measuring spoons
- Mystery ingredient (assigned by the teacher)



For this experiment, each group will work simultaneously with the two sets of eggs comparing and contrasting the results.

## Procedure:

- Crack an *aged* egg onto a small plate; crack a *fresh* egg onto a separate small plate; compare the two eggs; and record your observations.
- Carefully test the pH of both egg whites, and record the results on the data table; test each of the egg yolks, and record your results on the data table.

Complete the following steps for both the *aged* and the *fresh* eggs.

- Crack and separate two eggs.
- Place the egg whites into a small mixing bowl and the egg yolks into a separate small bowl.
- Beat the egg whites for three minutes on high speed.
- Record your observations on the data table.
- Add the mystery ingredient (to both bowls of egg white) assigned to your group.
- Beat for two more minutes.
- Record your observations on the data table.

# Data Table

	Fresh Eggs	Aged Eggs
Visual appearance		
pH of whites		
pH of yolks		
<b>Observations:</b> Which eggs frothed first?  Which eggs were the most stable?  Other observations:		
<b>Mystery Ingredient:</b>		
<b>What effect did the mystery ingredient have?</b>		

## Questions:

1. How did pH of the egg whites affect the development of foam?
2. How did the age of the egg affect the results?
3. How did your mystery ingredient affect the development of foam?

# Curds and Whey



**Objective:** To create a physical change of a liquid to a solid

**Supplies and Equipment:**

- 2 cups cold milk
- 2 T lemon juice
- Litmus strips
- 2 – 400 mL beakers or similar size clear containers
- 1 small saucepan
- Electronic balance
- Funnel
- Cheesecloth

**Procedure:**

1. Pour 1-cup cold milk into a beaker or clear container.
2. Test the pH of the milk and record on your data table.
3. Note the time on your data table, then add 1 T. of lemon juice to the milk and stir for ten minutes.
4. In a small saucepan, heat 1 cup of milk to 100°F, remove from heat.
5. Note the time on your data table, then add 1 T. lemon juice to the warm milk and stir for ten minutes.
6. Place cheesecloth in funnel and pour milk products through.
7. Mass curd solids and record on data table.
8. Test the pH of the curds.

## Data Table

	Cold Milk	Warm Milk
Milk pH		
Start time/ end time		
Total time to curds		
Mass of curds		
Curd pH		

**Questions:**

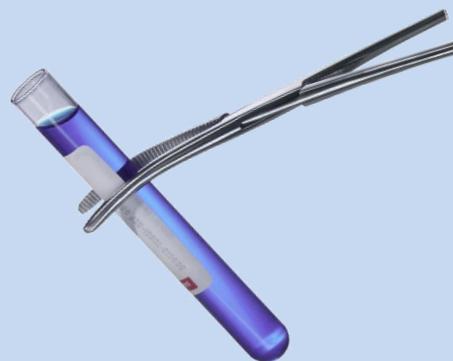
1. Describe the physical reaction that occurred in the milk.
2. How did the temperature of the milk affect the curdling process?
3. According to your mass calculations, how much milk is needed to produce 1 cup of curds?
4. Was there a difference in the pH of the liquid milk and the solid curds? Why?

# Chemical Reactions Which Cause Products to Rise: A Leavening Agent Experiment

**Objective:** The student will assess the effectiveness of various baking ingredients to leaven products.

## Equipment and supplies needed:

- 6 large eggs
- Baking soda
- Agave nectar
- Honey
- Molasses
- Stevia powder
- Buttermilk
- 10-100 mL cylinders for each lab group
- 7-200 mL spouted beakers for each lab group
- 7 stirring rods or long wooden skewers
- Forks for mixing



## Procedure:

1. Place a Dutch oven or large two handled saucepan on top of the range. Fill with about 3 inches of water. Turn burner on high.
2. Line 7-100 mL cylinders in a row, and label as Variation A-G.
3. Place a 200 mL beaker in front of each cylinder.
4. Place one large egg white in each beaker. Beat until frothy with a fork.
5. Add the remaining ingredients to the beakers and the cylinders according to the variations below.
6. When the lab groups are ready, the teacher will give the signal to immediately pour the contents of the beaker into the matching cylinder. Stir after each addition.
7. Use the teaching aid Chemical Reactions Which Cause Products to Rise Observation Chart to report the rise of the leavening agents.
8. In complete sentences, write three conclusions about the effectiveness of various leavening agents to make products rise.

## Variations:

- A. Place  $\frac{1}{2}$  tsp baking soda in the cylinder. Place 60 mL water in the beaker, and mix with the egg white.
- B. Place  $\frac{3}{4}$  tsp cream of tartar and 1 tsp baking soda in the cylinder. Place 60 mL water in the beaker, and mix with the egg white.
- C. Place  $\frac{1}{2}$  tsp baking soda in the cylinder. Place 60 mL buttermilk in the beaker, and mix with the egg white.
- D. Place  $\frac{1}{2}$  tsp baking soda and 2 tsp stevia powder in the cylinder. Place 60 mL buttermilk in the beaker, and mix with the egg white.
- E. Place  $\frac{1}{2}$  tsp baking soda in the cylinder. Place 30 mL agave nectar and 30 mL water in the beaker, and mix with the egg white.
- F. Place  $\frac{1}{2}$  tsp baking soda in the cylinder. Place 30 mL dark molasses and 30 mL water in the beaker, and mix with the egg white.
- G. Place  $\frac{1}{2}$  tsp baking soda in the cylinder. Place 30 mL honey and 30 mL water in the beaker, and mix with the egg white.



# Chemical Reactions Which Cause Products to Rise Observation Chart

**Directions:** Record the level to which the following leavening agents produced carbon dioxide causing the liquid to rise. After the six minute timing for room temperature heights, place the seven cylinders in a standing position in the heated water of the saucepan. Record the rise of the liquid for six minutes.

Leavening Agents	Room Temperature Heights						Heated Heights					
	1 min	2 min	3 min	4 min	5 min	6 min	1 min	2 min	3 min	4 min	5 min	6 min
Baking soda												
Baking soda/cream of tartar												
Baking soda/buttermilk												
Baking soda/stevia/buttermilk												
Baking soda/agave/water												
Baking soda/molasses/water												
Baking soda/honey/water												

## Conclusions:

In complete sentences, write three conclusions about the various leavening agents and their effectiveness in producing carbon dioxide which will make products rise.

- 1.
- 2.
- 3.