

Popcorn: Visualizing the Kinetic Molecular Theory

A Carolina Essentials™ Investigation

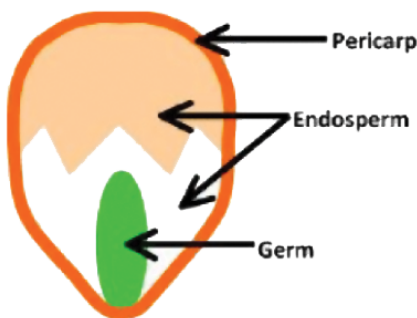
Student Worksheet



Overview

Popcorn may be one of your favorite snack foods. It's also the only grain in the corn family that pops open when exposed to temperatures above 180° C. What makes the kernels pop? Can a model be constructed using the kinetic molecular theory to explain the phenomenon of popping corn? In this activity, you'll design an investigation to gather data needed to support an explanatory model.

Here are the basics. A popcorn kernel is composed of 3 parts: the **pericarp**, **germ**, and **endosperm**. The pericarp is the tough outer shell surrounding a popcorn kernel, and the key to what makes it pop. Inside the pericarp is the germ, or seed embryo. Adjacent to the germ is the endosperm, which contains some trapped water plus soft and hard starch granules that serve as food for the germ when it sprouts.



When a popcorn kernel is heated, the trapped water in the endosperm turns into steam, building up pressure inside the pericarp to more than 9.0 atmospheres (atm). This pressurized, super-heated steam transforms the soft starch in the endosperm into a gelatinous material. The pericarp ruptures, releasing the steam and gelatinous starch that solidifies upon cooling. The resulting popped kernel is 40 to 50 times its original size. The optimum moisture level for popcorn is 14%. Below that value, the size of the popped kernels is smaller and the number of kernels that pop decreases.

SAFETY REQUIREMENTS



MATERIALS

Beaker, 250 mL
Graduated cylinder, 10 or 25 mL
Wire gauze
Support stand with iron rings
Bunsen burner or hot plate
Weighing boat
Balance
20 kernels of popcorn (number must remain constant among all groups)
Cooking oil
Disposable plastic pipet
Aluminum foil (for loosely covering the beakers)

Essential Question

How do the kinetic molecular theory and gas laws explain why popcorn pops?

Investigation Objectives

1. Design and conduct an experiment to determine the percent of water by mass in a sample of popcorn.
2. Use the kinetic molecular theory and gas laws to construct a model explaining why popcorn pops.

Safety and Disposal

Wear goggles and aprons or lab coats during the activity and exercise caution around Bunsen burners or hot plates. Cooking oil boils at a higher temperature than water (225° C). Loosely cover beakers with aluminum foil to contain the popping corn and boiling oil.

Note: Do not to eat any of the popcorn produced in the lab. Dispose of it in the trash.

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Investigation Procedures

1. Given the materials available to you, design an investigation to determine the percent by mass of water in popcorn. In your experimental design, include a hypothesis, materials list, procedures, data table, analysis methods, and error analysis method. Have your teacher approve the steps of your procedure before beginning.

(Teacher signature) _____

- **Hypothesis**
- **Materials**
- **Procedures**
- **Data**
- **Analysis**
- **Error Analysis**

2. Conduct the experiment, record the data, and complete the analysis.
3. On a class data table, record the percent by mass of water and the type of popcorn you used (bag or microwave).

Analysis and Discussion

1. What is the percent by mass of water in your sample of popcorn? Show your work and include all units.
2. Compile the class data and calculate the mean water percentage for bag popcorn and microwave popcorn.
3. Use the class data to explain any differences between bag and microwave popcorn.
4. Use the kinetic molecular theory, gas laws, and class data to construct a model explaining why popcorn pops.