

Experiment 2:

ANALYSIS FOR PERCENT WATER IN POPCORN

Purpose: The purpose is to determine and compare the mass percent of water and percent of duds in two brands of popcorn.

Introduction:

When popcorn kernels are heated, the water within the kernels is converted to water vapor, which expands with the temperature until it bursts out of the hard shell. In the process, the starchy material of the corn fluffs up and becomes “popped” corn.

Sometimes there is a crack in the hard shell of the kernels allowing the water vapor to slowly leak out. In such a case, no pressure will build up to “pop” the shell, and we have a “dud.” A stale kernel that has lost its water will also not be able to pop and end up as a “dud” as well.

In this experiment you will determine how much water is in the kernels by weighing them before and after they have been popped. You will also determine the percent of duds by counting how many kernels did not pop properly. This is repeated for a second brand of popcorn for comparison.

The general equation for percent is as follows:

$$\text{Percent} = \frac{\text{part}}{\text{whole}} \times 100$$

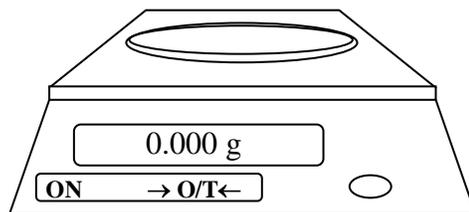
In determining the mass percent water in popcorn, “whole” would be the mass of the kernels including the water, and “part” would be the mass of the water driven from the kernels.

$$\% \text{ Water} = \frac{\text{Mass of Water}}{\text{Mass of Kernels Before Heating}} \times 100$$

In determining the percent duds in the popcorn, “whole” would be the total number of kernels used and “part” would be the number of duds.

$$\% \text{ Duds} = \frac{\text{\# of Duds}}{\text{\# Kernels Before Heating}} \times 100$$

Proper Use of the Electronic Balance:



1. Check that the balance pan is clean. If not, notify your instructor.
2. With nothing on the balance, it should read zero. If it does not, press O/T (or on some balances it may be "Tare") to set it to zero. This is called "zeroing" the balance. The last digit is likely to fluctuate a bit due to the draft in the room. It is quite acceptable to have it fluctuating by 0.002 in either direction. Wait until the "g" appears to show it has stabilized.
3. Gently, place the container you wish to weigh on the balance pan. **Remember to never place chemicals directly on the balance pan.**
4. Wait until "g" appears again. Always record all the digits that appear on the display. **DO NOT ROUND OFF ANY DIGITS UNLESS THE PROCEDURE SPECIFICALLY TELLS YOU TO!!**
5. If you are to add something to the container, always remove the container first, before adding the sample. **Never add a sample to a container that is sitting on the balance pan.** It is too easy to spill chemicals around the balance pan which will corrode the sensitive electronics inside the balance.
6. Before you leave the balance area zero the balance, and check that the balance area is clean. Report any spillage to your instructor.

Procedure: *Work individually. You will analyze two different brands of popcorn: Orville Redenbacher and an unknown Brand X. Reread "The Lab Notebook" on p. 9–11, and before arriving to the lab, prepare your data table in your lab notebook by copying the table from p. 26.*

1. Obtain a ceramic heat pad from the side shelf and a pair of crucible tongs from your drawer. Attach an iron ring onto a ring stand, place a wire gauze on top, and place a Bunsen burner below the ring. Position the iron ring at a height such that the tip of the blue cone of the flame would be touching the wire gauze. Adjust as necessary.
2. Review the operation of the Bunsen burner in Experiment 1 before lighting the burner. You will need a very hot flame. *From last week's experiment, how do you obtain such a flame?*
3. Heat the wire gauze (without the beaker) for 5 minutes to drive off any moisture that may have collected on it. Turn off the burner after 5 minutes.
4. Meanwhile, weigh and record the mass of a clean and dry evaporating dish. (Review instructions for the use of the electronic balance shown above.) Place exactly 10 kernels of one of the brands in the evaporating dish and record the total mass of the dish and kernels. From the two masses the mass of the kernels can be calculated. This is called *weighing by difference*. In other words, you are not measuring the mass of the kernels directly, but determining the mass by weighing the dish before and after the kernels have been added. Learn the meaning of this expression of

“weighing by difference.” Always use the same balance when this method of weighing is used. Any instrumental error will cancel out in the subtraction.

- Obtain a 250-mL beaker and remove any labels that may have been left on it. (They will char and burn if you don't!) Wrap the sides (not the bottom) of a 250-mL beaker with aluminum foil to provide insulation (see demonstration setup). Place the evaporating dish on top of the beaker, cover it with a watch glass, and set everything on top of the wire gauze as shown in Fig. 2.1.

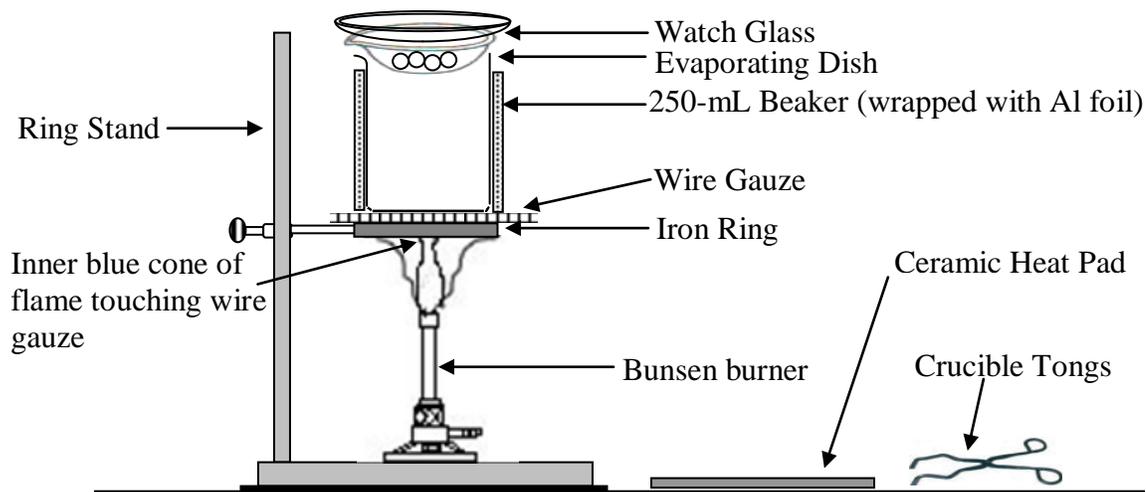


Figure 2.1

- Heat the kernels until they pop (*roughly* 8 minutes). After they appear to have stopped popping, continue heating for another 10 seconds. If it starts to smoke, remove the Bunsen burner immediately, and with your crucible tongs, remove the watch glass and place the evaporating dish on the ceramic heat pad. You may have to repeat the experiment if it smoked badly because you would have lost more than water as the popcorn burns!
- After the popping is finished, turn off the gas and allow the evaporating dish to cool down. Do not attempt to move it while it is still hot.
- When the evaporating dish and its contents are at room temperature, weigh and record the mass. Objects that you weigh must always be at room temperature or it would give a false mass. Warm objects will heat up the air around it and create a convection current. If it is placed on the balance pan while still warm, the air current will lift up the pan and the mass would appear to be lighter than it actually is. If the mass displayed on the balance keeps increasing, it is a sign that the object is still warmer than room temperature.
- Examine the popped corn and record the number of duds, if any. For our purpose, you can count as duds any that looked only half-popped. Use your own judgment.
- The popped corn can be discarded in the trash can. Do not wash your evaporating dish with water between the first and second sample. Just wipe it clean with paper towels. Repeat the experiment with the second brand of popcorn starting at Step 4. (You do not have to dry the wire gauze again as described in Steps 1 – 3.)
- While you are waiting you can begin your calculations for the first sample.

12. CLEANUP: After you have analyzed your second brand of popcorn, you can scrub out the evaporating dish with detergent and hot water. Remove the iron ring from the ring stand and return all equipment to the proper locations.

Data for Percent Water in Popcorn		
Brand of Popcorn	Orville Redenbacher	Brand X
# of kernels used		
Mass of Empty Evaporating Dish		
Mass of Evaporating Dish + Kernels Before Heating		
Mass of Evaporating Dish + Popped Corn (including duds)		
# of Duds		

As you prepare your lab notebook, remember to use 2 lines whenever the description is lengthy, so that there is ample space to record the actual data.

Calculations: Perform the calculations needed to complete the tables on the Calculations & Results page (p. 29). Show calculation setups for all calculations unless specified otherwise. Be sure to follow the rules for using the correct number of significant figures.

Sample Calculations: *Your instructor will go through these calculations in pre-lab discussion. Take careful notes so that you know how to set up your own calculations.*

# of kernels used = 10	
Mass of Empty Evaporating Dish	= 49.079 g
Mass of Evaporating Dish + Kernels Before Heating	= 50.714 g
Mass of Evaporating dish + Popped Corn (including duds)	= 50.480 g
# of duds = 1	

Calc mass of kernels before heating

Calc mass of kernels after heating

Calc mass of water driven from kernels

Calc % water in popcorn

Calc % duds in popcorn

Special Instructions for the Formal Lab Report

One of the objectives of this course is to have you learn to follow a stated format when writing a lab report. In the professional world, if you were to submit an article for publication and you did not follow the format specified by the journal, your article would not be accepted.

Follow the general instructions on pp. 13-19 for writing a formal lab report. It should contain all the items listed (Cover page, abstract, etc.). Below are the specific instructions that apply to this particular experiment.

Summary of Results & Discussion:

SUMMARY OF RESULTS: Considering the purpose of the experiment, it would be logical to prepare a table to compare the percent water and percent duds in the two brands. Do not include raw data.

DISCUSSION: Based on your results, does the brand with a lower percent duds show a lower or higher percent water? Can a conclusion be drawn as to which brand has a poorer quality of kernels? Explain your answers **fully**.

Conclusion: State the percent water and percent duds in the brands you studied. Next summarize the conclusion(s) drawn in your discussion. Remember not to bring in any new information that you have not already mentioned.

Post-Lab Questions: (about 10% of grade for lab report)

(Remember to answer in full sentences. Answers MUST be typed and stapled to your report.)

1. Based on your results, were the duds in the brand with the highest % duds due to cracks in the shell and water was leaking out slowly during the heating process? Explain.
2. If a stale sample of popcorn were to be analyzed, would you expect the % water to be higher or lower than a sample that is not stale? Explain why.
3. If you miscounted and worked with only 9 kernels, would it affect your calculated percent of water? Be specific. Do not merely say it is inaccurate. Would the percent be too high, too low or unaffected? Explain.
4. If you weighed the popped kernels while they were still warm, how would that affect your calculated mass of water, and your percent of water? Be specific (would they be too high or too low) and explain your line of reasoning in a well-organized paragraph.
5. The usual instructions for popping popcorn in the microwave oven tell us to stop the heating when the popping slows down to 1 or 2 minutes between pops. At this time, we often find there are unpopped kernels remaining. Explain why we cannot separate these duds and reheat them to get them to pop.

Calculations & Results

Name: _____

Lab Sec: _____

Show calculation setups for all unless specified otherwise, then fill in Results Table at the bottom of the page. **USE PENCIL!** *Since this is not raw data, you are allowed to use pencil.*

1. Calculate the “Mass of Kernels Before Heating” for each brand:

Orville Redenbacher

Brand X

2. Calculate the “Mass of Kernels After Heating” for each brand:

Orville Redenbacher

Brand X

3. Calculate the “Mass of Water Driven from Kernels” for each brand.

Orville Redenbacher

Brand X

4. Calculate the “% Water in Popcorn” for each brand:

Orville Redenbacher

Brand X

Results Table for Percent Water in Popcorn		
Brand of Popcorn	Orville Redenbacher	Brand X
Mass of Kernels Before Heating		
Mass of Kernels After Heating		
Mass of Water Driven from Kernels		
% Water in Popcorn		

Double check sig. fig. & units before you proceed.

(continued next page)

Name: _____

5. Calculate the “% Duds in Popcorn.” Note that the number of kernels or duds is a counting number and therefore considered an “exact” number. You may leave the percent as a whole number rather than rounding it to one significant figure.

Brand of Popcorn	Orville Redenbacher	Brand X
Number of Kernels Tested		
Number of Duds		
% Duds in Popcorn		