

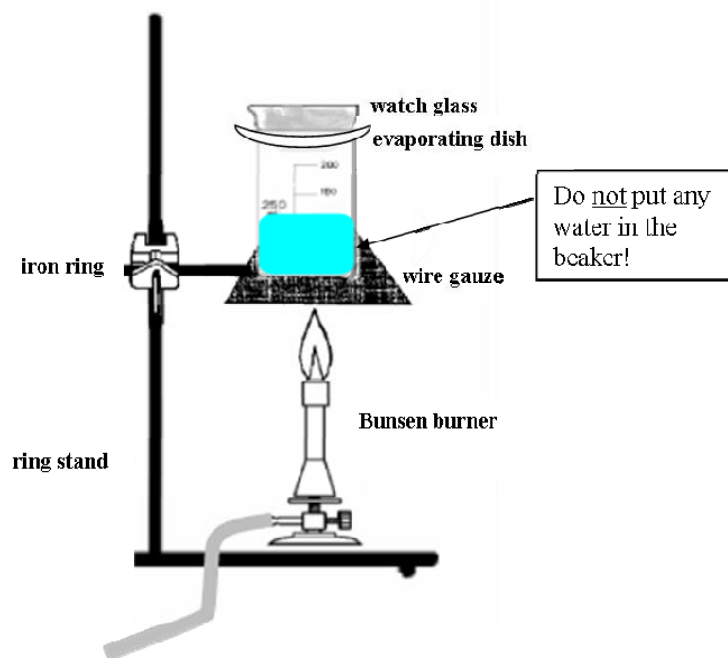
## Experiment 12: Percentage of Water in Popcorn

The science behind how popcorn kernels pop is quite simple. Each kernel contains a small amount of water trapped inside of it. Heating the kernels causes the water to become high-energy molecules of steam. As we continue to heat the kernels, the pressure exerted by the trapped steam on the inside of the kernel becomes so great that it eventually causes it to burst. What remains is, of course, a popular snack. Unfortunately, not all kernels in a given sample of popcorn will pop, regardless of how much heat we apply. These “duds” may contain very small cracks, through which any water already may have escaped. Any water remaining in these kernels easily escapes through the cracks as steam when we heat the popcorn. Without this high-pressure build up of steam, the kernel remains unpoped. In today’s experiment we will determine the percentage (by mass) of water in a sample of popcorn by comparing the mass of kernels before and after popping. We will also determine the average number of “duds” in a given sample of popcorn.

$$\% \text{ water} = \frac{\text{mass of water}}{\text{total mass of kernels}} \times 100\%$$

### PROCEDURE

1. Using an electronic balance, determine the mass of your dry evaporating dish and record it on the report sheet.
2. Obtain exactly ten kernels of popcorn and place them in the evaporating dish. Weigh the dish with the kernels inside it, and record the mass on the report sheet.
3. You will now pop your kernels by constructing a “hot air popper” using a ring stand assembly, a beaker, the evaporating dish, and a watch glass. It is a good idea to put an additional iron ring around the beaker to stabilize it if the assembly is inadvertently shaken. *Be sure to choose the size of beaker which the evaporating dish will fit best into, as you see in the diagram. The dish should not fall in to the beaker, nor should it be too large to rest on its rim. Do not pour water into the beaker!*



4. Place something fairly heavy on the watch glass; otherwise, the popping kernels may knock it off and shatter it. Good choices include metal cylinders, very-large rubber stoppers, etc.
5. Turn on the Bunsen burner, and adjust the flame so that the tip of the inner cone is at the level of the wire gauze. The air in the beaker will gradually become hot enough to pop the popcorn. Note that this may require ten minutes or more.
6. Continue heating until all kernels have popped, or until the popcorn begins to brown. Do not burn the popcorn to a black crisp. Not only will that ruin your experiment, it will produce a terrible odor in the lab room! It is likely that a few “duds” will remain unpopped.
7. Allow the apparatus to cool for at least 10 minutes. Remove the evaporating dish from the assembly and weigh it with the popped corn and any “duds” inside. Be sure that you do not inadvertently include the watch glass in your weighing. Record this mass on the report sheet. Additionally, you should record the number of “duds” in your sample.
8. Repeat this process a second time, using a different brand of popcorn if one is available. You should clean the evaporating dish as best as you can with a *dry* paper towel.
  - a. Popped popcorn may go in the trash. Do not eat it!

### Percentage of Water in Popcorn

*Always give the appropriate units!*

|  | Trial 1 | Trial 2 |
|--|---------|---------|
| Mass of empty evaporating dish                         |         |         |
| Mass of evaporating dish + kernels                     |         |         |
| Mass of kernels<br><i>Calculation:</i>                 |         |         |
| Mass of dish, popped kernels, and duds (after heating) |         |         |
| Mass of popped kernels and duds<br><i>Calculation:</i> |         |         |
| Mass of water lost<br><i>Calculation:</i>              |         |         |
| % water in popcorn<br><i>Calculation</i>               |         |         |

Average % water in popcorn: \_\_\_\_\_

Number of kernels used                      Trial One\_\_\_\_\_ Trial Two\_\_\_\_\_

Number of duds remaining                      Trial One\_\_\_\_\_ Trial Two\_\_\_\_\_

Percentage of kernels which were duds                      Trial One\_\_\_\_\_ Trial Two\_\_\_\_\_

**Questions**

Suppose that you have two samples of the same type of popcorn. One sample contains 100. grams of kernels, and the other contains 200. grams. Which contains (i) the greatest mass of water, and (ii) the greatest percentage of water?

Is the percentage of water an intensive or extensive property?

Why should you not eat any of the popcorn you produced in this experiment. Be as specific as possible.

**Materials for this lab:**

Popcorn (preferably two or more different brands): 25 kernels per student

Very large rubber stoppers, metal cylinders, or any other heavy objects which will help to weigh down the watch glass (see step 4).