

## Experimental Design: Inventing a Cookie Recipe

Science is concerned with how and why things happen. Scientists ask themselves questions, and then invent and perform experiments to find out the answers. What actually happens in the experiment is much more important than whether the scientist's hypothesis is right or wrong. In fact, being wrong is much more exciting to a scientist than being right, because when you are wrong, you usually learn something.

There is an art to designing an experiment. You need to be able to predict the most likely outcomes, both if you are right and if you are wrong. Then, you need to control (keep constant) everything except for the factor(s) you're specifically looking at. Finally, you need be able to perform experiments without worrying about whether or not it will work as planned.

Your experiment is to practice designing an experiment by inventing a cookie recipe, using scientific principles. This process is intended to give you some insight into how scientists design and perform experiments.

### About Cookies

Cookies usually contain the following ingredients:

Category	Amount	Description
dry bulk	$2\frac{1}{2}$ –4 cups	usually flour or some other kind of grain, though cocoa, oats, granola, and various “breakfast cereals” are also fairly common.
sugars	100–200 g	sugar ( $\frac{1}{2}$ –1 cup), honey, molasses, maple syrup, fruit juice, applesauce, Coca-Cola, <i>etc.</i> Try to get at least 100 g of total sugars. (Remember that some of these also contribute to the liquid.)
leavening	about 1 tsp	usually baking powder and/or baking soda
fats/oils	$\frac{1}{2}$ –1 cup	usually butter or shortening, though oil is sometimes used. (Remember that a stick of butter is $\frac{1}{2}$ cup.)
binder	1–2 eggs	helps hold cookies together so they don't crumble.
salt	$\frac{1}{2}$ –1 tsp	otherwise your cookies will taste like something is missing.
liquid	“enough”	Judge this by the consistency of the dough. Usually the egg(s) provide enough liquid and you don't need to add any. If the dough ends up too runny, add more dry bulk, or decide that the experiment didn't work and you're making something more like brownies. If the dough is too crumbly, you can add a little extra fat and/or a little milk.
flavorings	to taste	these can be nuts, fruit, chips, vanilla, or anything else you think would taste good. Be creative!

It's always safe to grease the cookie sheets. It may be unnecessary if the cookie dough has a lot of fat, but it won't hurt.

The time and oven temperature will depend on the size and shape of your cookies. You need to cook the dough on the inside without burning the outside. For very thin cookies, you need a fairly hot oven (400°–425°F) for a short time (about 8–10 minutes). For thicker cookies, you need a cooler oven (350°–375°F), and a longer baking time (15–20 minutes or more).

## The Experiment

Your experiment will involve making cookies without a recipe, and writing up the experiment in your laboratory notebook. You may work by yourself, or with up to two partners. However, each of you must write up the experiment separately in your own handwriting.

### Objective

Write 1–2 sentences describing the objective of the experiment. Be sure to mention specifically what question you're trying to answer, and what you'll be observing in order to get the information.

### Overview / Plan

You will need to see which ingredients you have at home (and possibly do some shopping), and then jot down your plan. The plan can be in any form that is most convenient for you—a written paragraph, a bulleted or number list, or even a flow chart—as long as it conveys what you intend to do. However, it should *not* be a detailed procedure. You will write the detailed procedure when you perform the experiment.

### Procedure

Record detailed descriptions of each step *exactly* as you perform it. Be sure to list all chemicals (ingredients) and quantities, experimental conditions (such as size & shape of cookies, oven temperature, baking time, *etc.*) and anything else that someone would need to know in order to exactly duplicate your experiment at a later date.

### Data & Observations

You need to record two kinds of data. *Quantitative* data are things that can be quantified by a number or value. This will include information like the approximate size and thickness of the cookies, and how long you baked them. *Qualitative* data are things that do not have numbers or amounts associated with them, such as texture and flavor.

### Conclusions

Write a few sentences that describe how well your cookies came out, how much variation there was from one extreme to the other, any possible sources of errors/problems, and what you might do differently next time.

### Share Your Data. . .

. . . and your cookies too. Yum! Make sure you provide a complete list of the ingredients you used (particularly nuts or peanuts), because some of your classmates may have life-threatening allergies.