

Explore It!

SCIENCE INVESTIGATIONS
IN OUT-OF-SCHOOL PROGRAMS



Cake Chemistry

EDC
CENTER FOR *Science Education*



Cake Chemistry

How to Use This Guide.....	ix
Overview.....	xi
Exploration 1: Making Up Your Own Recipe	1
Exploration 2: Changing Your Recipe and Collecting Baking Powder Gas	13
Exploration 3: Taking a More Careful Look at Baking Powder Gas.....	25
Exploration 4: Using Baking Soda and Buttermilk	33
Exploration 5: Capturing Baking Soda Gas.....	43
Exploration 6: Experimenting with Yeast	53
Exploration 7: Testing the Gas from Different Ingredients	65
Appendix	
Materials Shopping List.....	81
Additional Resources	83
Letter to Families	85

MAKING UP YOUR OWN RECIPE

EXPLORATION 1

Discovery Question

What are the right amounts of ingredients used to make a recipe for a good cake?

WHAT TO DO

PART 1 Mixing the Ingredients

1. Decide with your teammates on the ingredients for your recipe. How many spoonfuls of each ingredient you will use?
2. Measure out the dry ingredients in one cup.
3. Measure out the wet ingredients in another cup.
4. Mix both sets of ingredients well in the aluminum pan until the batter is smooth.
5. Wait for further instructions.

PART 2 Which Combinations of Ingredients Fizz?

Your program leader will give you further instructions.

WHAT TO THINK ABOUT

- How much of the wet ingredients do you think you should use compared with the dry ingredients?
- How important is the baking powder?
- What do the eggs add to the cake?
- What does the cooking oil add to the cake?
- What is it about a cake that makes it taste “good?”



MAKING UP YOUR OWN RECIPE

EXPLORATION 1

EXPLORERS' SHEET →

OUR RECIPE

Ingredient	Number of Spoonfuls or Drops

MAKING UP YOUR OWN RECIPE

EXPLORATION 1

MIXING WET AND DRY INGREDIENTS

While waiting for your cake to bake, you can carry out some testing of your ingredients. Which combinations of ingredients give off gas bubbles when mixed together? Use the grid sheet of aluminum foil to make your mixtures. Write the results of your wet/dry mixtures in the appropriate squares below.

	Flour	Sugar	Baking Powder
Milk			
Cooking Oil			
Egg			

MAKING UP YOUR OWN RECIPE

EXPLORATION 1

MATERIALS

For Each Team

- 8 clear plastic cups (6- to 7-ounce)
- 8 plastic spoons* (standard)
- 1/2 cup flour
- 1/2 cup sugar
- 1/2 cup baking powder
- 1/2 cup milk
- 1/2 cup cooking oil (any type)
- 1/2 cup liquid egg or egg substitute* (unflavored) (alternative: 1 whole egg, beaten)
- 1 small aluminum cake pan* (approximately 4 inches in diameter) or mini loaf pan
- 1 12-inch ruler
- 1 sheet of aluminum foil (12 inches long)
- 1 Explorers' Sheet, including the *Our Recipe* chart and *Mixing Wet and Dry Ingredients* chart

Shared

- permanent markers
- additional amounts of all ingredients
- newspapers and sponges (for cleanup)
- access to an oven (or toaster oven or cardboard box oven)
- optional: trays or stiff sheets of cardboard (8-1/2 inches x 11 inches)

For the Program Leader

- toothpicks
- 1 eyedropper
- vanilla extract

**Additional information is available under Special Notes About Materials (page xvi) for those materials noted with an asterisk.*

PREPARING FOR THE EXPLORATION

- Before the start of each exploration, place newspapers on the tables. This will make cleanup easier and faster. Also, the explorations should take place near a sink so that water can be accessed easily for some of the explorations and for easier cleanup. If this is not possible, you will need to provide some buckets or large containers of water so that any spillage or cleanup can be done with a minimum of work.

MAKING UP YOUR OWN RECIPE

EXPLORATION 1

GUIDING THE EXPLORATION

The cardboard box oven is the same as that presented in the *Explore It!* project “Heating a House and an Oven.” You will have to use a 100-watt bulb to get the temperature high enough to bake a cake (350°). However, this kind of oven can only handle two containers at a time, so you may have to make several of them. Consult the curriculum guide for this project to construct one of these ovens.

- Label a set of cups for each team with a permanent marker (Figure 1). Create a set of six cups for each team filled with about 1/2 cup of each of the ingredients listed above. You can decide to put more or less of the ingredients in these cups.



Figure 1
A set of cups for one team.

- If you are preparing the materials long before the session, cover the cups with paper or some other material to keep anything from getting into the cups before students use them. To make it easier for handing out to each team, you could place each set of materials in some kind of tray or on a sheet of stiff cardboard.
- You will need access to an oven to bake the small cakes. Alternatives include a toaster oven or a cardboard box oven.¹
- Turn on your oven(s) before the start of each session and set the temperature to 350°.
- Make one copy of the Explorers’ Sheet, including the *Our Recipe* chart and *Mixing Wet and Dry Ingredients* chart, for each team. However, wait to pass them out until after you have explained the task at hand.



SAFETY: Some children may be allergic to eggs or some of the other ingredients used in this project. Make sure to check with parents before beginning.

INTRODUCING THE EXPLORATION

Start off by asking the children if they have done any baking at home with their parents. Specifically:

- Have they helped their parents or watched them make a cake from scratch?
- What do they remember about the amount of ingredients in the recipe and how it was baked?
- What ingredients do they recall were needed to bake the cake?
- If they haven’t participated in cake baking at home, what do they think the ingredients are that make up a cake?

MAKING UP YOUR OWN RECIPE

EXPLORATION 1

Make the following list of ingredients on a sheet of chart paper or white board²:

- Flour
- Sugar
- Baking powder
- Milk
- Cooking oil
- Eggs
- Flavoring

If they mention other ingredients, such as butter or baking soda, include these on the list. Circle those that you will make available to them during *this* exploration.

Tell them that they will have the chance to make up and bake their own cake recipes. First, they need to think about the amount of each ingredient to use. Explain to children that to conserve materials and to help make comparisons among the recipes, each team will be limited to 15 spoonfuls of flour. (Teams can use fewer than 15 spoonfuls if they prefer, but no more than 15.) They can decide their own amounts of the other ingredients, but they must measure everything out in spoonfuls. Refer to the Discovery Question on the Explorer's Sheet.³

To help them think about relative proportions, have a general discussion about the relative number of spoonfuls of each ingredient.

- What do they think should be the amount of wet ingredients compared with dry ingredients?
- Do they need lots of baking powder?
- Show them the size of the bottle of vanilla extract. Does this size suggest that they use many spoonfuls?

Then assign members to each team and review the roles they can have. Have them talk among themselves first, deciding what ingredients they will include in their recipe and how many spoonfuls of each they will measure out.

Show them how to measure out a level spoonful of material (Figures 2 and 3). Point out that they need to be precise and that they should write down the amounts they use on the *Our Recipe* chart, because they may want to change their recipes later and it will be helpful for them to compare.

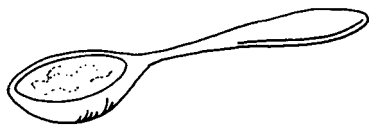


Figure 2
A level spoonful.

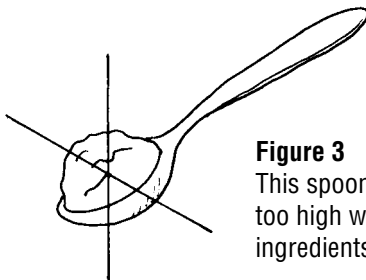


Figure 3
This spoon is filled too high with dry ingredients.

² There are lots of different recipes for cakes using different ingredients. The ingredients used here will make a very basic cake. With the right kind of proportions, a decent-tasting cake can be produced. Since there will be opportunities for children to do more baking in later explorations, limit them to the ingredients suggested in the materials list.

³ Teams are limited to 15 spoonfuls of flour also because children have a tendency to use a lot of this particular ingredient. And, the larger amount of cake batter they make up, the longer it will take to cook and the more room it will take up in the pan.

MAKING UP YOUR OWN RECIPE

EXPLORATION 1

GUIDING THE EXPLORATION

Some teams may use 4 several spoonfuls of baking powder. Since this is meant to be an experiment, let them try it. They will find out later that the cake may either collapse or be bitter. They can modify their recipe the next time.

Have the materials manager from each team collect a set of materials. One team member can measure out the dry ingredients into a clean cup and another team member can measure out the wet ingredients into a different clean cup. Both wet and dry ingredients can be mixed in the pan by a third person.

LEADING THE EXPLORATION

PART 1

As children are mixing the cake ingredients, go around the room with the bottle of vanilla extract and have teams decide how many drops they want to use. You will need to do this for all explorations where children are working on their cake recipes.



SAFETY: Make sure children are clear that they are not to taste the raw batter, because raw eggs can cause illness.

Some teams may end up with a mixture that is very soupy or very dry. You might want to point this out to them. They can add a little more of some ingredient after they have mixed everything together.⁴



SAFETY: It is very tempting for children to lick the spoon after mixing the batter. However, it is strongly urged that you discourage them from doing this.

Some children may not thoroughly mix the wet and dry ingredients. Watch the teams closely and remind them to do this.

Check to see that each team has recorded their recipe on the *Our Recipe* chart.

After the ingredients have been mixed and the batter has sat for a few minutes, there may be some bubbles emerging from the top of the batter. Point this out to the children. Ask them how these bubbles are being made. Did they just come about from the mixing or are they coming from the ingredients? If from the ingredients, what ingredient or ingredients may be making the bubbles?

Once all the teams have mixed their ingredients and their pans are ready, collect them and place them in the oven(s). Check the temperature and time. The cakes should take around 12–15 minutes to bake, depending on the type of oven you use and the amount of batter in the pans.

PART 2

While waiting for the batter to cook, children can carry out a test related to the baking of the cakes. This will help them focus on some of the science of cake baking. If their ingredient cups are empty, have the materials manager come up to central supply to get a little more (a couple of spoonfuls should be more than enough for this part of the exploration).

MAKING UP YOUR OWN RECIPE

EXPLORATION 1

Recall to the children that you pointed out that some bubbles were in the batter.

- Can they think of a way of testing the ingredients to determine which ones may be producing the bubbles? (You can help them by pointing out that they need to mix a wet ingredient with a dry ingredient.)
- Which combination would they try?
- How would they know if they have tried all possible combinations?

From here you can go two routes.

1. The children can set up their own tests and eventually report the results. However, if they do their own, they may not end up testing all possible combinations.
2. Show them the *Mixing Wet and Dry Ingredients* chart on the Explorers' Sheet and explain the instructions that follow:
 - a. Give each team a sheet of aluminum foil about 12 inches long.
 - b. Have children use a ruler and a pencil to gently make a grid outline with labels like the one shown on the *Mixing Wet and Dry Ingredients* chart.
 - c. They should first put down a little of each dry ingredient inside the squares of the grid according to the labels.⁵
 - d. They should then pour a little of each liquid listed on the left of the chart/grid onto the dry ingredients within the squares. You may need to explain how the different ingredients intersect on the grid and how that will tell them what wet ingredient goes with which dry ingredient.
 - e. Have them look closely to see which dry ingredients fizzed with a liquid. Make sure they record their results on the *Mixing Wet and Dry Ingredients* chart.

RETURN TO PART 1

One way of testing a cake to see if it is done is to stick a toothpick in the middle. If it comes out dry, the cake is done. You should also press the middle lightly to see how soft it is.

Let the children taste their cakes. Also, give them some time to sample other teams' cakes.

Save the materials cups that each team used, but discard the ingredients and wash them. You will refill the cups in the next exploration.⁶

⁵ In this activity, the children do not need to use a lot of materials. To conserve the materials, tell them to use half a spoonful or less of each of the ingredients.

⁶ You will need to plan an orderly way of cleaning up the materials and workstations. Some children like the responsibility of collecting the materials to return to a central point. At the end of each activity, you can appoint a few children to do this.

MAKING UP YOUR OWN RECIPE

EXPLORATION 1

When carrying out⁷ discussions, it is helpful to have children first put away the materials or move to an area where they do not have access to materials.

This will allow a discussion to occur without the distraction of children playing around with materials while others talk.

GUIDING THE EXPLORATION →

LEADING THE DISCUSSION⁷

PART 1

One way of fostering a lively comparison of recipes is to have each team put their recipe and the results of their “taste test” on a large sheet of paper and tape the paper on a wall to see. Each team can reflect on their own results and make a decision on how they would change their recipe. Also encourage them to think about the results of other teams.

- How did the cake turn out for the team that used the most spoonfuls of baking powder?
- How did the cake turn out for the team that used the least spoonfuls of baking powder?
- If a team’s batter started out thick, how did it look after baking?
- If a team’s batter started out thin (liquidy), how did it look after baking?

Go through the list of ingredients, comparing the relative amounts of each and the results that were obtained. The purpose here is to get children to reconsider their recipe in light of their own results and others’.

Once children have completed their first recipe and tasted theirs and the other teams’ cakes, settle them down away from the materials to discuss what they just experienced. How would they modify their own recipes? They should consider the taste and ingredients of the other cakes in the room. Which cake tasted the best and what amounts did that team use for their ingredients? They can learn from each others’ recipes. Tell them to think about how they would change their recipes, as they will have another chance to bake a cake.

PART 2

After all the teams have completed the testing, move them away from the materials. Create a large version of the *Mixing Wet and Dry Ingredients* chart on chart paper. While each team’s reporter gives the results of their test, record these results on the large chart in front of the whole group. Some of the results should be as follows:

- Nothing fizzed with cooking oil.
- Flour and sugar did not fizz with milk.
- Baking powder fizzed with milk.
- The results with eggs were uncertain.

As they saw, baking powder fizzed with milk. Ask them how this might be important for the cakes they are baking. What would happen if there was no baking powder?

MAKING UP YOUR OWN RECIPE

EXPLORATION 1

RATIONALE

Cooking is a very popular activity with children. It offers opportunities to get at some basic science in a tasty way. The first part of the exploration is more about design than inquiry. The goal for the children is to come up with a workable recipe. This necessarily involves some trial and error and some experimenting. With minimal coaching, they can come up with something that may not be a terrific cake but is good enough for eating.

While working with the recipes, children have to think about the proportions of each ingredient and, in doing so, are working with practical math. Ratios and proportions are challenging relationships to understand, so giving children the opportunity to make a recipe will help them see how these relationships can be applied to real-life situations.

The second part of the exploration, involving testing the different ingredients, is more closely related to the scientific process. It is especially so if done in a systematic manner as suggested by the use of a grid (or matrix). The activity opens with the general question, “What makes the cake rise?” As scientific sleuths, children carry out some different tests to find out which ingredient in different recipes causes cakes and breads to rise, and how this ingredient brings about this effect.

SCIENCE/TECHNOLOGY BACKGROUND

Coming up with a recipe for a cake is in some ways like trying to find the right combination of ingredients to bring about a chemical change. If the proportions are just right, you will get the chemical product you want (i.e., the cake will be edible).

Some of the cakes may collapse. There are a number of reasons why this may happen:

- The recipes may have too much liquid.
- There may be too much baking powder.
- There may not be enough egg.

After they have tasted their results, you may want to mention one point. In regular cake recipes, the amount of baking powder is very small compared with the total amount of wet and dry ingredients. For example, for 2 cups (total) of flour and sugar, it is suggested that only 1 or 2 teaspoons of baking powder be used. What does this suggest for the amount of baking powder children should use in their own recipes, considering they use no more than 15 spoonfuls of flour? This can be a way of thinking about proportionality.

At this point, it may not be readily apparent to the children why baking powder is used. You can try to discuss with them what would happen if it was not added to the ingredients. From the testing in Part 2, they saw that it fizzes with milk, making bubbles. You can point out that the wet flour is now dough—a clump of something that can be stretched. If bubbles form inside this stretchy mass, they can cause it to grow or expand.

OBSERVING PROGRESS

The first exploration of this project provides an important occasion for establishing a benchmark by which you can get a sense of what children are getting out of the series of explorations. In most of the activities within this project, children will be measuring ingredients and carrying out operations that require the development of fine motor skills. During the first exploration, observe and listen closely to how the children are working with the materials and how they talk about what they are discovering and observing.

MAKING UP YOUR OWN RECIPE

EXPLORATION 1

Take some notes of what is happening in regard to the extent to which children are not careful in their measuring or if they are having problems manipulating the materials. Also, take note of some of their comments during the follow-up discussion, which reveal their attempted explanations. Then, once you've completed the final exploration in this guide, compare these final manipulations and the children's talk with their original discussions and behaviors. You can also make children aware of their newly gained skills and understanding as they move through the project.

More specifically for this exploration:

During Manipulation of Materials

When measuring out the ingredients, it is important that the children measure out level spoonfuls. In this manner, they can make comparisons to other recipes and make changes in their recipe in a methodical manner. This is important throughout the remaining explorations.

When carrying out the experiment using the matrix in Part 2, watch for the way children add the liquids.

- Do they add too much liquid or not enough?
- Do they wait for a while to see what may happen?

During Discussion

- Do children become aware of trying to balance out the amount of wet ingredients to dry ingredients?
- Do they speculate about the bubbling action and attempt some kind of explanation?